

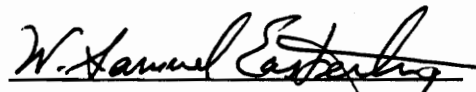
**STANDOFF SCREWS FUNCTIONING AS MECHANICAL SHEAR
CONNECTORS IN COMPOSITE JOISTS**

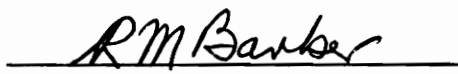
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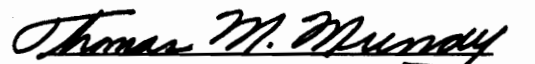
Steven C. Hankins

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APPROVED:


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STANDOFF SCREWS FUNCTIONING AS MECHANICAL SHEAR CONNECTORS IN COMPOSITE JOISTS

by

Steven C. Hankins

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Civil Engineering

(ABSTRACT)

The results of sixty-five double-sided pushout tests utilizing the Elco grade 8, 5/16 in. diameter, standoff screw functioning as a mechanical shear connector are presented. In all tests, the base material, through which the screw was fastened, was fabricated out of back to back angle to simulate the top chord of an open web steel joist. Varied test parameters include: steel deck profile, base angle thickness, screw embedment depth, slab thickness, and slab width. The objectives of the testing were (1) to provide an understanding of the strength of the standoff screw in various test geometries and (2) to provide an understanding of the slip characteristics, or ductility, of the connector.

A review of literature presents several applicable existing welded stud strength models based on post-test observations of failure mechanisms. Modeled failure mechanisms include: concrete splitting, concrete pullout, rib

shear, and stud shear. After applying the existing models to the pushout test data, the following conclusions are drawn: (1) the concrete splitting model developed by Oehlers (1989) can be used to predict the strength of the standoff screw in flat slab geometries and (2) no existing model adequately predicts the strength of the standoff screw in geometries utilizing profiled steel deck. An equation, based on a rederivation of a wedged shaped shear-cone pullout model (Lloyd & Wright 1990), is presented which predicts the strength of the standoff screw in geometries with steel deck with acceptable accuracy.

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*To my loving wife, Jennifer,
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CHAPTER 1

INTRODUCTION

1.1 Background

Composite construction techniques have been utilized in the United States for many years. The primary early use of composite technology was in the design of roadway bridge girders (Sabnis 1979). In more recent years, however, this technology has been applied to building structures in the form of composite beam supported floor systems.

In many instances, an economical alternative to the steel beam is the open web steel joist. The steel joist provides advantages over the steel beam in that it is typically lighter in weight for a given span length and the web openings allow mechanical and electrical conduits to pass directly through the joist thereby reducing total floor depth.

Unlike standardized beam shapes, the steel joist is a built-up section consisting of several separate members composed of angles and/or bars. The built-up nature of the steel joist allows it to be optimized for composite applications. By enlarging the angles of the bottom chord and reducing the angles of the top chord, an efficient section can be designed.

A section is said to be "composite" if sufficient connection is provided to transfer the horizontal shear force at the interface developed due to bending. The typical means of providing mechanical shear connection is through the use of welded headed shear studs attached to the top flange or chord and

subsequently embedded in the concrete deck (Figure 1.1). Welded studs have proven to be effective in composite beam construction, however in short-span (25 ft.-35 ft.) composite joist construction their use is questionable.

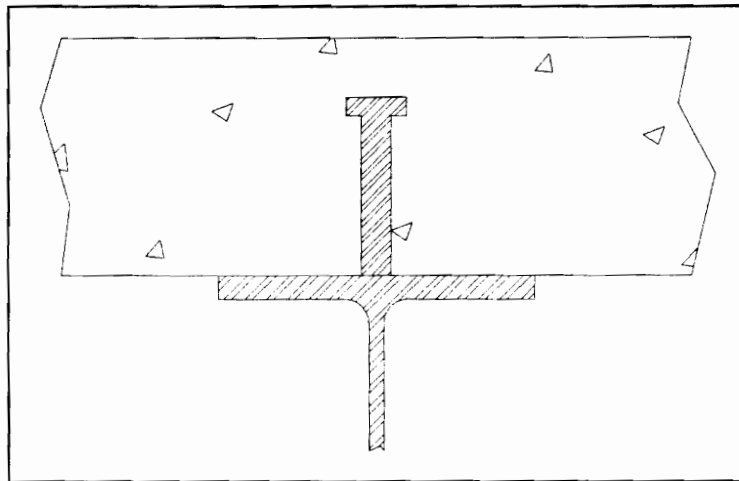


Fig. 1.1 Typical Composite Beam Detail

To develop the full shear strength of the headed stud, the stud diameter to flange thickness ratio must be no greater than 2.5 (*Specifications for 1989*). The small size of the top chord angles in a typical short-span steel joist often make the satisfaction of this requirement difficult.

The method of stud attachment, namely welding, presents another problem. It is difficult to achieve a good quality weld on a thin base angle. Often burn-through occurs resulting in a hole in the top chord of the joist. This problem is magnified when studs are welded through metal floor deck, in which case the welding time or heat must be increased to burn through the deck to effectively fuse the stud to the top chord angle.

To develop an effective means of achieving composite action utilizing short-span open-web steel joists, a research program is in progress at Virginia

Tech to determine the feasibility of the self-drilling, self-tapping, standoff screw functioning as a mechanical shear connector (Figure 1.2). The screw is characterized by a standoff shank (region between the head and the threaded portion) which, after attachment to the joist top chord, is embedded in the concrete slab, thereby providing connection at the joist-slab interface. The small diameter (0.280 in.) of the standoff screw and means of attachment, screwing rather than welding, avoid the problems associated with the welded shear stud. Additionally, the standoff screw is attached with a screw gun, which eliminates the need for trained welders and bulky welding equipment.

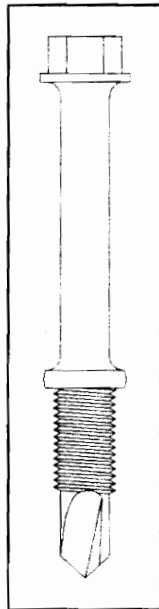


Fig. 1.2 Typical Standoff Screw

1.2 Review of Literature

In the past, much research has been conducted to determine the strength of the welded headed shear stud. Analytical models have been developed by

many to predict the strength of such studs. While many models were developed to fit specific stud test data, they may also be applicable for predicting the strength of the standoff screw. The focus of this literature review is to present several analytical models developed to predict the strength of the headed shear stud based on modes of failure observed in full-scale beam and pushout tests. Models developed to predict the following modes of failure are presented: concrete pullout failure, rib shear failure, stud shear failure, and concrete splitting failure.

1.2.1 Concrete Pullout Failure

Hawkins and Mitchell (1984) conducted thirteen pushout tests of which seven incorporated steel deck profiles oriented transverse to the direction of applied shear. Of these seven tests, five were observed to fail by means of concrete pullout. An analytical model based on the shear-friction concept and a pyramidal approximation of the observed pullout cone failure surface was proposed.

The applied shear force, V_c , produces a slip of the concrete relative to the steel beam section. The slip in return produces a tensile force, T , in the shear stud. This stud tensile force is resisted by a distributed compression force acting along the steel-concrete interface. The applied shear force is resisted by a friction force, μT , where μ is the coefficient of friction of the steel-concrete interface. This mechanism, as illustrated in Fig. 1.3, represents the shear-friction concept introduced by Anderson in 1960 (Hawkins and Mitchell 1984) and yields the following equation for stud strength based on concrete pullout:

$$V_c = \mu T \tag{1.1}$$

where:

V_C = Connector shear strength, kips

μ = Coefficient of friction of the steel-concrete interface

T = Tensile force in connector due to slip, kips

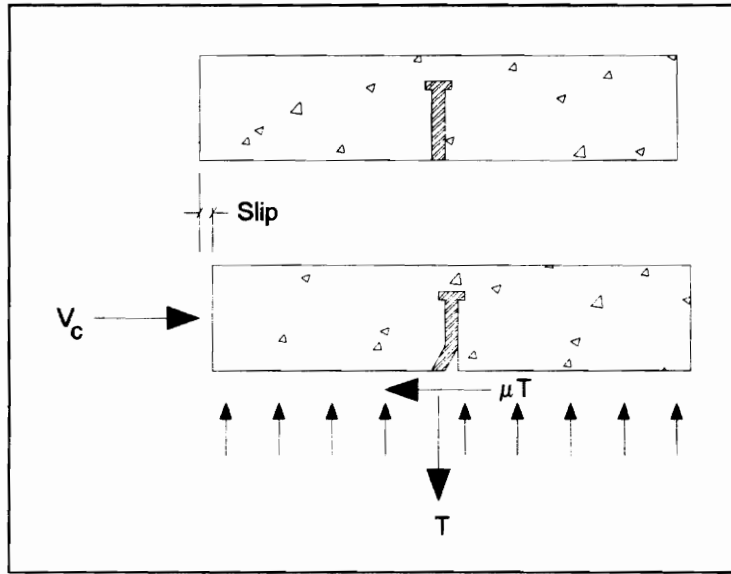


Fig. 1.3 Shear-Friction Concept (after Hawkins and Mitchell 1984)

The stud tensile force, T , was determined by conducting tension pullout tests and was found to be a function of the concrete compressive strength, f'_C , and the area of a 45° pyramid-shaped failure surface, A_C , originating at the top of the stud as illustrated in Fig. 1.4. The pullout failure surface, A_C , is a function of stud height and deck geometry. The following equation approximates the pullout forces obtained in the tension tests:

$$T = 5.56A_C\sqrt{f'_C} \quad (1.2)$$

where:

$$A_C = 2\sqrt{2} \left[2(H_s - h_r)^2 + h_r w_r \right] \quad \text{if: } H_s - h_r > \frac{w_r}{2} \quad (1.3)$$

or:

$$A_c = 2\sqrt{2}(H_s w_r) \quad \text{if: } H_s - h_r < \frac{w_{r2}}{2} \quad (1.4)$$

where:

T = Tensile force in connector due to slip, kips

A_c = Area of pyramidal tensile concrete pullout cone, in.²

f'_c = Concrete compressive strength, psi

h_r = Nominal rib height of steel deck, in.

H_s = Total length of shear connector, in.

w_r = Average concrete rib width, in.

w_{r1} = Concrete rib width at bottom flange of steel deck, in.

w_{r2} = Concrete rib width at top flange of steel deck, in.

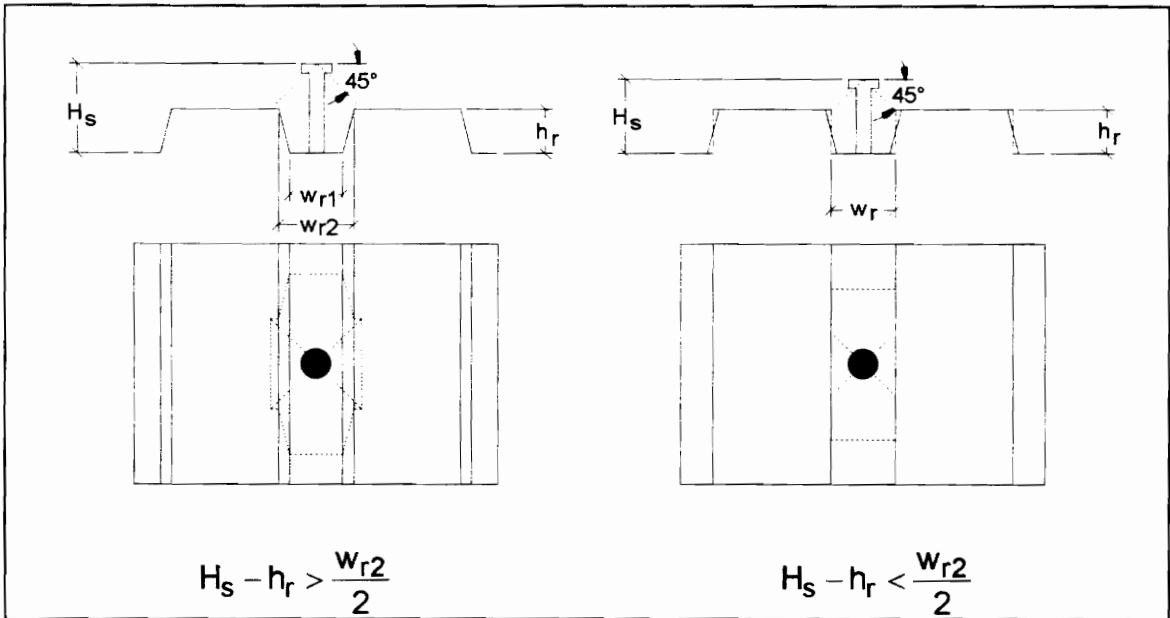


Fig. 1.4 Pyramidal Pullout Surface Areas (after Hawkins and Mitchell 1984)

The coefficient of friction, μ , of the steel-concrete interface was determined experimentally by dividing the shear force obtained in the pushout tests by the

tension force obtained in the pullout tests. A value of 0.97 was suggested for the coefficient of friction which leads to the final form of the pullout strength equation:

$$V_c = 5.4A_c\sqrt{f'_c} \quad (1.5)$$

where:

V_c = Connector shear strength, kips

A_c = Area of pyramidal tensile concrete pullout cone, in.²

f'_c = Concrete compressive strength, psi

Lloyd and Wright (1990) conducted forty-two composite beam pushout tests of which thirty-nine utilized steel deck oriented transverse to the direction of applied load. Thirty-six of the thirty-nine tests were observed to fail by concrete pullout to some degree. An analytical model predicting connector shear strength as a function of the area of a wedge shaped failure surface was presented.

The longitudinal shear force in a composite beam or pushout test will take the "path of least resistance" as indicated in Fig. 1.5 (Lloyd and Wright 1990).

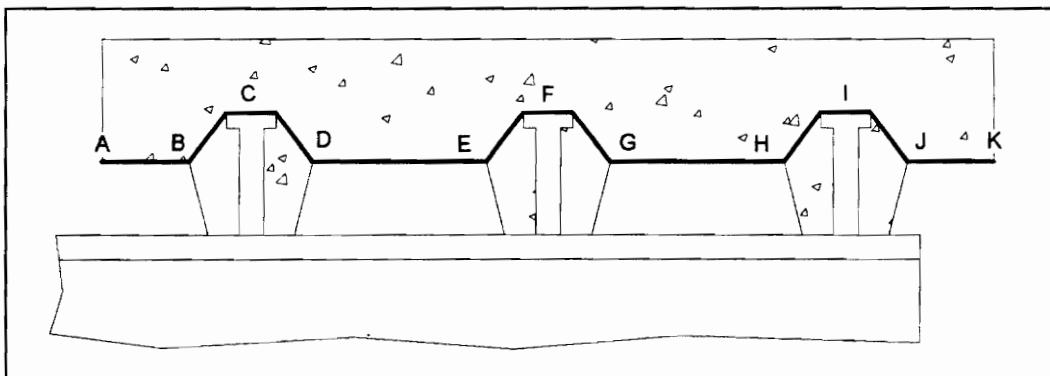


Fig. 1.5 Longitudinal Shear Path (after Lloyd and Wright 1990)

The slope of the failure planes along the longitudinal shear path do not coincide with the 45° failure planes from the pyramidal failure surface model (Hawkins and Mitchell 1984). Likewise, the failure surface observed in the pushout tests appeared to be wedge shaped rather than the symmetrical failure surface proposed by Hawkins and Mitchell. As a result of these observations, a model based on a wedged shaped failure surface was developed.

The wedged shear cone failure surface proposed by Lloyd and Wright is defined in Figure 1.6.

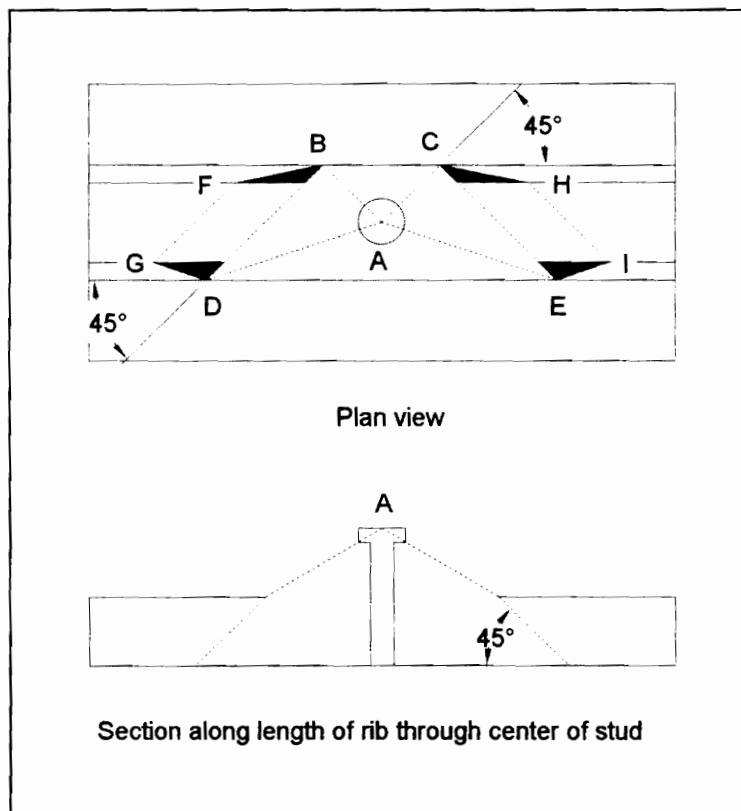


Fig. 1.6 Wedged Shear Cone (after Lloyd and Wright 1990)

Primary shear plane ABC develops along 45° angles from the top center of the shear stud and propagates along the longitudinal shear path presented in Fig.

1.5. Primary shear plane ADE also propagates along the longitudinal shear path and intersects the top flange of the deck at points located by running lines at 45° angles from points B and C. Secondary shear planes, ABD and ACE, are defined by the triangular surfaces connecting the primary shear planes. The secondary shear planes are assumed to propagate through the depth of the concrete rib at a 45° in the direction of the deck span, forming planes BDFG and CEHI.

The following equation (Lloyd and Wright 1990) represents the area of the wedged failure surface if the shaded areas of Fig. 1.6 are ignored:

$$A_{wc} = 2w_{r2}\sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} + w_{r2}\sqrt{w_{r2}^2 + 2(H_s - h_r)^2} + 2w_{r1}\sqrt{3h_r^2} \quad (1.6)$$

where:

A_{wc} = Area of wedge shaped tensile concrete pullout cone, mm²

h_r = Nominal rib height of steel deck, mm

H_s = Total length of shear connector, mm

w_{r1} = Concrete rib width at bottom flange of steel deck, mm

w_{r2} = Concrete rib width at top flange of steel deck, mm

The result of the above equation yields a failure surface area 1.49 to 2.23 times greater than the area resulting from the pyramidal failure surface area given by equations 1.3 and 1.4 and more accurately models the observed failure surface area.

By plotting the logarithm of the ultimate experimental connection resistance, Q_{ult} , versus the logarithm of the wedged-shear-cone failure surface, A_{wc} , multiplied by the square root of the concrete compressive strength, f'_c , a linear relationship was obtained. Based on this linear relationship, the following

equation was presented to predict the connector shear strength based on the wedge shaped concrete pullout surface:

$$V_{wc} = 0.92(A_{wc}\sqrt{f'_c})^{0.349} \quad (1.7)$$

where:

V_{wc} = Connector shear strength, kN

A_{wc} = Area of wedge shaped tensile concrete pullout cone, mm²

f'_c = Concrete compressive strength, N/mm²

1.2.2 Rib Shear Failure

Rib shear was observed to be the controlling mode of failure in one pushout test conducted by Hawkins and Mitchell (1984) and in three pushout tests conducted by Lloyd and Wright (1990). All four tests were constructed with relatively narrow slab widths (24" for the Hawkins and Mitchell test and approximately 18 " for the Lloyd and Wright tests).

Rib shear is similar to pullout in that it involves a concrete failure along the longitudinal shear path, however, rather than forming a conical failure surface, the secondary shear planes propagate along the top of the rib the entire width of the specimen. Thus, rib shear failure is characterized by shearing of the entire concrete rib at a stud location. Because rib shear was observed to be dependent on specimen width, both Hawkins and Mitchell and Lloyd and Wright urge caution in the design of composite edge beams (Fig. 1.7).

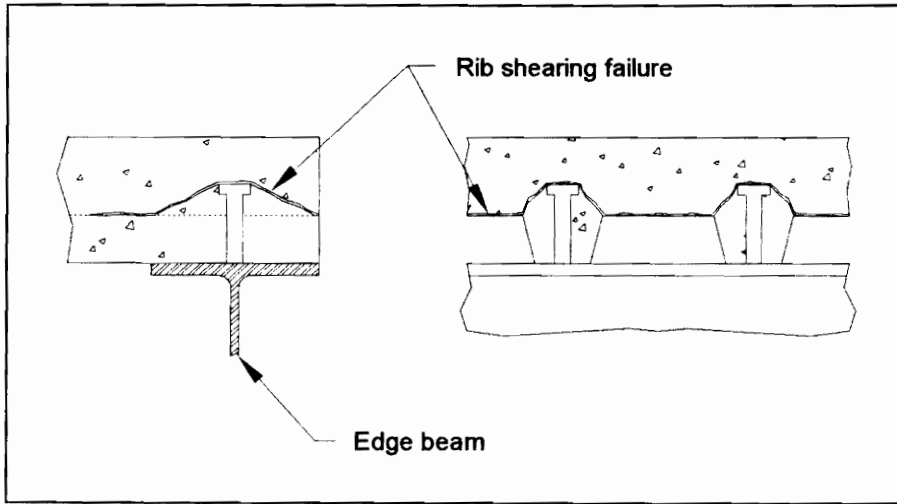


Fig. 1.7 Rib Shear Failure at Edge Beam (after Hawkins and Mitchell 1984)

Lloyd and Wright presented the following equation based on the wedged-shear-cone failure surface area presented in Eq. 1.6 to model the rib shear failure surface area:

$$A_{rs} = w_{r2} \sqrt{\frac{b^2}{4} + (H_s - h_r)^2} + b \sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} \quad (1.8)$$

where:

A_{rs} = Rib shear failure surface area, mm²

b = Pushout specimen slab width, mm

h_r = Nominal rib height of steel deck, mm

H_s = Total length of shear connector, mm

w_{r2} = Concrete rib width at top flange of steel deck, mm

By setting the wedged pullout failure surface area equal to the rib shear failure surface area, the critical specimen width, b_{cr} , below which rib shear is the controlling mode of failure can be determined:

$$b_{cr} = \frac{A_{wc}}{(H_s - h_r)^2} \sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} - \frac{w_{r2}}{2(H_s - h_r)^2} \sqrt{A_{wc}^2 + 4H_s^4} \quad (1.9)$$

where:

b_{cr} = Critical specimen width below which rib shear governs, mm

A_{wc} = Area of wedge shape tensile concrete pullout cone, mm²

h_r = Nominal rib height of steel deck, mm

H_s = Total length of shear connector, mm

w_{r2} = Concrete rib width at top flange of steel deck, mm

At the present time, no adequate model exists by which rib shear failure strength can be predicted (Lloyd and Wright 1990).

1.2.3 Stud Shear Failure

Ollgaard, et al. (1971) conducted 48 solid slab pushout tests to determine the direct shear strength of the welded headed shear stud. Both stud shear and concrete pullout failures were observed.

Following multiple regression analyses, the following empirical equation was proposed to model the direct shear strength of the headed stud:

$$V_s = 1.106 A_{sc} f'_c{}^{0.3} E_c{}^{0.44} \leq A_{sc} F_u \quad (1.10)$$

where:

V_s = Connector shear strength, kips

A_{sc} = Connector cross-sectional area, in.²

f'_c = Concrete compressive strength, ksi

E_c = Concrete modulus of elasticity, ksi

F_u = Connector ultimate tensile strength, ksi

Through analysis of the test data, it was determined that stud shear strength, V_s , is dependent on the strength, f'_c , and Modulus of Elasticity, E_c , of the concrete up to the point where the tensile strength of the stud controls.

Equation 1.10 was simplified by rounding the exponents resulting in the following equation for nominal connector strength:

$$V_s = 0.5A_{sc}\sqrt{f'_c E_c} \leq A_{sc}F_u \quad (1.11)$$

where:

V_s = Connector shear strength, kips

A_{sc} = Connector cross-sectional area, in.²

f'_c = Concrete compressive strength, ksi

E_c = Concrete modulus of elasticity, ksi

F_u = Connector ultimate tensile strength, ksi

Equation 1.11 has become widely accepted and is the basis for stud design using the American Institute of Steel Construction (AISC) specifications (*Load and Resistance Factor Design 1986, Specifications for 1989*).

1.2.4 Concrete Splitting Failure

Oehlers (1989) suggested that the strength of a shear stud may be dependent on the strength and stiffness of the concrete in the triaxial compression zone located directly behind the stud as illustrated in Fig. 1.8. If the concrete in the zone is weakened by the formation of a crack, the triaxial restraint is lost resulting in a lower shear strength for the stud connector (Oehlers 1989; Oehlers and Park 1992).

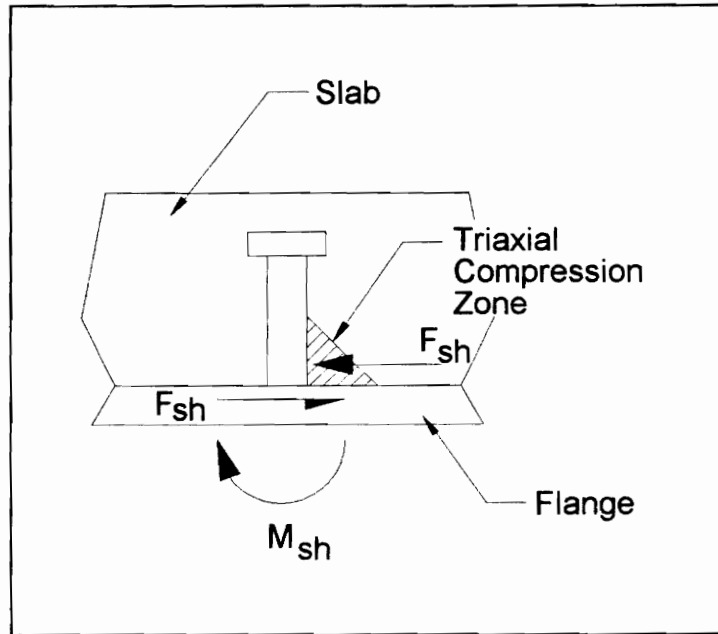


Fig. 1.8 Triaxial Compression Zone (after Oehlers and Park 1992)

Oehlers conducted fifty pushout tests to determine the splitting strength of concrete slabs.

Concrete splitting denotes the formation of a crack running in the direction of applied shear originating behind a shear stud as illustrated in Fig. 1.9. A splitting crack develops as the result of the failure of the slab to resist the relatively large concentrated load transferred to the concrete by the shear stud. The transfer of the concentrated load at the stud-concrete interface results in the introduction of lateral tensile forces in the slab. As the magnitude of the concentrated load increases, the magnitude of the lateral tensile forces also increases until a splitting crack develops (Oehlers 1989).

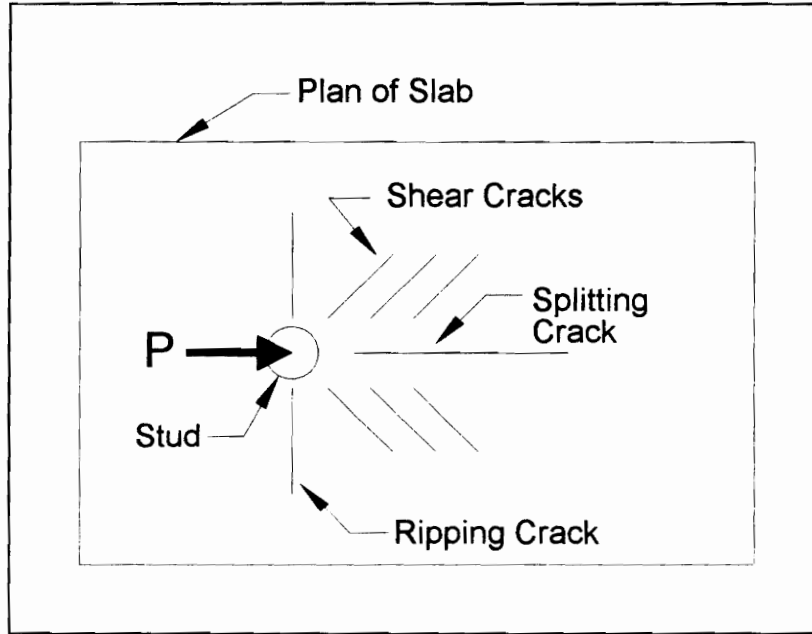


Fig. 1.9 Crack Formation in Slabs (after Oehlers 1990)

By modeling the force transferred by the stud to the concrete as a single concentrated load, the following equation was developed to predict the force at which a splitting crack will develop (Oehlers 1989):

$$P_s = \frac{0.6h_a f_t b \pi}{\left(1 - \frac{d_s}{b}\right)^2} \quad (1.12)$$

where:

P_s = Concentrated connector force resulting in concrete splitting, N

h_a = Effective connector height, $1.8 \times d_s$, mm

f_t = Indirect tensile strength of concrete, N/mm²

b = Pushout specimen slab width, mm

d_s = Connector diameter, mm

Based on observations made following the tests it was determined that the concentrated force, P_s , was not uniformly distributed over the entire stud height, but over an effective height, h_a . Oehlers found that flexible connectors, such as shear studs, tend to concentrate the shear load near the base. A value of $1.8d_s$ was suggested for the effective height of a headed shear stud.

The effect of transverse reinforcement on the splitting strength of concrete slabs was also examined by Oehlers (1989). It was determined that transverse reinforcement does not affect the initiation of a splitting crack however it does limit the propagation of the split. Rather than the sudden loss in stud resistance witnessed in tests with no reinforcement, studs in tests with transverse reinforcement tended to lose resistance gradually.

1.3 Scope of Research

This study evaluates standoff screws functioning as mechanical shear connectors in short-span composite joists. To gain an understanding of the strength, stiffness, and ductility characteristics of standoff screws, seventy-four pushout tests were conducted at the Virginia Tech Structures and Materials Research Laboratory. The varied test parameters include: base angle thickness, slab thickness, deck profile, specimen width, screw type, and standoff length.

The work contained herein is a continuation of studies undertaken by Lauer (1994) to determine the feasibility of a short-span composite joist system. Lauer reported the results of eight full-scale composite joist tests utilizing various mechanical shear connectors. Shear connection in three of the eight tests was

provided by standoff screws. Based on the results of these three tests, it was decided that the standoff screw connector warranted further study.

Typical short-span joists utilize lightweight angle and/or bar members. Due to the lightweight nature of such joists, conventional means of mechanical connection, i.e. headed shear studs, are impractical. To satisfy stud diameter to base thickness requirements set forth by AISC (*Specifications for 1989*) the engineer must specify a heavy top chord angle size resulting in an inefficient and uneconomical joist design. Also, as observed in the full-scale tests, it is difficult to obtain a good quality weld on thin base material.

The standoff screw, due to its small diameter and means of installation, screwing rather than welding, is free from the problems associated with the use of the headed shear stud. This study is concerned with the performance of the standoff screw functioning as a mechanical shear connector in specimens of varying base angle thickness and deck geometry. The pushout test was selected as the experimental method due to its simplicity and the ability to conduct numerous tests on a variety of parameters in a timely fashion.

Detailed information on the specimen configurations and test setup is given in Chapter 2. A summary of the results of the seventy-four pushout tests is presented in Chapter 3. The results of the tests, as compared to several existing stud strength models, are presented in Chapter 4. Conclusions, recommendations, and limitations are presented in Chapter 5. Individual test results and data are contained in Appendix A and Appendix B. Sample calculations of the prediction models are presented in Appendix C.

CHAPTER 2

SPECIMEN CONFIGURATION AND TEST PROCEDURE

2.1 Specimen Designation

Each pushout test is numbered by a three digit series, e.g. 3-2-1. The first term represents the series number, 1 through 5. The second term denotes the series group number, 1 through 6. The final term represents the test number, 1 through 4. Tests in the preliminary series are denoted by P in the first term of the test number.

The pushout specimens are further identified by a configuration series, e.g. SC-8-2-0.245-1.5VL-4-2. The first term identifies the connector type; SC denotes standoff screw. The second term represents the standoff screw type: a B denotes the Buildex standoff screw, an 8 or 5 denotes the Elco grade 8 or grade 5 standoff screw respectively. The third term denotes the standoff length in inches: 1.5, 2, or 2.5. The fourth term represents the measured base angle thickness in inches. The fifth term identifies the Vulcraft deck profile: S (denotes solid slab, i.e. no deck), 0.6C, 1.0C, or 1.5VL. The sixth term denotes the slab depth in inches. The final term identifies the test number (the third term in the test number series).

2.2 General

The performance of three types of standoff screws is evaluated in this study. The three types utilized are the Buildex , Elco grade 5, and the Elco grade 8 standoff screws. The performance of the three standoff screws functioning as mechanical shear connectors in composite joists is determined from pushout tests. The pushout test has been used for many years to directly evaluate the performance characteristics of mechanical shear connectors. A typical composite beam pushout specimen is illustrated in Figure 2.1.

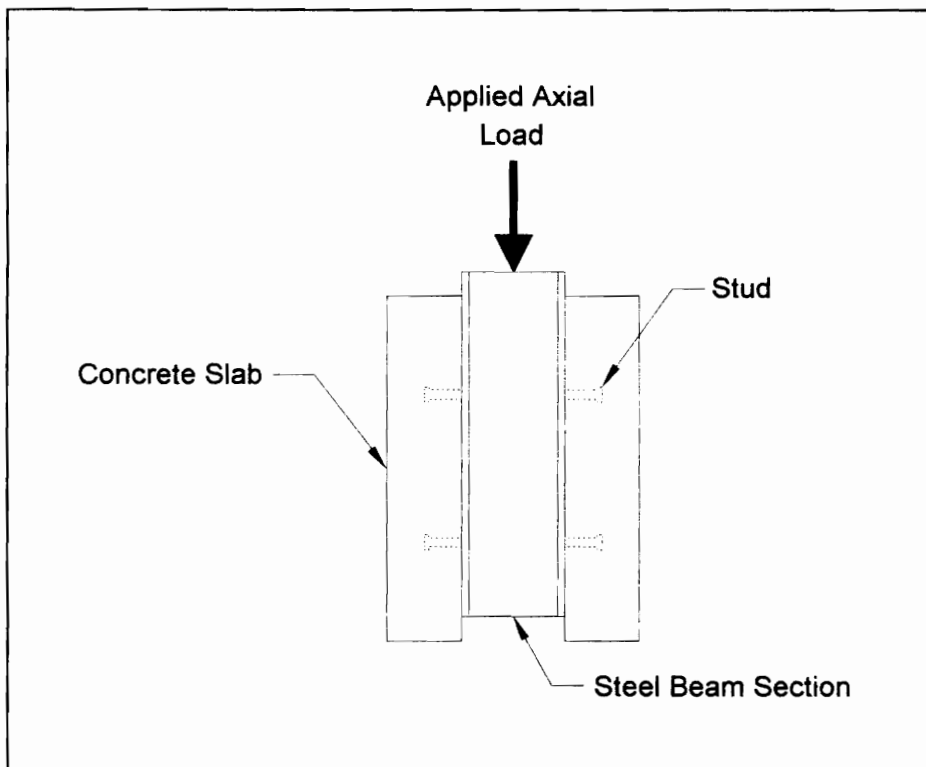


Fig. 2.1 Typical Composite Beam Pushout Specimen

The horizontal shear force at the steel-concrete interface in a full-scale composite beam, or joist, is modeled as an axial load applied directly to the

beam, or chord, members of the pushout test. This applied load is resisted by the shear connectors embedded in the concrete slabs.

The preliminary series of tests was used to evaluate the three screw types on a comparative basis. Based on the results of the preliminary series, five additional series of tests were conducted to determine the performance of the Elco grade 8 standoff screw. The Elco grade 8 screw with a 1.5 in., 2 in., and 2.5 in. standoff length was evaluated (Figure 2.2).

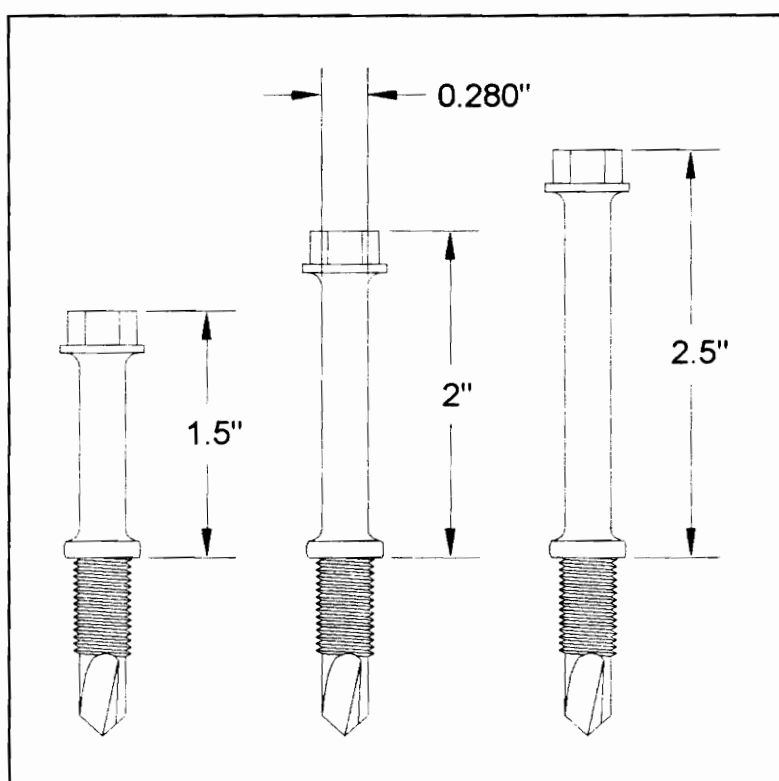


Fig. 2.2 Screws with Various Standoff Lengths

2.3 Specimen Configuration

This section details the general construction and fabrication of the seventy-four composite joist pushout specimens.

The steel component of the pushout specimen was fabricated to model a joist top chord. Equal leg angles were welded back to back at a 1/2 in. spacing provided by filler plates. The longitudinal spacing between filler plates was chosen to approximate the panel widths of a typical open web steel joist. The fabrication details of the top chord section are illustrated in Figure 2.3.

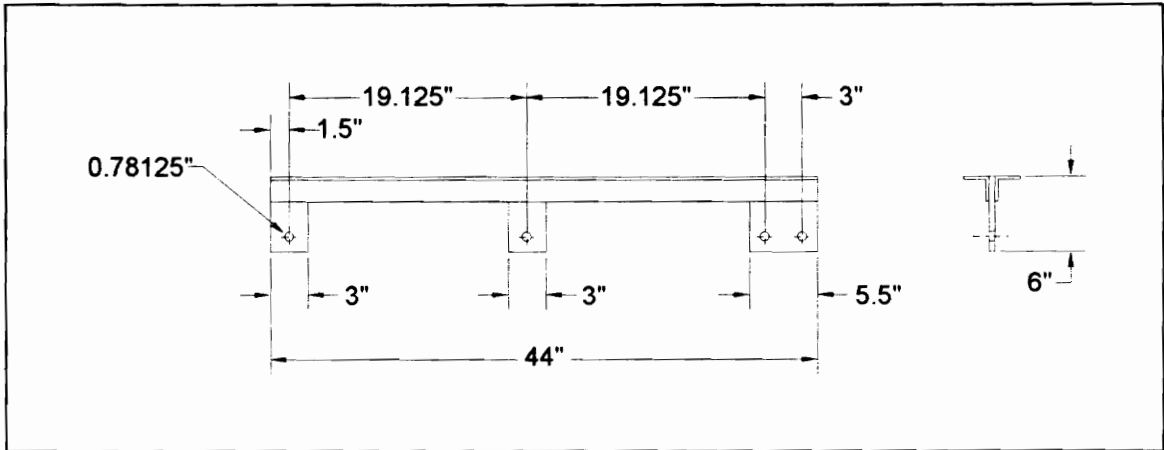


Fig. 2.3 Typical Top Chord Section

The top chord sections were placed in wooden forms in a horizontal position. A 1.5 in. offset was provided between the end of the top chord section and the formed edge of the slab to allow for slip of the steel section relative to the concrete slab. If required in the series configuration, steel deck was placed atop the angle section. Details of the various deck configurations are shown in Figure 2.4. The standoff screws were then attached in a staggered pattern in the number and spacing specified in the individual series configuration. The screws were located in the center of the angle leg in all tests. Welded wire fabric (WWF 6x6-W1.4xW1.4) was then placed in the forms.

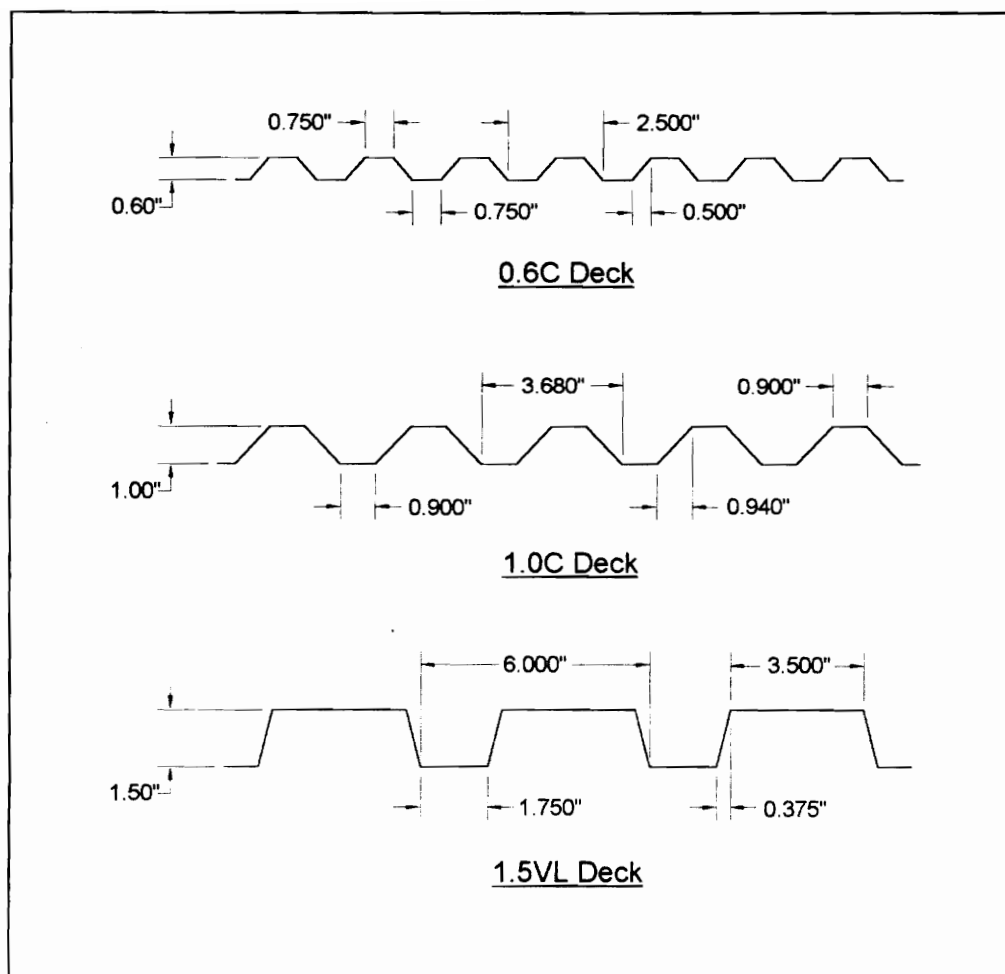


Fig. 2.4 Vulcraft Deck Profiles

Concrete was placed in the form and vibrated with a spud-type vibrator to minimize the formation of voids in the slab. Concrete test cylinders were made and allowed to cure with the specimens. The pushout specimens and cylinders were covered with a plastic sheet and moist cured for seven days. After the concrete had cured sufficiently, the specimen and cylinder forms were stripped. The specimen halves were then matched and bolted together. The pushout specimens and cylinders were air cured until testing.

2.3.1 Preliminary Series Configuration

The preliminary pushout series consisted of nine tests and was conducted to compare the performance of the three types of standoff connectors (Buildex, Elco grade 5, and Elco grade 8). One group of three specimens was constructed for each of the three standoff screw types.

The top chord section of all tests was fabricated out of 1.50 in. $\times$ 1.50 in. $\times$ 0.123 in. angle with a minimum specified tensile yield stress of 50 ksi. The deck used for all tests was Vulcraft 1.0C, 26 ga., with the ribs oriented transverse to the direction of applied axial load. Three 2 in. standoff screws were provided per specimen half and were placed in a staggered pattern which resulted in two screws on one angle and the third screw on the adjacent angle. The location of the screws is illustrated in Figure 2.5. The specimens were constructed with a 36 in. long by 36 in. wide by 4 in. thick (total thickness) slab. Concrete with a minimum specified compressive stress of 3 ksi was used. Preliminary series test configurations are summarized in Table 2.1.

Table 2.1 Preliminary Series Configuration

Test Number	Top Chord Section (in.)	Deck Type	Connector Type	Slab Length (in.)	Slab Width (in.)	Slab Thick. (in.)
P-1-1	2L 1.50 $\times$ 1.50 $\times$ 0.123	1.0C, 26ga.	2" Buildex	36	36	4
P-1-2	2L 1.50 $\times$ 1.50 $\times$ 0.123	1.0C, 26ga.	2" Buildex	36	36	4
P-1-3	2L 1.50 $\times$ 1.50 $\times$ 0.123	1.0C, 26ga.	2" Buildex	36	36	4
P-2-1	2L 1.50 $\times$ 1.50 $\times$ 0.123	1.0C, 26ga.	2" Elco grade 5	36	36	4
P-2-2	2L 1.50 $\times$ 1.50 $\times$ 0.123	1.0C, 26ga.	2" Elco grade 5	36	36	4
P-2-3	2L 1.50 $\times$ 1.50 $\times$ 0.123	1.0C, 26ga.	2" Elco grade 5	36	36	4
P-3-1	2L 1.50 $\times$ 1.50 $\times$ 0.123	1.0C, 26ga.	2" Elco grade 8	36	36	4
P-3-2	2L 1.50 $\times$ 1.50 $\times$ 0.123	1.0C, 26ga.	2" Elco grade 8	36	36	4
P-3-3	2L 1.50 $\times$ 1.50 $\times$ 0.123	1.0C, 26ga.	2" Elco grade 8	36	36	4

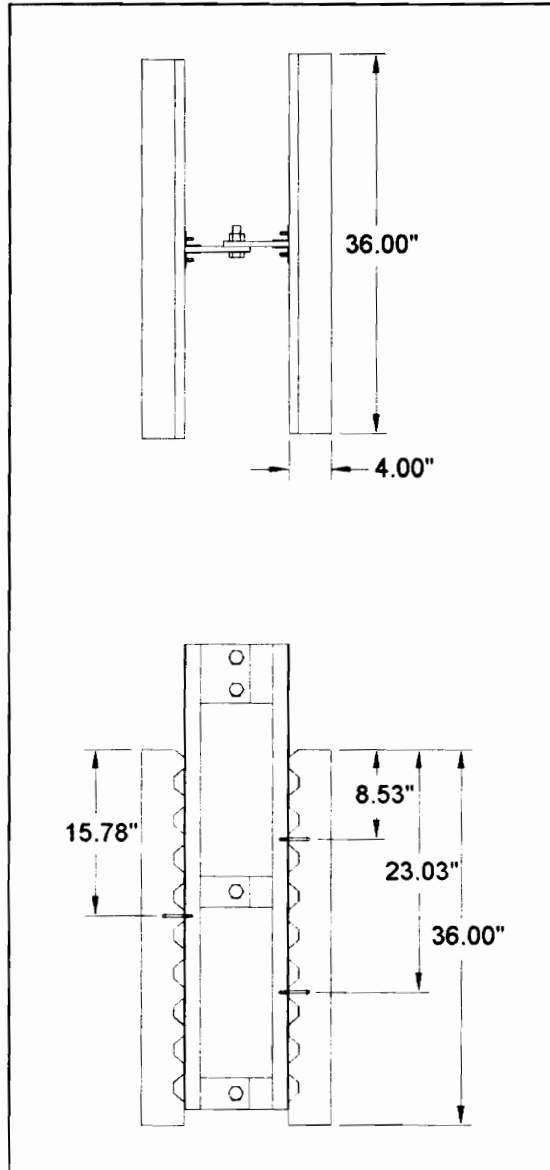


Fig. 2.5 Preliminary Series Pushout Specimen

2.3.2 Series 1 Configuration

Pushout series 1 consisted of six groups totaling twenty tests and was conducted to evaluate the performance of the Elco grade 8 screw with a 2 in.

standoff in specimens with solid slabs (i.e. no deck) and varying top chord sections.

Parameters common to all tests in the series include: 50 ksi minimum specified yield stress for the top chord sections; four, Elco grade 8, 2 in. standoff screws per specimen half placed in a staggered pattern and located according to Fig. 2.6; placement of a 5 in. wide section of flat sheet atop the angle section to prevent bonding of the steel and concrete; the use of 1 in. steel chairs to support the welded wire fabric off the formed slab face; solid slab sections measuring 36 in. long by 36 in. wide with a minimum specified compressive stress of 3 ksi. A configuration summary for all series 1 tests is presented in Table 2.2.

Table 2.2 Series 1 Configuration

Test Number	Top Chord Section (in.)	Deck Type	Connector Type	Slab Length (in.)	Slab Width (in.)	Slab Thick. (in.)
1-1-1	2L 1.25×1.25×0.109	None	2" Elco grade 8	36	36	4
1-1-2	2L 1.25×1.25×0.109	None	2" Elco grade 8	36	36	4
1-1-3	2L 1.25×1.25×0.109	None	2" Elco grade 8	36	36	4
1-2-1	2L 1.50×1.50×0.123	None	2" Elco grade 8	36	36	4
1-2-2	2L 1.50×1.50×0.123	None	2" Elco grade 8	36	36	4
1-2-3	2L 1.50×1.50×0.123	None	2" Elco grade 8	36	36	4
1-3-1	2L 1.50×1.50×0.170	None	2" Elco grade 8	36	36	4
1-3-2	2L 1.50×1.50×0.170	None	2" Elco grade 8	36	36	4
1-3-3	2L 1.50×1.50×0.170	None	2" Elco grade 8	36	36	4
1-3-4	2L 1.50×1.50×0.170	None	2" Elco grade 8	36	36	4
1-4-1	2L 2.00×2.00×0.205	None	2" Elco grade 8	36	36	4
1-4-2	2L 2.00×2.00×0.205	None	2" Elco grade 8	36	36	4
1-4-3	2L 2.00×2.00×0.205	None	2" Elco grade 8	36	36	4
1-5-1	2L 2.00×2.00×0.238	None	2" Elco grade 8	36	36	4
1-5-2	2L 2.00×2.00×0.238	None	2" Elco grade 8	36	36	4
1-5-3	2L 2.00×2.00×0.238	None	2" Elco grade 8	36	36	4
1-6-1	2L 1.50×1.50×0.170	None	2" Elco grade 8	36	36	2.5
1-6-2	2L 1.50×1.50×0.170	None	2" Elco grade 8	36	36	2.5
1-6-3	2L 1.50×1.50×0.170	None	2" Elco grade 8	36	36	2.5
1-6-4	2L 1.50×1.50×0.170	None	2" Elco grade 8	36	36	2.5

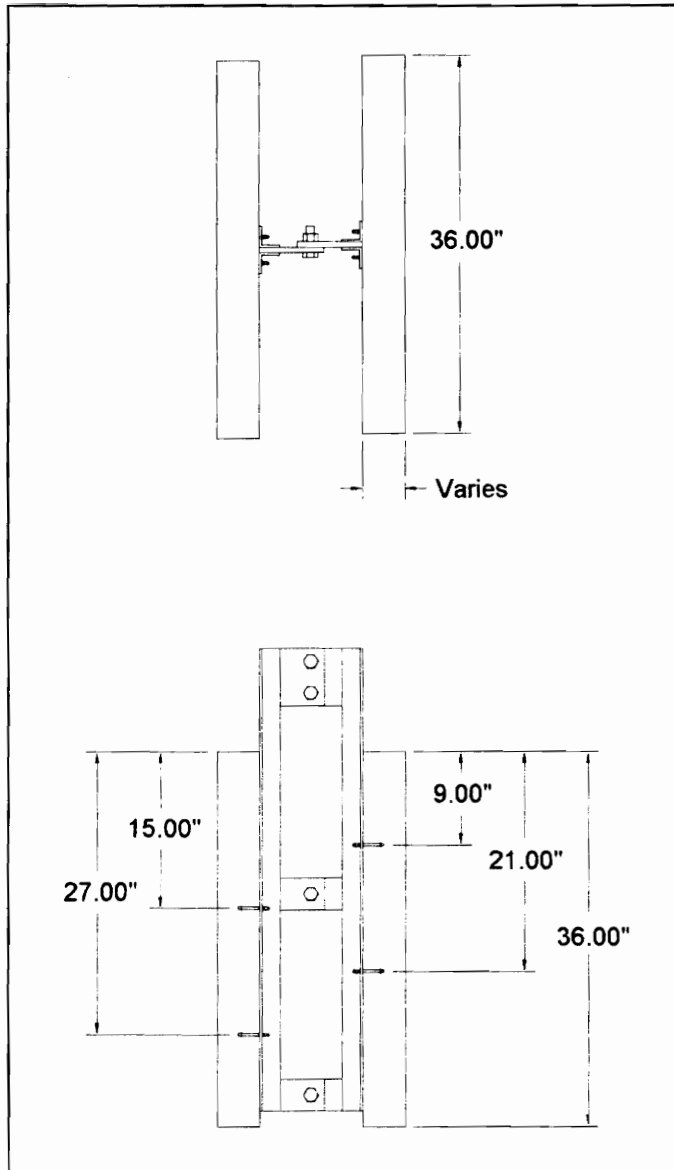


Fig. 2.6 Series 1 Pushout Specimen

2.3.3 Series 2 Configuration

Pushout series 2 was comprised of twelve tests and was conducted to determine the performance of the Elco, grade 8, 1.5 in. standoff screw in

Vulcraft 0.6C deck (Fig. 2.4). One group of three tests was constructed for each of four varying base angle thicknesses.

The test parameters include: 50 ksi minimum specified yield stress for the top chord sections; four, Elco grade 8, 1.5 in. standoff screws per specimen half placed in a staggered pattern and located as illustrated in Fig. 2.7; 0.6C deck, 28 ga., with the ribs oriented perpendicular to the direction of applied axial load; 36 in. long by 24 in. wide by 2 in. thick (total thickness) slab sections with a minimum specified compressive stress of 3 ksi. A summary of the configuration of the series 2 specimens is presented in Table 2.3.

Table 2.3 Series 2 Configuration

Test Number	Top Chord Section (in.)	Deck Type	Connector Type	Slab Length (in.)	Slab Width (in.)	Slab Thick. (in.)
2-1-1	2L 1.25×1.25×0.109	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2
2-1-2	2L 1.25×1.25×0.109	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2
2-1-3	2L 1.25×1.25×0.109	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2
2-2-1	2L 1.50×1.50×0.155	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2
2-2-2	2L 1.50×1.50×0.155	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2
2-2-3	2L 1.50×1.50×0.155	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2
2-3-1	2L 2.00×2.00×0.205	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2
2-3-2	2L 2.00×2.00×0.205	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2
2-3-3	2L 2.00×2.00×0.205	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2
2-4-1	2L 2.00×2.00×0.250	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2
2-4-2	2L 2.00×2.00×0.250	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2
2-4-3	2L 2.00×2.00×0.250	0.6C, 28 ga.	1.5" Elco grade 8	36	24	2

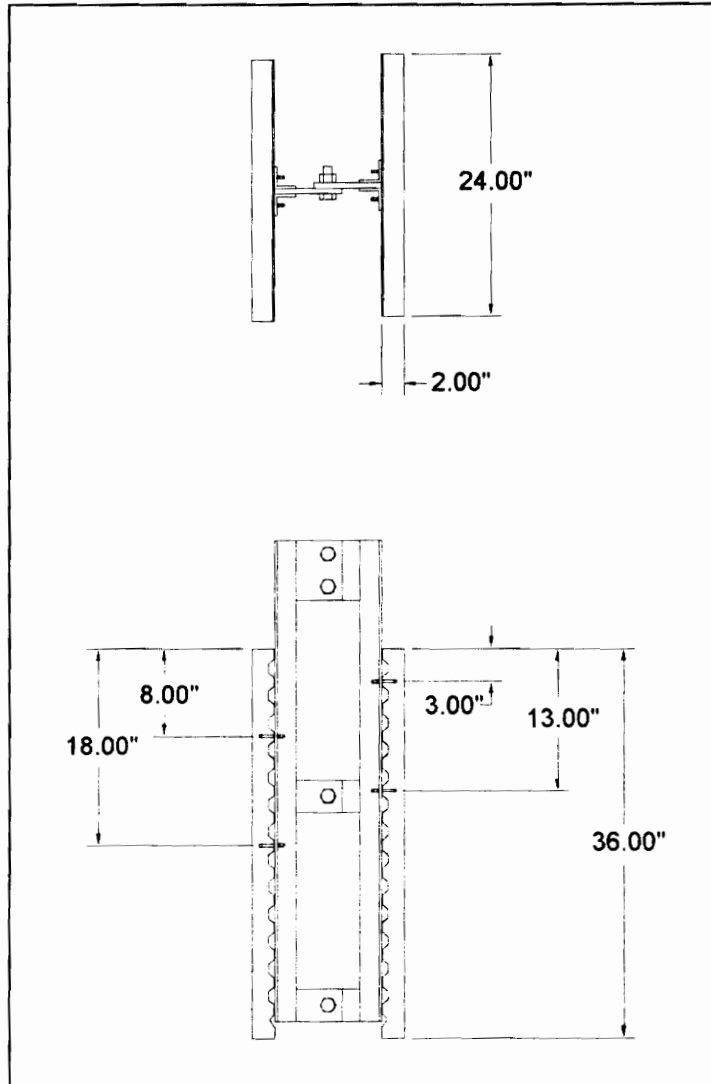


Fig. 2.7 Series 2 Pushout Specimen

2.3.4 Series 3 Configuration

Pushout series 3 consisted of twelve tests and was conducted to determine the performance of the Elco, grade 8, 2 in. standoff screw in Vulcraft 1.0C deck (Fig. 2.4). One group of three tests was constructed for each of four varying base angle thicknesses.

The test parameters include: 50 ksi minimum specified yield stress for the top chord sections; four, Elco grade 8, 2 in. standoff screws per specimen half placed in a staggered pattern and located according to Fig. 2.8; 1.0C deck, 26 ga., with the ribs oriented perpendicular to the direction of applied axial load; 36 in. long by 36 in. wide by 2.5 in. thick (total thickness) slab sections with a minimum specified compressive stress of 3 ksi. A summary of the configuration of the series 2 specimens is presented in Table 2.4.

Table 2.4 Series 3 Configuration

Test Number	Top Chord Section (in.)	Deck Type	Connector Type	Slab Length (in.)	Slab Width (in.)	Slab Thick. (in.)
3-1-1	2L 1.25×1.25×0.109	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5
3-1-2	2L 1.25×1.25×0.109	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5
3-1-3	2L 1.25×1.25×0.109	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5
3-2-1	2L 1.50×1.50×0.155	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5
3-2-2	2L 1.50×1.50×0.155	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5
3-2-3	2L 1.50×1.50×0.155	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5
3-3-1	2L 2.00×2.00×0.205	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5
3-3-2	2L 2.00×2.00×0.205	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5
3-3-3	2L 2.00×2.00×0.205	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5
3-4-1	2L 2.00×2.00×0.250	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5
3-4-2	2L 2.00×2.00×0.250	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5
3-4-3	2L 2.00×2.00×0.250	1.0C, 26 ga.	2" Elco grade 8	36	36	2.5

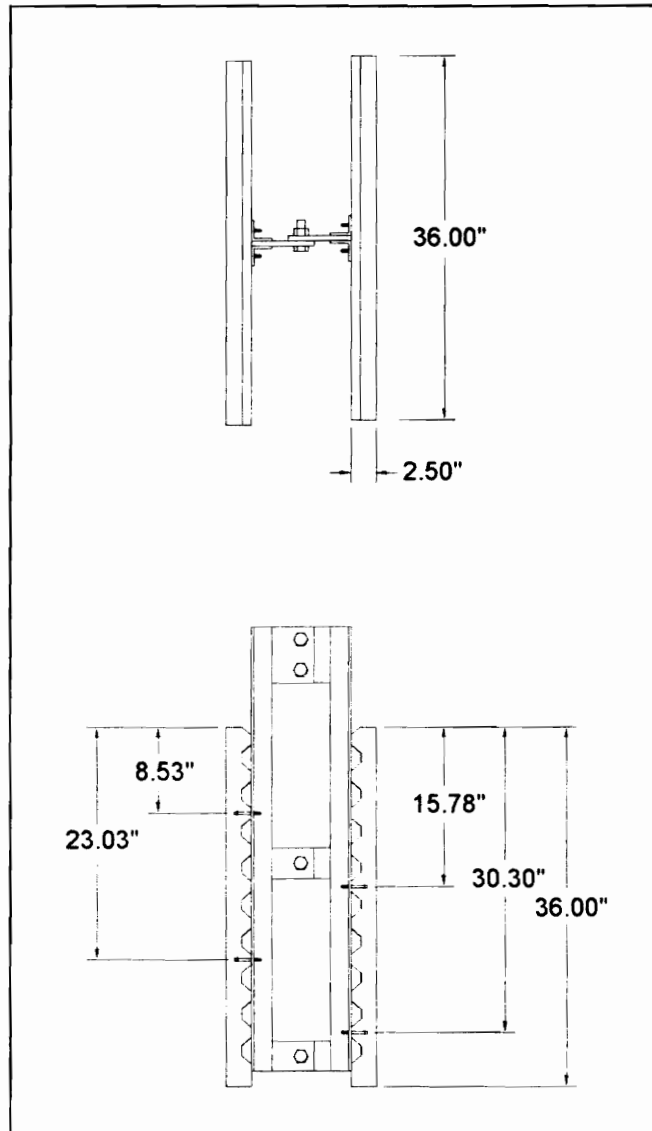


Fig. 2.8 Series 3 Pushout Specimen

2.3.5 Series 4 Configuration

Pushout series 4 consisted of four groups totaling twelve tests and was conducted to evaluate the performance of the Elco grade 8 screw with a 2 in. standoff in Vulcraft 1.5VL deck (Fig. 2.4).

The common test parameters include: 50 ksi minimum specified yield stress for the top chord sections; four, Elco grade 8, 2 in. standoff screws per specimen half placed in a staggered pattern and located according to Fig. 2.9; 1.5VL deck, 22 ga., with the ribs oriented perpendicular to the direction of applied axial load; 36 in. long by 36 in. wide slab sections of varying thickness with a minimum specified compressive stress of 3 ksi. The series 4 configuration summary is presented in Table 2.5.

Table 2.5 Series 4 Configuration

Test Number	Top Chord Section (in.)	Deck Type	Connector Type	Slab Length (in.)	Slab Width (in.)	Slab Thick. (in.)
4-1-1	2L 1.25×1.25×0.109	1.5VL, 22 ga.	2" Elco grade 8	36	36	4
4-1-2	2L 1.25×1.25×0.109	1.5VL, 22 ga.	2" Elco grade 8	36	36	4
4-1-3	2L 1.25×1.25×0.109	1.5VL, 22 ga.	2" Elco grade 8	36	36	4
4-2-1	2L 1.50×1.50×0.155	1.5VL, 22 ga.	2" Elco grade 8	36	36	4
4-2-2	2L 1.50×1.50×0.155	1.5VL, 22 ga.	2" Elco grade 8	36	36	4
4-2-3	2L 1.50×1.50×0.155	1.5VL, 22 ga.	2" Elco grade 8	36	36	4
4-3-1	2L 2.00×2.00×0.243	1.5VL, 22 ga.	2" Elco grade 8	36	36	4
4-3-2	2L 2.00×2.00×0.245	1.5VL, 22 ga.	2" Elco grade 8	36	36	4
4-3-3	2L 2.00×2.00×0.239	1.5VL, 22 ga.	2" Elco grade 8	36	36	4
4-4-1	2L 2.00×2.00×0.252	1.5VL, 22 ga.	2" Elco grade 8	36	36	3.5
4-4-2	2L 2.00×2.00×0.252	1.5VL, 22 ga.	2" Elco grade 8	36	36	3.5
4-4-3	2L 2.00×2.00×0.252	1.5VL, 22 ga.	2" Elco grade 8	36	36	3.5

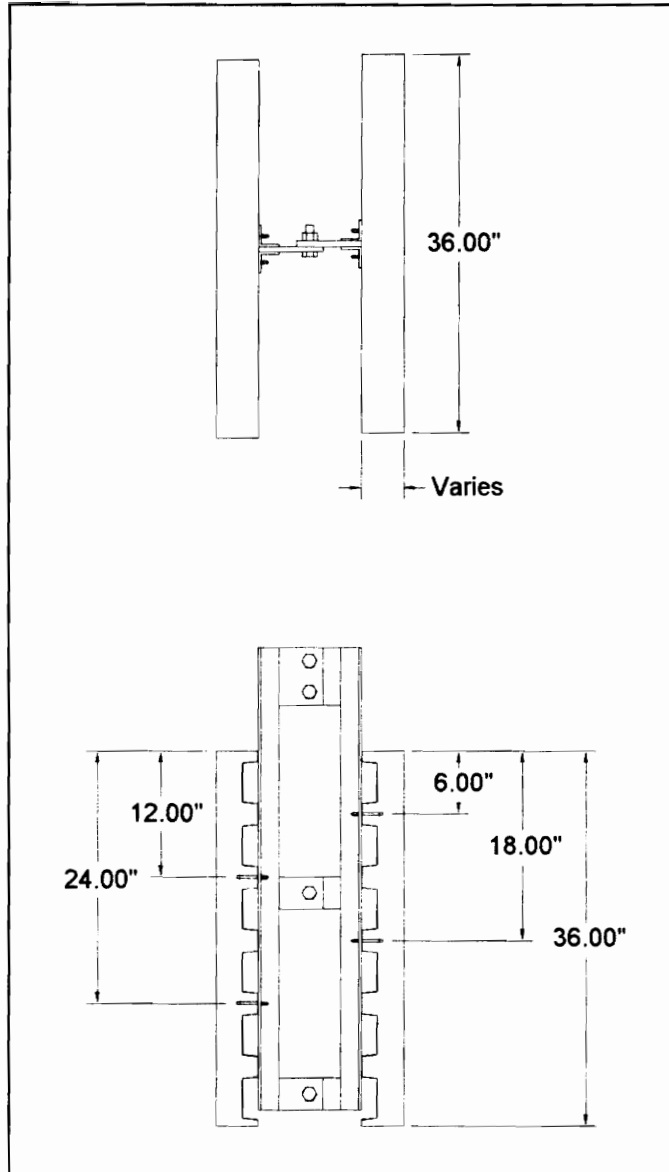


Fig. 2.9 Series 4 Pushout Specimen

2.3.6 Series 5 Configuration

Pushout series 5 consisted of nine tests and was conducted to determine the performance of the Elco, grade 8, 2.5 in. standoff screw in Vulcraft 1.5VL

deck (Fig. 2.4). One group of three tests was constructed for each of three varying base angle thicknesses.

The test parameters include: 50 ksi minimum specified yield stress for the top chord sections; four, Elco grade 8, 2.5 in. standoff screws per specimen half placed in a staggered pattern and located according to Fig. 2.10; 1.5VL deck, 22 ga., with the ribs oriented perpendicular to the direction of applied axial load; 36 in. long by 36 in. wide by 3.5 in. thick (total thickness) slab sections with a minimum specified compressive stress of 3 ksi. A summary of the configuration of the series 5 specimens is presented in Table 2.6.

Table 2.6 Series 5 Configuration

Test Number	Top Chord Section (in.)	Deck Type	Connector Type	Slab Length (in.)	Slab Width (in.)	Slab Thk. (in.)
5-1-1	2L 1.25×1.25×0.109	1.5VL, 22 ga.	2.5" Elco grade 8	36	36	3.5
5-1-2	2L 1.25×1.25×0.109	1.5VL, 22 ga.	2.5" Elco grade 8	36	36	3.5
5-1-3	2L 1.25×1.25×0.109	1.5VL, 22 ga.	2.5" Elco grade 8	36	36	3.5
5-2-1	2L 1.50×1.50×0.155	1.5VL, 22 ga.	2.5" Elco grade 8	36	36	3.5
5-2-2	2L 1.50×1.50×0.155	1.5VL, 22 ga.	2.5" Elco grade 8	36	36	3.5
5-2-3	2L 1.50×1.50×0.155	1.5VL, 22 ga.	2.5" Elco grade 8	36	36	3.5
5-3-1	2L 2.00×2.00×0.205	1.5VL, 22 ga.	2.5" Elco grade 8	36	36	3.5
5-3-2	2L 2.00×2.00×0.205	1.5VL, 22 ga.	2.5" Elco grade 8	36	36	3.5
5-3-3	2L 2.00×2.00×0.205	1.5VL, 22 ga.	2.5" Elco grade 8	36	36	3.5

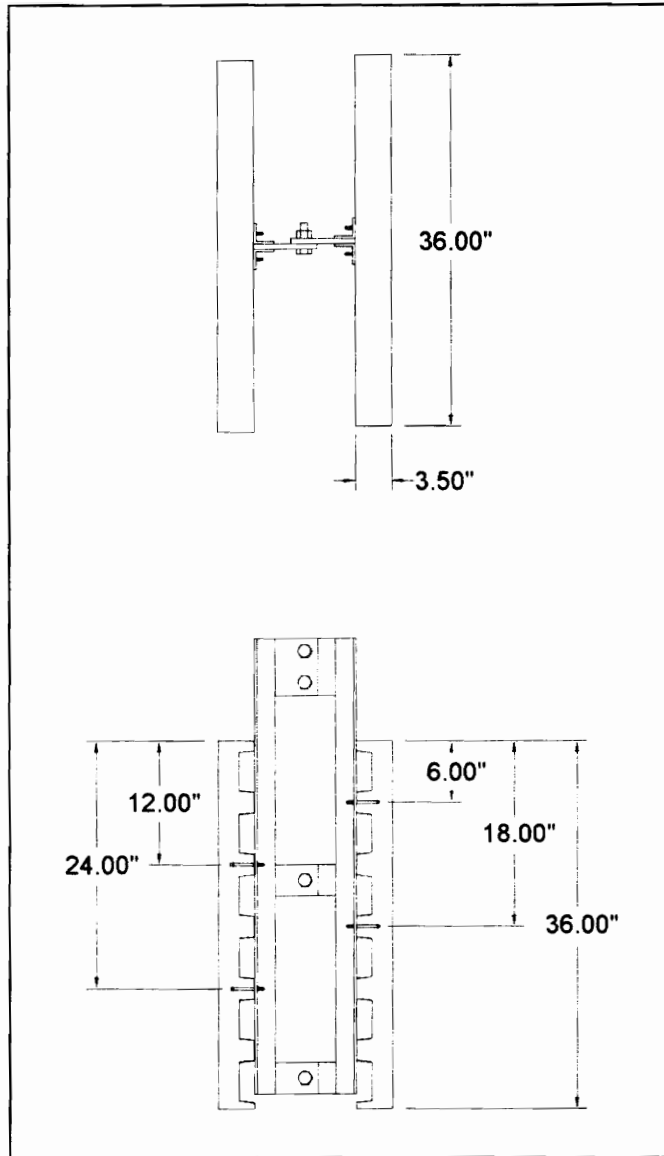


Fig. 2.10 Series 5 Pushout Specimen

2.4 Test Setup

The test setup for all seventy-four pushout tests was identical. The test specimen was placed upright in a load frame composed of structural steel members. The base of each slab rested on a 1 in. elastomeric bearing pad

resting on the reaction floor. The elastomeric pads insured a uniform loading in the concrete slabs. The protruding end of the top chord section was ground down to provide a level loading surface. A loading plate, used to equally distribute the applied axial load to both halves of the specimen, was placed atop the top chord section.

To more accurately model the load mechanism of a full-scale composite joist and to prevent the slabs from separating laterally from the steel section in later stages of loading, a normal load apparatus was placed around the specimen. The apparatus consisted of two vertical spreader beams centered on the top chord sections of the test specimen and surrounded by a distribution frame. The frame equally distributed the normal load, supplied by a hydraulic ram, to each side of the pushout specimen. A heavy canvas strap was placed between the spreader beams and specimen slabs to provide an even contact surface. The beams were supported by 1 in. steel plates during the initial loading stage. Once a normal force capable of holding the distribution beams against the slab face was reached (approximately 1500 lb.) the plates were removed. A typical pushout test setup is illustrated in Fig. 2.11.

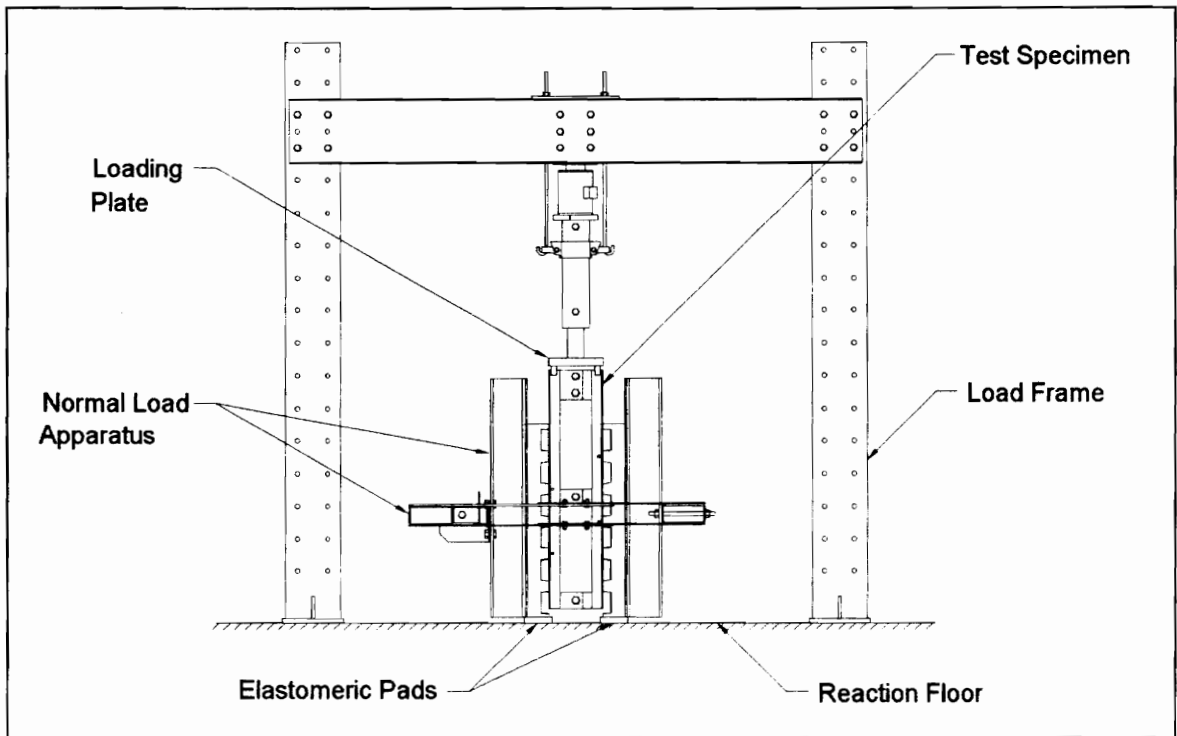


Fig. 2.11 Typical Test Setup

2.5 Instrumentation and Test Procedure

To provide the basis for an understanding of the stiffness and ductility of the standoff screw connectors, slip of the steel top chord section relative to the concrete slabs was measured in all tests. Relative slips were measured at each standoff screw location.

Holes measuring $5/32$ in. diameter by approximately 1 in. deep were drilled in the slabs next to each screw location. In test specimens configured with steel deck, a $3/4$ in. diameter hole was drilled through the deck at each screw location before the concrete was placed. Care was taken to insure that the slabs were not damaged. Vinyl anchors were placed in each hole. A nail was tapped into each anchor and left protruding out of the slab surface. Linear transducers (or

potentiometers) with a 6 in. stroke were clamped to the top chord section (one transducer per standoff screw). The shaft of each potentiometer was extended and clamped to the corresponding nail by means of a nut and washer. Cables wired into the data acquisition system were then connected to the transducers.

The axial, or shear, force was applied to the test specimen by means of a hydraulic ram driven by an electric pump. The magnitude of the applied load was measured with a compression load cell (Fig. 2.12).

The normal force was supplied by a hydraulic ram driven by a hand pump. The magnitude of the normal force was measured with a compression load cell (Fig. 2.12).

The loading method was identical in all of the pushout tests. First, a normal force of approximately 10% of the target shear force was applied to the specimen. Following the application of the normal load, the direct shear load was applied. The system was given time to "settle in" before taking a data reading and proceeding to the next target load level to minimize dynamic effects.

Test data (loads and slips) were recorded in increments and plotted by hand as the test progressed. Significant occurrences and observations were noted throughout the test. Failure was determined to occur after a significant drop in shear load was observed on the shear load vs. slip plot.

The load and slip data were recorded electronically at various increments during the test by a Measurements Group, System 4000 data acquisition unit and the associated software.

Following the test, the specimen was disassembled. The mode of failure and limits of slab damage (e.g. cracking, spalling) were noted.

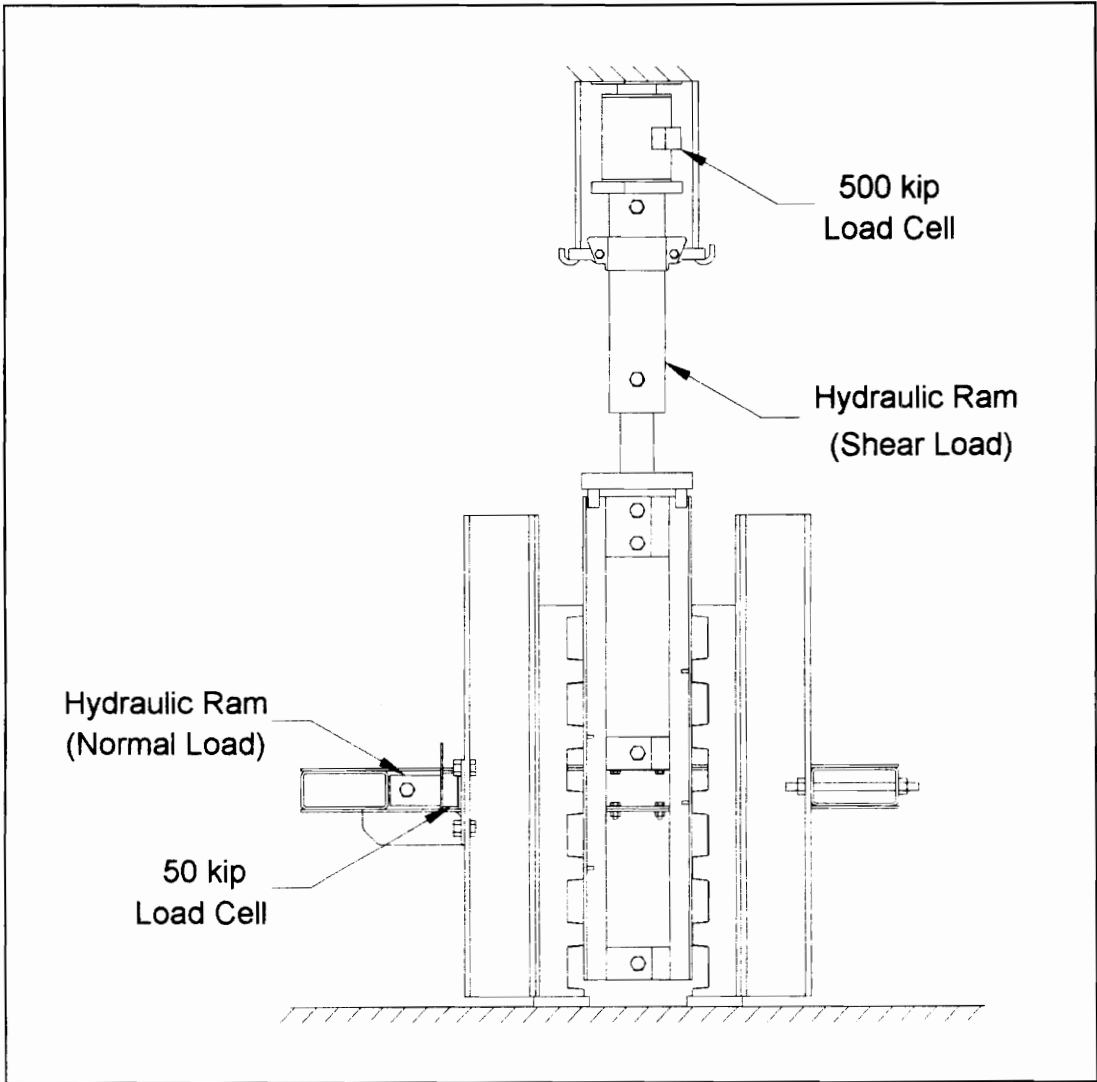


Fig. 2.12 Specimen Loading Detail

CHAPTER 3

TEST RESULTS

3.1 General

Results of the seventy-four pushout tests are summarized and compared in this chapter. Data detailing the configuration and results for series 1 through series 5 tests (i.e. the tests utilizing the Elco grade 8 shear connector) are presented in Appendix A. Data summarizing the configuration and results of the preliminary series tests (i.e. the tests conducted to compare the three screw types, Buildex, Elco grade 5, and Elco grade 8) can be found in Appendix B.

3.1.1 Description of Data Pack

A data pack consisting of a summary sheet, plots of applied shear load versus slip, and the raw test data is provided for each test. The summary sheet provides information on the respective test configuration and measured material properties. The concrete compressive stress, f'_c , was determined by averaging the results of three tests conducted on 4 in. by 8 in. cylinders placed per ASTM C192. Deck and base angle tensile yield stresses were determined by averaging the results of two tensile tests conducted on coupons fabricated per ASTM A370. A section on test results is also provided along with comments noted during and after the specimen testing. A sketch of the specimen details the extent of the concrete failure observed after the completion of testing.

One plot of shear load versus slip is presented for each slab of a given test specimen (i.e. two plots per test). The plots are designated load vs. north or south slip as determined from the sketch included in the respective test summary sheet. (Note: Specimen sides have been designated "north" or "south" for convenience in distinguishing one slab from the other, no explicit directional meaning is intended.) The standoff screws are numbered SC1 through SC8 according to the sketch in the summary sheet.

The reduced data for each test is presented in a data sheet. Shear load, normal load, and the relative slip at each screw location is presented.

3.2 Properties of the Buildex Connector

Independent tests were conducted by Buildex to determine the physical properties of the 5/16 in. diameter standoff screw connector. This section presents the results of these tests and comments on the Buildex connector in general.

Measured Dimensions:

Diameter of Shank Below Hex Head: 0.280 in.

Cross-sectional Area Through Shank: 0.0616 in.²

Nominal Diameter of Threads: 0.3125 in.

Net Area Through Threads: 0.0581 in.²

Material Properties:

Average Tensile Strength, T: 9.99 kips

Average Ultimate Tensile Stress, F_U : 164.0 ksi

Average Shear Strength, V: 4.61 kips

Average Shear Stress, F_V : 79.3 ksi

To provide an understanding of the force required to pull a screw out of the base angle material, withdrawal tests were conducted by Buildex. The standoff screws were attached to angle sections of varying thickness and then pulled out of the base material in direct tension. In all tests, the fastener pulled out of the base steel with no fastener failure or damage noted.

Withdrawal Test Results:

Average Withdrawal force, T_w , from 0.109 in. thick base material: 2.292 kips
Average Withdrawal force, T_w , from 0.123 in. thick base material: 2.550 kips
Average Withdrawal force, T_w , from 0.138 in. thick base material: 2.706 kips
Average Withdrawal force, T_w , from 0.155 in. thick base material: 3.024 kips
Average Withdrawal force, T_w , from 0.170 in. thick base material: 3.600 kips
Average Withdrawal force, T_w , from 0.187 in. thick base material: 3.374 kips
Average Withdrawal force, T_w , from 0.232 in. thick base material: 5.048 kips
Average Withdrawal force, T_w , from 0.250 in. thick base material: 5.488 kips

3.3 Properties of the Elco Grade 5 and Grade 8 Connectors

Independent testing was conducted by Elco to determine physical properties for the grade 5 and grade 8 standoff screws. This section summarizes the results of the testing and comments on the general fabrication of the Elco connectors.

Measured Dimensions of the Elco Grade 5 and Grade 8 Screws:

Diameter of Shank Below Hex Head: 0.280 in.
Cross-sectional Area Through Shank: 0.0616 in.²
Nominal Diameter of Threads: 0.3125 in.
Net Area Through Threads: 0.0581 in.²

Material Properties of the Elco Grade 5 Screw:

Minimum Specified Tensile Yield Stress, F_Y : 92.0 ksi
Minimum Specified Ultimate Tensile Stress, F_U : 120.0 ksi
Average Tensile Strength, T : 9.167 kips
Average Ultimate Tensile Stress, F_U : 148.8 ksi
Average Shear Strength, V : 5.100 kips
Average Shear Stress, F_V : 87.8 ksi

Material Properties of the Elco Grade 8 Screw:

Minimum Specified Tensile Yield Stress, F_Y : 130.0 ksi
Minimum Specified Ultimate Tensile Stress, F_U : 150.0 ksi
Average Tensile Strength, T : 10.438 kips
Average Ultimate Tensile Stress, F_U : 169.4 ksi
Average Shear Strength, V : 5.625 kips
Average Shear Stress, F_V : 96.8 ksi

Withdrawal tests were not conducted utilizing the Elco connectors.

3.4 Test Results

This section presents the results of the seventy-four pushout tests. Tables summarizing the results are provided for each of the six pushout test series.

3.4.1 Definition of Results

A results table is provided for each pushout test series. Slab thickness, deck profile, concrete compressive strength (f'_C), base thickness (for series 1 through series 5), ultimate shear load per screw, average slip at the ultimate shear load, secant stiffness, and failure mode is reported for each test.

The slip values presented in the results tables represent the average of the slip values at screw locations, recorded at the ultimate applied shear load. Due to interference between the slip transducers and the profiled steel deck in some tests, the potentiometers were removed at various points during the testing. The presented values represent the average slip determined from the potentiometers still attached at the ultimate shear load.

The secant stiffness is defined as the slope of a line drawn from the origin through a point defined by a shear load of 40% of the ultimate shear load and the corresponding average slip.

Five failure modes were observed in the pushout tests: screw shear, cone pullout, screw pullout, longitudinal splitting, and angle buckling. Screw shear failure is characterized by shearing of one or more connectors in a given test specimen. Cone pullout denotes failure by tensile pullout from the concrete slab of one or more standoff screw connectors. Screw pullout failure is characterized by tensile pullout of one or more standoff screws from the base angle. Longitudinal splitting failure denotes the formation of a splitting crack running along the line of connectors in either or both slabs of a given test specimen. Angle buckling failure is characterized by a lateral buckling of the top chord angle sections of a given test.

Prior to failure by angle buckling, substantial rotation was observed at the base of the standoff screws. The screw rotation resulted in considerable deformation of the base angle and the formation of a local buckle at the screw location. Once the local buckle developed at the screw locations, a plastic hinge was formed and the angle assembly was free to buckle laterally above the topmost screws. A schematic of the rotation induced local buckling is presented

in Fig. 3.1. Although the theoretical buckling resistance of the angle section was greater than the axial load level applied in a given test, the bending moment transferred to the base angle due to the screw rotation effectively reduced the capacity of the section resulting in a buckling failure.

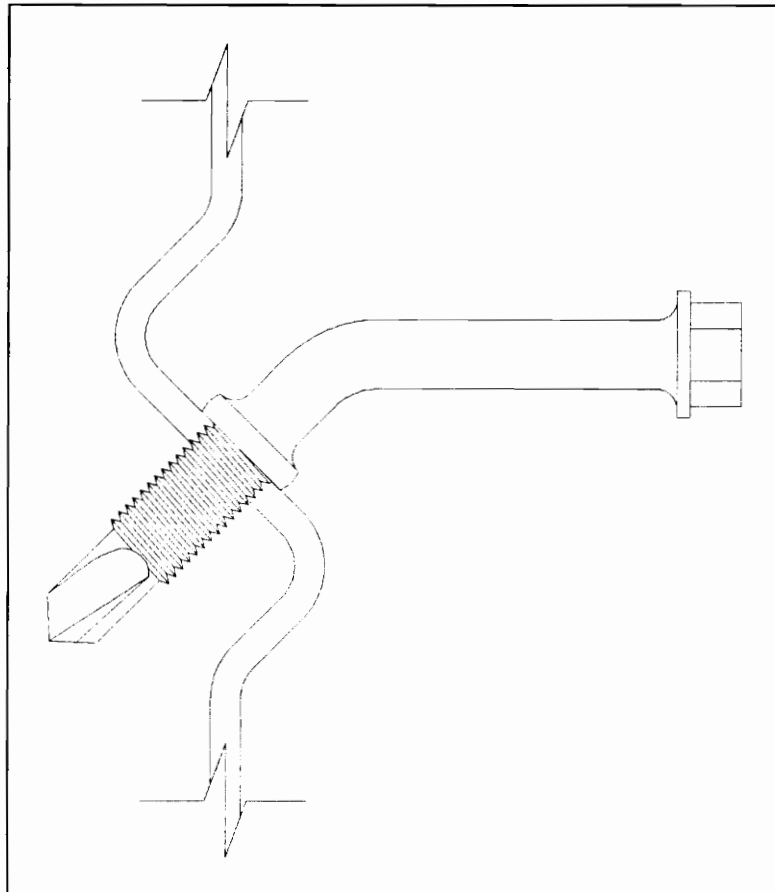


Fig. 3.1 Typical Screw Rotation

An additional table summarizing the average results for each test group of a given series is provided for series 1 through series 5 (the tests utilizing the Elco grade 8 screw in various test configurations). A plot of shear load per screw versus base angle thickness is also provided for the series 1 through series 5 tests.

3.4.2 Preliminary Series Test Results

The preliminary series consisted of nine pushout tests conducted to compare the characteristics of the three types of standoff screw connectors (Buildex, Elco Grade 5, and Elco Grade 8). The results of the nine tests are presented below in Table 3.1. The results of the preliminary series are presented in greater detail in Appendix B.

Table 3.1 Preliminary Series Results

Test No.	Connector Type	f'_c (psi)	Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Secant Stiffness (kips/in.)	Failure Mode
P-1-1	Buildex	4090	2.83	0.110	1540	screw shear
P-1-2	Buildex	4200	3.25	0.298	745	screw shear
P-1-3	Buildex	4110	2.72	0.239	605	screw shear
P-2-1	Elco, gr. 5	4290	4.13	0.759	682	screw pullout
P-2-2	Elco, gr. 5	4270	3.97	0.641	959	screw pullout
P-2-3	Elco, gr. 5	4280	3.80	0.680	506	screw pullout
P-3-1	Elco, gr. 8	4300	3.86	0.709	825	screw pullout
P-3-2	Elco, gr. 8	4140	3.69	0.637	1180	screw pullout
P-3-3	Elco, gr. 8	4320	3.53	0.723	985	screw pullout

The Buildex screw connector developed an average shear strength of 2.93 kips compared to averages of 3.97 kips and 3.69 kips for the Elco grade 5 and Elco grade 8 connectors respectively. The slip tolerated by the Buildex standoff screw was an average of 0.216". The specimens utilizing the Elco grade 5 screw failed at an average slip of 0.693". The Elco grade 8 screw tolerated an average slip of 0.690". The two Elco connectors were over 3 times more ductile than the Buildex standoff screw. The average secant stiffness for the Buildex connector was 963 kips/in. compared to an average stiffness of 716 kips/in. and 997 kips/in. for the Elco grade 5 and Elco grade 8 screws respectively.

The difference in fabrication methods between the Buildex and Elco connectors became apparent in the preliminary test series. To harden the threads so that the connector would be capable of drilling and tapping the base angle, the entire Buildex screw was heat treated. This heat treatment made the Buildex screw brittle and resulted in an overall loss of ductility. In contrast to the Buildex screw, only the bit and the first few threads of the Elco connectors were heat treated to provide the hardness required to drill and tap the base angle. This selective hardening left the screw shank (the standoff portion) very ductile. In an illustrative test, the Elco connectors were attached to an angle and bent approximately 90° with no signs of tensile fracture.

Due to the brittle nature of the Buildex standoff screw (i.e. failure by screw shear), the Elco connectors were determined to be more promising for application as mechanical shear connectors in composite joists. Because the resistance to pullout of the base material controlled the failure of the Elco connectors (i.e. failure by screw pullout), the results of the preliminary series tests alone could not be used to comparatively evaluate the two Elco standoff screws. The higher theoretical shear and tensile strength of the Elco grade 8 standoff screw can be realized with a minimal cost increase over the Elco grade 5 connector, for this reason the Elco grade 8 connector was chosen for further consideration. Pushout test series 1 through series 5 were conducted to further evaluate the performance of the Elco grade 8 standoff screw.

3.4.3 Series 1 Test Results

Pushout series 1 consisted of twenty tests conducted to determine the performance characteristics of the 2 in. Elco grade 8 standoff screw functioning

as a mechanical shear connector in tests configured with solid slabs (i.e. no deck) and varying base angle thicknesses. The results for each individual test are summarized in Table 3.2; the average results for each test group are presented in Table 3.3. The ultimate shear load per screw for each test, as well as the average ultimate shear load per screw for each of the six test groups, is plotted versus base angle thickness in Fig. 3.2. The series 1 test results are presented in greater detail in Appendix A.

Table 3.2 Series 1 Results

Test No.	Slab Thk. (in.)	Deck Type	f'_c (psi)	Base Thk. (in.)	Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Secant Stiffness (kips/in.)	Failure Mode
1-1-1	4	None	3850	0.109	5.21	0.301	1140	screw shear
1-1-2	4	None	3860	0.109	5.19	0.352	1130	angles buckled
1-1-3	4	None	3860	0.109	5.50	0.303	1800	screw shear
1-2-1	4	None	3820	0.123	6.50	0.494	1650	longitudinal splitting
1-2-2	4	None	3830	0.123	5.14	0.308	2640	angles buckled
1-2-3	4	None	3830	0.123	5.46	0.460	2010	screw shear
1-3-1	4	None	3390	0.170	6.09	0.387	850	longitudinal splitting
1-3-2	4	None	3860	0.170	7.05	0.535	1420	screw shear
1-3-3	4	None	3860	0.170	6.71	0.417	2350	angles buckled
1-3-4	4	None	3870	0.170	6.58	0.281	1270	angles buckled
1-4-1	4	None	3450	0.205	7.23	0.443	2020	longitudinal splitting
1-4-2	4	None	3910	0.205	7.36	0.480	1510	screw shear
1-4-3	4	None	3910	0.205	7.60	0.451	1710	screw shear
1-5-1	4	None	3560	0.238	5.74	0.621	1900	screw shear
1-5-2	4	None	3910	0.238	6.26	0.169	1190	screw shear
1-5-3	4	None	3910	0.238	5.90	0.188	2010	screw shear
1-6-1	2.5	None	3390	0.170	5.50	0.297	2180	longitudinal splitting
1-6-2	2.5	None	3920	0.170	5.19	0.174	5580	longitudinal splitting
1-6-3	2.5	None	3920	0.170	5.17	0.137	3310	longitudinal splitting
1-6-4	2.5	None	3920	0.170	5.08	0.144	1860	longitudinal splitting

All screws: 2 in. Elco, gr. 8

Table 3.3 Series 1 Average Results

Test Series-Group	Slab Thk. (in.)	Deck Type	Avg. f'_c (psi)	Avg. Base Thk. (in.)	Avg. Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Avg. Stiffness (kips/in.)
1-1	4	None	3860	0.109	5.30	0.319	1360
1-2	4	None	3830	0.123	5.70	0.421	2100
1-3	4	None	3750	0.170	6.61	0.405	1470
1-4	4	None	3760	0.205	7.40	0.458	1750
1-5	4	None	3790	0.238	5.97	0.326	1700
1-6	2.5	None	3790	0.170	5.24	0.188	3230

All screws: 2 in. Elco, gr. 8

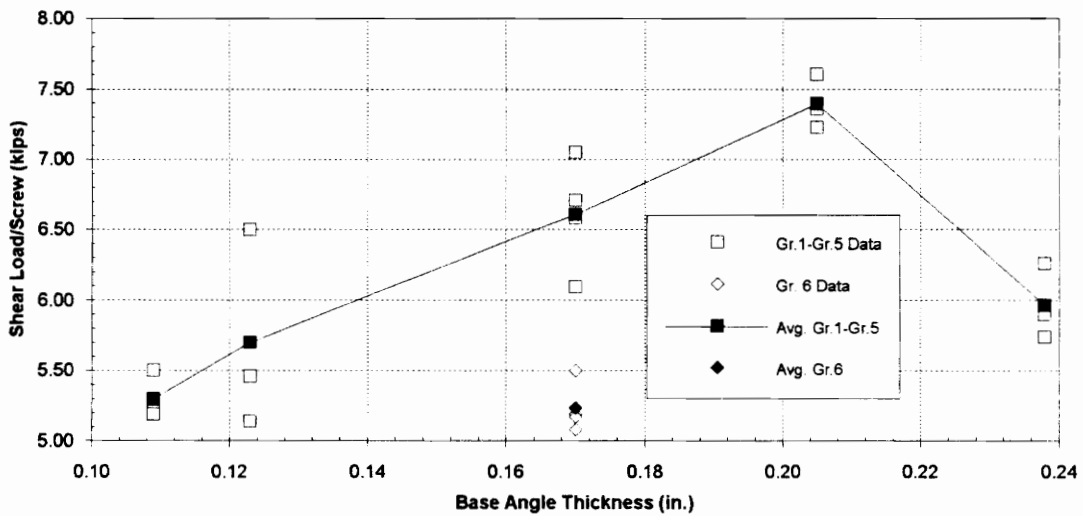


Fig. 3.2 Series 1 Shear Load/Screw vs. Base Angle Thickness

3.4.4 Series 2 Test Results

Series 2 consisted of twelve tests and was conducted to determine the performance characteristics of the 1.5 in. Elco grade 8 connector in test configurations utilizing Vulcraft 0.6C deck and varying base angle thicknesses. The results of each of the series 2 tests are summarized in Table 3.4. The average results of the four test groups are presented in Table 3.5. The strength

results are plotted versus base angle thickness in Fig. 3.3. The test results are presented in greater detail in Appendix A.

Table 3.4 Series 2 Results

Test No.	Slab Thk. (in.)	Deck Type	f'_c (psi)	Base Thk. (in.)	Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Secant Stiffness (kips/in.)	Failure Mode
2-1-1	2	0.6C	6960	0.109	3.64	0.396	1600	cone pullout
2-1-2	2	0.6C	6960	0.109	3.62	0.425	540	cone pullout
2-1-3	2	0.6C	6960	0.109	3.56	0.384	2950	cone pullout
2-2-1	2	0.6C	6960	0.155	4.01	0.389	1570	cone pullout
2-2-2	2	0.6C	6960	0.155	4.17	0.402	1350	cone pullout
2-2-3	2	0.6C	6960	0.155	3.98	0.384	1250	cone pullout
2-3-1	2	0.6C	6960	0.205	4.37	0.419	1060	cone pullout
2-3-2	2	0.6C	6960	0.205	3.88	0.260	1110	cone pullout
2-3-3	2	0.6C	6960	0.205	4.03	0.321	940	cone pullout
2-4-1	2	0.6C	6960	0.252	3.80	0.309	990	cone pullout
2-4-2	2	0.6C	6960	0.252	4.12	0.286	560	cone pullout
2-4-3	2	0.6C	6960	0.252	3.72	0.264	500	cone pullout

All screws: 1.5 in. Elco, gr. 8

Table 3.5 Series 2 Average Results

Test Series-Group	Slab Thk. (in.)	Deck Type	Avg. f'_c (psi)	Avg. Base Thk. (in.)	Avg. Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Avg. Stiffness (kips/in.)
2-1	2	0.6C	6960	0.109	3.61	0.402	1700
2-2	2	0.6C	6960	0.155	4.05	0.392	1390
2-3	2	0.6C	6960	0.205	4.09	0.333	1040
2-4	2	0.6C	6960	0.252	3.88	0.286	680

All screws: 1.5 in. Elco, gr. 8

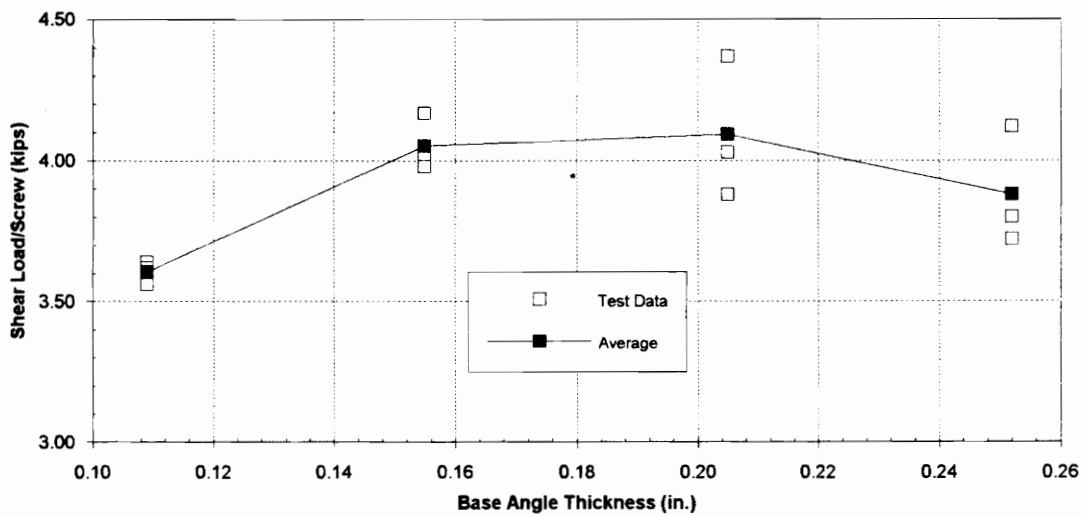


Fig. 3.3 Series 2 Shear Load/Screw vs. Base Angle Thickness

3.4.5 Series 3 Test Results

Pushout series 3 consisted of twelve tests and was conducted to determine the properties of the 2 in. Elco grade 8 screw functioning as a mechanical shear connector in test specimens configured with Vulcraft 1.0C deck and varying base angle thicknesses. A summary of the results for each test is presented in Table 3.6. The average results for each of the four test groups are provided in Table 3.7. The ultimate shear load per screw is plotted versus base angle thickness in Fig. 3.4. The individual test results are presented in greater detail in Appendix A.

Table 3.6 Series 3 Results

Test No.	Slab Thk. (in.)	Deck Type	f'_c (psi)	Base Thk. (in.)	Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Secant Stiffness (kips/in.)	Failure Mode
3-1-1	2.5	1.0C	4870	0.109	3.64	0.543	1000	angles buckled
3-1-2	2.5	1.0C	4870	0.109	3.33	0.640	380	angles buckled
3-1-3	2.5	1.0C	4870	0.109	3.43	0.619	940	angles buckled
3-2-1	2.5	1.0C	4880	0.155	4.40	0.799	1500	cone pullout
3-2-2	2.5	1.0C	4890	0.155	4.38	0.579	1650	cone pullout
3-2-3	2.5	1.0C	4770	0.155	4.17	0.566	1020	screw shear
3-3-1	2.5	1.0C	4580	0.205	4.77	0.605	910	cone pullout
3-3-2	2.5	1.0C	4580	0.205	4.41	0.584	720	screw shear
3-3-3	2.5	1.0C	4580	0.205	4.67	0.645	2070	screw shear
3-4-1	2.5	1.0C	4770	0.252	4.19	0.430	3880	screw shear
3-4-2	2.5	1.0C	4580	0.252	3.70	0.424	3110	screw shear
3-4-3	2.5	1.0C	4580	0.252	4.48	0.574	1790	cone pullout

All screws: 2 in. Elco, gr. 8

Table 3.7 Series 3 Average Results

Test Series-Group	Slab Thk. (in.)	Deck Type	Avg. f'_c (psi)	Avg. Base Thk. (in.)	Avg. Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Avg. Stiffness (kips/in.)
3-1	2.5	1.0C	4870	0.109	3.47	0.601	770
3-2	2.5	1.0C	4850	0.155	4.32	0.648	1390
3-3	2.5	1.0C	4580	0.205	4.62	0.611	1230
3-4	2.5	1.0C	4640	0.252	4.12	0.476	2930

All screws: 2 in. Elco, gr. 8

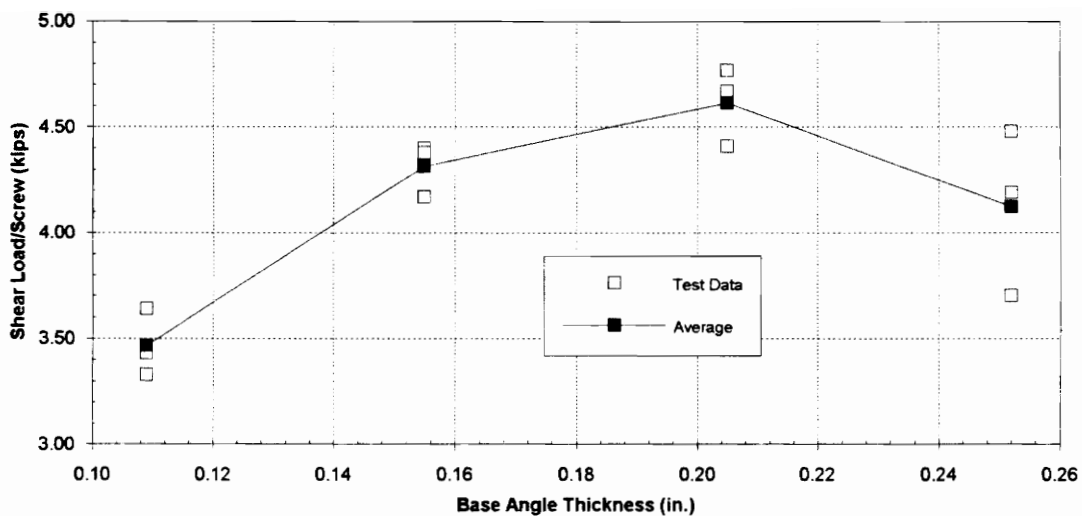


Fig. 3.4 Series 3 Shear Load/Screw vs. Base Angle Thickness

3.4.6 Series 4 Test Results

Series 4 consisted of twelve tests conducted to determine the properties of the 2 in. Elco grade 8 connector in pushout specimens constructed with Vulcraft 1.5VL deck and varying base angle thicknesses. Individual test results and average group results are presented in Table 3.8 and Table 3.9 respectively. The ultimate shear strength per connector for each test as well as the group average ultimate shear strength per connector are plotted versus base angle thickness in Fig. 3.5. Complete results and comments are presented for each test in Appendix A.

Table 3.8 Series 4 Results

Test No.	Slab Thk. (in.)	Deck Type	f'_c (psi)	Base Thk. (in.)	Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Secant Stiffness (kips/in.)	Failure Mode
4-1-1	4	1.5VL	5400	0.109	3.98	0.407	4340	angles buckled
4-1-2	4	1.5VL	5400	0.109	4.30	0.483	1390	angles buckled
4-1-3	4	1.5VL	5400	0.109	4.33	0.506	1720	angles buckled
4-2-1	4	1.5VL	5080	0.170	4.79	0.610	3490	cone pullout
4-2-2	4	1.5VL	5290	0.170	4.87	0.688	2370	cone pullout
4-2-3	4	1.5VL	5290	0.170	5.13	0.519	2290	cone pullout
4-3-1	4	1.5VL	5290	0.243	4.58	0.573	1160	cone pullout
4-3-2	4	1.5VL	5290	0.245	4.75	0.418	4400	cone pullout
4-3-3	4	1.5VL	5290	0.239	4.88	0.447	2540	cone pullout
4-4-1	3.5	1.5VL	4810	0.252	4.92	0.353	2060	cone pullout
4-4-2	3.5	1.5VL	4810	0.252	4.24	0.220	3610	screw shear
4-4-3	3.5	1.5VL	4810	0.252	4.85	0.500	1950	cone pullout

All screws: 2 in. Elco, gr. 8

Table 3.9 Series 4 Average Results

Test Series-Group	Slab Thk. (in.)	Deck Type	Avg. f'_c (psi)	Avg. Base Thk. (in.)	Avg. Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Avg. Stiffness (kips/in.)
4-1	4	1.5VL	5400	0.109	4.20	0.465	2480
4-2	4	1.5VL	5220	0.170	4.93	0.606	2720
4-3	4	1.5VL	5290	0.242	4.74	0.479	2700
4-4	3.5	1.5VL	4810	0.252	4.67	0.358	2540

All screws: 2 in. Elco, gr. 8

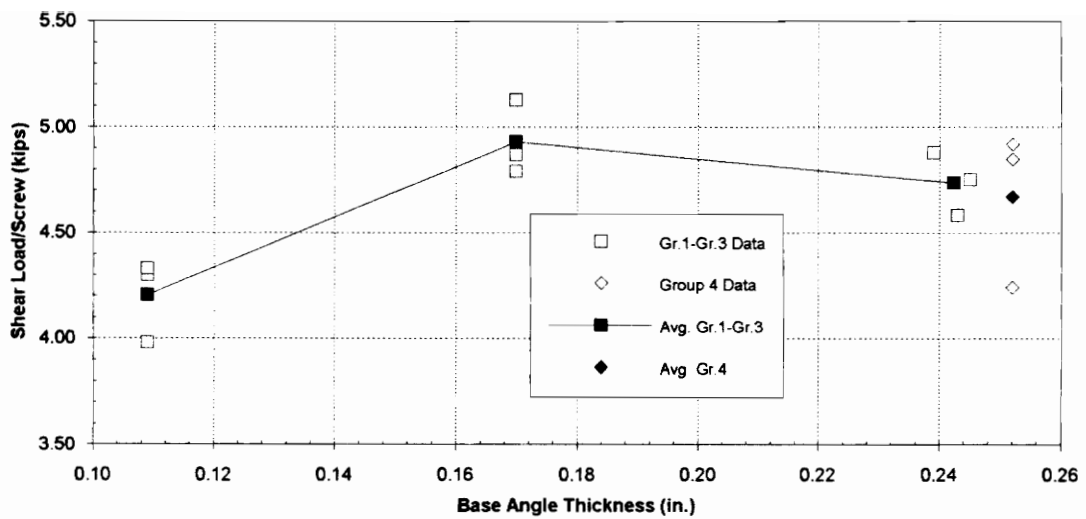


Fig. 3.5 Series 4 Shear Load/Screw vs. Base Angle Thickness

3.4.7 Series 5 Test Results

Pushout series 5 consisted of nine tests and was conducted to provide information on the performance of the 2.5 in. Elco grade 8 standoff screw in specimens constructed with Vulcraft 1.5VL deck and varying base angle thickness. The individual test results are presented in summary form in Table 3.10. Average results for the three test groups are provided in Table 3.11. A plot of ultimate shear load per screw versus base angle thickness is given in Fig. 3.6. Detailed information can be found in Appendix A for each test.

Table 3.10 Series 5 Results

Test No.	Slab Thk. (in.)	Deck Type	f'_c (psi)	Base Thk. (in.)	Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Secant Stiffness (kips/in.)	Failure Mode
5-1-1	3.5	1.5VL	4420	0.109	5.01	0.732	1390	screw pullout
5-1-2	3.5	1.5VL	4420	0.109	4.87	0.600	3150	screw pullout
5-1-3	3.5	1.5VL	4420	0.109	5.01	0.679	1620	screw pullout
5-2-1	3.5	1.5VL	4400	0.155	5.46	0.782	2820	cone pullout
5-2-2	3.5	1.5VL	4390	0.155	5.50	0.824	1800	cone pullout
5-2-3	3.5	1.5VL	4390	0.155	5.55	0.704	1470	cone pullout
5-3-1	3.5	1.5VL	4390	0.205	5.11	0.443	2310	cone pullout
5-3-2	3.5	1.5VL	4390	0.205	5.46	0.617	1780	screw shear
5-3-3	3.5	1.5VL	4420	0.205	5.21	0.849	2160	cone pullout

All screws: 2.5 in. Elco, gr. 8

Table 3.11 Series 5 Average Results

Test Series-Group	Slab Thk. (in.)	Deck Type	Avg. f'_c (psi)	Avg. Base Thk. (in.)	Avg. Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Avg. Stiffness (kips/in.)
5-1	3.5	1.5VL	4420	0.109	4.96	0.670	2050
5-2	3.5	1.5VL	4390	0.155	5.50	0.770	2030
5-3	3.5	1.5VL	4400	0.205	5.26	0.636	2080

All screws: 2.5 in. Elco, gr. 8

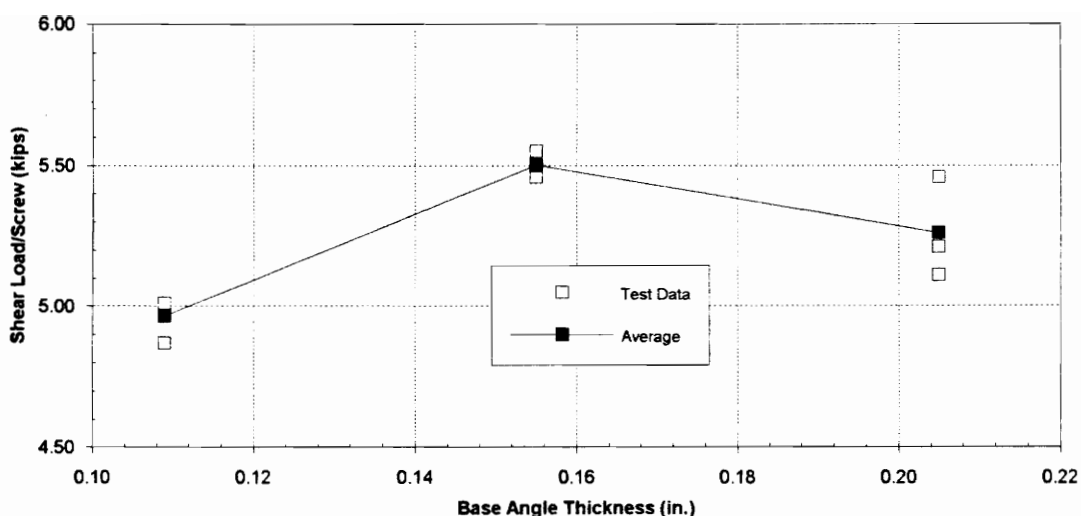


Fig. 3.6 Series 5 Shear Load/Screw vs. Base Angle Thickness

3.4.8 Series 1 Through Series 5 Comparative Results

Sixty-five pushout tests were conducted to determine the properties of the Elco grade 8 standoff screw functioning as a mechanical shear connector in composite joists. The tests comprised five series and a total of twenty-one groups; the average results for each test group are presented in Table 3.12. A plot of the group average shear load per screw is plotted versus base angle thickness in Fig. 3.7.

To directly compare the results obtained for each test group, the average shear load per screw values were normalized to remove the effects of variation in concrete compressive strength, f'_c . The values were normalized to a concrete strength of 3000 psi by multiplying the average shear load per screw by the square root of the quantity 3000 divided by the average concrete compressive strength in psi units, as given by:

$$\text{Normalized Value} = \text{Actual Value} \sqrt{\frac{3000 \text{ psi}}{\text{Avg. } f'_c}} \quad (3.1)$$

The normalized screw strength values are presented for each test group in Table 3.12. The normalized shear load per screw values are plotted versus base angle thickness in Fig. 3.8.

Table 3.12 Comparative Results

Test Series - Group	Connector Type	Avg. f'_c (psi)	Avg. Base Thk. (in.)	Avg. Shear Load/Screw (kips)	Normalized Shear Load/Screw (kips)	Avg. Slip at Ult. Shear Load (in.)	Avg. Stiffness (kips/in.)
1-1	2" Elco, gr.8	3860	0.109	5.30	4.67	0.319	1360
1-2	2" Elco, gr.8	3830	0.123	5.70	5.04	0.421	2100
1-3	2" Elco, gr.8	3750	0.170	6.61	5.91	0.405	1470
1-4	2" Elco, gr.8	3760	0.205	7.40	6.61	0.458	1750
1-5	2" Elco, gr.8	3790	0.238	5.97	5.31	0.326	1700
1-6	2" Elco, gr.8	3790	0.170	5.24	4.66	0.188	3230
2-1	1.5" Elco, gr.8	6960	0.109	3.61	2.37	0.402	1700
2-2	1.5" Elco, gr.8	6960	0.155	4.05	2.66	0.392	1390
2-3	1.5" Elco, gr.8	6960	0.205	4.09	2.69	0.333	1040
2-4	1.5" Elco, gr.8	6960	0.252	3.88	2.55	0.286	680
3-1	2" Elco, gr.8	4870	0.109	3.47	2.72	0.601	770
3-2	2" Elco, gr.8	4850	0.155	4.32	3.40	0.648	1390
3-3	2" Elco, gr.8	4580	0.205	4.62	3.74	0.611	1230
3-4	2" Elco, gr.8	4640	0.252	4.12	3.31	0.476	2930
4-1	2" Elco, gr.8	5400	0.109	4.20	3.13	0.465	2480
4-2	2" Elco, gr.8	5220	0.170	4.93	3.74	0.606	2720
4-3	2" Elco, gr.8	5290	0.242	4.74	3.57	0.479	2700
4-4	2" Elco, gr.8	4810	0.252	4.67	3.69	0.358	2540
5-1	2.5" Elco, gr.8	4420	0.109	4.96	4.09	0.670	2050
5-2	2.5" Elco, gr.8	4390	0.155	5.50	4.55	0.770	2030
5-3	2.5" Elco, gr.8	4400	0.205	5.26	4.34	0.636	2080

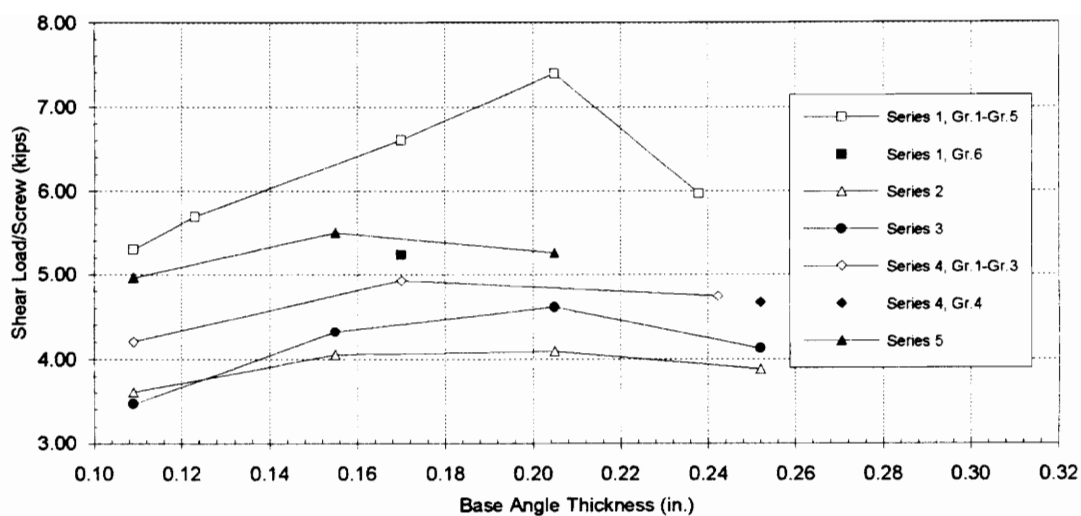


Fig. 3.7 Group Avg. Shear Load/Screw vs. Base Angle Thickness

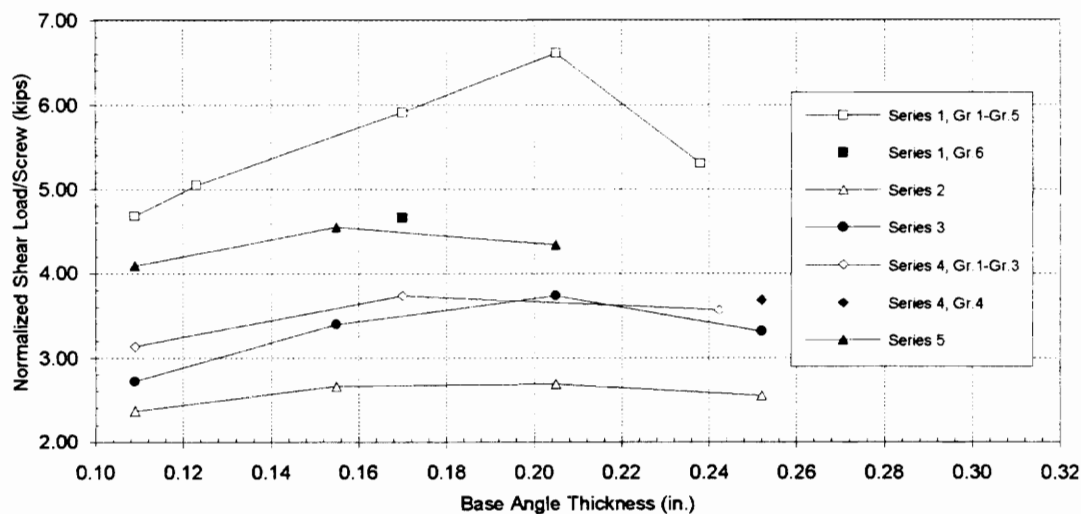


Fig. 3.8 Group Avg. Normalized Shear Load/Screw vs. Base Angle Thickness

An interesting observation apparent in all test series utilizing the Elco grade 8 screw, is that as base angle thickness increases, screw strength also increases. However, a point is reached where the base angle acts relatively fixed and the screw strength drops off. This relationship suggests that greater connector strength may be realized if the base material is somewhat flexible. Rotation, due to deformation of the base angle, allows for substantial rotation of the shear connector resulting in a primarily tensile loading of the screw. Limiting the deformation of the base angle (by increasing thickness) results in a reduction in screw rotation, and therefore, greater shear loading of the connector. The drop in connector strength, associated with moving above the limiting base thickness, reflects an interaction between shear and tension (shear capacity being lesser than tensile capacity).

CHAPTER 4

ANALYTICAL STUDY

4.1 General

Results obtained by applying the analytical models presented in Chapter 1 to the test geometries of the sixty-five pushout tests utilizing the Elco grade 8 connector (series 1 through series 5) are summarized and discussed in this chapter. The analytical results are compared to the normalized experimental results. Based on this comparison, the predictability of the shear strength of the Elco grade 8 standoff screw is determined. Calculations are presented for each of the models in Appendix C.

4.2 Ollgaard et al. Stud Shear Failure

The stud shear strength equation (Eq. 1.10) developed by Ollgaard et al. presents connector shear strength as a function of the cross sectional area of the connector, concrete compressive strength, and the concrete modulus of elasticity. The equation was developed following multiple regression analyses of existing test data and is therefore empirical in nature. Stud strength is calculated directly from the equation rather than predicted based on observed failure mechanisms.

The empirical nature of the Ollgaard et al. equation, as well as the fact that it was derived to fit specific test data, limit its application. AISC stipulates that

the stud diameter to base angle thickness ratio shall not exceed 2.5 (LRFD 1986). Ratios greater than 2.5 fall outside of the scope of the Ollgaard et al. research. The limiting base angle thickness for the Elco grade 8 connector is 0.112 in. (based on a diameter of 0.280 in.), therefore all base angle thicknesses utilized in this study satisfy the constraints of the Ollgaard et al. equation with the exception of the 0.109 in. thick angle (diameter to thickness ratio of 2.57).

Additionally, the Ollgaard et al. shear value represents the ultimate strength of a given stud connector and must be reduced in some instances to account for the use of profiled steel deck (LRFD 1986). The reduction factor for steel deck oriented perpendicular to the direction of applied axial load is calculated by the following equation:

$$R = \frac{0.85}{\sqrt{N_r}} \left(\frac{w_r}{h_r} \right) \left[\left(\frac{H_s}{h_r} \right) - 1.0 \right] \leq 1.0 \quad (4.1)$$

where:

R = Deck reduction factor

N_r = Number of connectors per deck rib

w_r = Average concrete rib width, in.

h_r = Nominal rib height of steel deck, in.

H_s = Total length of shear connector, in

The 0.6C and 1.0C deck profiles used in this research require no reduction. The calculated reduction factor is 0.4 for the 2 in. screw and 0.8 for the 2.5 in. screw in 1.5VL deck.

As calculated in Appendix C, the ultimate shear strength per connector based on the Ollgaard et al. equation is 3.22 kips (assuming concrete strength of 3 ksi). Application of the deck reduction factor results in shear values per

connector of 1.29 kips and 2.58 kips for the 2 in. and 2.5 in. screw in 1.5VL deck respectively. Normalized average experimental results are compared to the strength values obtained by applying the Ollgaard et al. equation in Table 4.1.

Table 4.1 Normalized Avg. Results vs. Ollgaard et al. Predicted Results

Test Series-Group	Connector Type	Normalized Shear Load/Screw (kips)	Ollgaard et al. Predicted Shear Load (kips)	Normalized/Predicted Strength
1-1	2" Elco, gr.8	4.67	3.22	1.45
1-2	2" Elco, gr.8	5.04	3.22	1.57
1-3	2" Elco, gr.8	5.91	3.22	1.84
1-4	2" Elco, gr.8	6.61	3.22	2.05
1-5	2" Elco, gr.8	5.31	3.22	1.65
1-6	2" Elco, gr.8	4.66	3.22	1.45
2-1	1.5" Elco, gr.8	2.37	3.22	0.74
2-2	1.5" Elco, gr.8	2.66	3.22	0.83
2-3	1.5" Elco, gr.8	2.69	3.22	0.84
2-4	1.5" Elco, gr.8	2.55	3.22	0.79
3-1	2" Elco, gr.8	2.72	3.22	0.84
3-2	2" Elco, gr.8	3.40	3.22	1.06
3-3	2" Elco, gr.8	3.74	3.22	1.16
3-4	2" Elco, gr.8	3.31	3.22	1.03
4-1	2" Elco, gr.8	3.13	1.29	2.43
4-2	2" Elco, gr.8	3.74	1.29	2.90
4-3	2" Elco, gr.8	3.57	1.29	2.77
4-4	2" Elco, gr.8	3.69	1.29	2.86
5-1	2.5" Elco, gr.8	4.09	2.58	1.59
5-2	2.5" Elco, gr.8	4.55	2.58	1.76
5-3	2.5" Elco, gr.8	4.34	2.58	1.68

Comparing the normalized experimental results with results obtained by applying the Ollgaard et al. equation, a poor correlation is noted. The Ollgaard et al. research, while applicable to the welded stud connector, does not appear applicable to the Elco standoff screw. A possible explanation for the inapplicability of the Ollgaard et al. method is that the equation was derived to fit specific test data; the results obtained in test geometries using the standoff

screw simply do not correlate with the stud test data. Also, the smaller system associated with the standoff screw connector may tend to amplify the effect of several test variables (i.e. base angle thickness, deck profile, and standoff length) on connector strength.

4.3 Oehlers Concrete Splitting Failure

As presented in Chapter 1, Oehlers (1989) suggested that connector strength may be dependent on the strength and stiffness of the concrete in the triaxial compression region. The high stresses in this region, due to the transfer of force from the connector to the concrete slab, often result in the formation of a splitting crack below the connector. The splitting strength of the concrete in the triaxial zone is approximated by Eq. 1.11.

Oehlers observed that the force transferred from the connector to the concrete was not distributed over the full height of the connector, but rather over an effective height, h_a , located near the base of the stud. This observation is consistent with observations noted in this study. The shaft of the standoff screw remains relatively straight for some distance above the base then deforms in bending due to forces developed at the embedded head of the connector. Oehler recommends a value of $1.8d_s$ for the effective height of a flexible connector (0.5 in. for the standoff screw).

The applicability of Oehlers research to test configurations utilizing formed steel deck is questionable. While concrete splitting may control connector strength in solid slab situations, limitations on lateral concrete cover in the ribs formed by profiled steel deck result in concrete failure in the triaxial zone at a lower stress level. This concrete failure was observed to be of the form of

localized crushing below a screw connector; once this failure occurs, stresses in the triaxial zone are relieved and a propagating splitting crack is not developed. Thus, in cases where profiled steel deck is utilized, failure tends to be due to concrete tensile pullout rather than concrete splitting.

Normalized average experimental results for the solid slab tests (series 1) are compared to the results obtained by applying Oehlers research in Table 4.2. A sample calculation to determine the concrete splitting strength is presented in Appendix C. In applying Eq. 1.11, the value for indirect tensile strength of concrete, f_t , is taken as $6\sqrt{f'_c}$ (an approximation of the split cylinder tensile strength of concrete).

Table 4.2 Normalized Avg. Results vs. Oehlers Splitting Strength

Test Series-Group	Connector Type	Normalized Shear Load/Screw (kips)	Oehlers Splitting Strength (kips)	Normalized/Predicted Strength
1-1	2" Elco, gr.8	4.67	11.46	0.41
1-2	2" Elco, gr.8	5.04	11.46	0.44
1-3	2" Elco, gr.8	5.91	11.46	0.52
1-4	2" Elco, gr.8	6.61	11.46	0.58
1-5	2" Elco, gr.8	5.31	11.46	0.46
1-6	2" Elco, gr.8	4.66	11.46	0.41

Comparing the normalized shear values with the results obtained by applying Oehlers research, using an approximation of the split cylinder tensile strength of concrete for the indirect tensile strength, a poor correlation between concrete splitting strength and connector strength is observed for the solid slab tests. A close relationship between screw shear strength and concrete splitting strength was expected considering splitting was the observed mode of failure in several of the series 1 tests (see Table 3.2).

If an approximation of the direct tensile strength of concrete, $3\sqrt{f'_c}$, is substituted for the indirect tensile strength, f_t , in Oehlers' model, the results are comparable in magnitude to the failure loads of the standoff screws in the series 1 tests. Normalized average experimental results for the solid slab tests are compared to the results obtained by modifying Oehlers research in Table 4.3.

Table 4.3 Normalized Avg. Results vs. Modified Splitting Strength

Test Series-Group	Connector Type	Normalized Shear Load/Screw (kips)	Modified Splitting Strength (kips)	Normalized/Predicted Strength
1-1	2" Elco, gr.8	4.67	5.73	0.82
1-2	2" Elco, gr.8	5.05	5.73	0.88
1-3	2" Elco, gr.8	5.91	5.73	1.03
1-4	2" Elco, gr.8	6.61	5.73	1.15
1-5	2" Elco, gr.8	5.31	5.73	0.93
1-6	2" Elco, gr.8	4.66	5.73	0.81

4.4 Hawkins and Mitchell Concrete Pullout Failure

As detailed in Chapter 1, Hawkins and Mitchell (1984) proposed that shear connector strength, in test configurations utilizing profiled steel deck, is a function of concrete strength and the area of a tensile pullout cone. Slip at the concrete-steel interface results in a tensile force in the stud which is resisted by the concrete in a localized area around the connector. The Hawkins and Mitchell pullout cone is pyramidal in shape, emanating from the top of the connector at 45° angles and truncating at the concrete-deck interface (see Fig. 1.4). The area of the pyramidal failure surface is calculated according to Eqs. 1.3 and 1.4. The relationship between cone area and connector strength is given in Eq. 1.5. Normalized average experimental results for the test series

utilizing steel deck (series 2-5) are compared to the results obtained by applying the Hawkins and Mitchell model in Table 4.4.

Table 4.4 Normalized Avg. Results vs. Hawkins & Mitchell Results

Test Series-Group	Connector Type	Normalized Shear Load/ Screw (kips)	Hawkins and Mitchell Shear Load (kips)	Normalized/ Predicted Strength
2-1	1.5" Elco, gr.8	2.37	1.98	1.20
2-2	1.5" Elco, gr.8	2.66	1.98	1.34
2-3	1.5" Elco, gr.8	2.69	1.98	1.36
2-4	1.5" Elco, gr.8	2.55	1.98	1.29
3-1	2" Elco, gr.8	2.72	3.08	0.88
3-2	2" Elco, gr.8	3.40	3.08	1.10
3-3	2" Elco, gr.8	3.74	3.08	1.21
3-4	2" Elco, gr.8	3.31	3.08	1.07
4-1	2" Elco, gr.8	3.13	3.56	0.88
4-2	2" Elco, gr.8	3.74	3.56	1.05
4-3	2" Elco, gr.8	3.57	3.56	1.00
4-4	2" Elco, gr.8	3.69	3.56	1.04
5-1	2.5" Elco, gr.8	4.09	4.44	0.92
5-2	2.5" Elco, gr.8	4.55	4.44	1.02
5-3	2.5" Elco, gr.8	4.34	4.44	0.98

As can be observed from the table above, the Hawkins and Mitchell concrete pullout model appears to predict the strength of the standoff screw in tests configured with profiled steel deck fairly well. In many instances, a strong correlation is apparent between the experimental results and the predicted values obtained by the Hawkins and Mitchell pullout model.

4.5 Lloyd and Wright Concrete Pullout Failure

Lloyd and Wright (1990) noted that the model developed by Hawkins and Mitchell (1984) was not consistent with post-test observations noted in their research. The 45° failure planes proposed by Hawkins and Mitchell were not

consistent with the slope of the failure surfaces along a theorized path of least resistance (see Fig. 1.5). Additionally, Lloyd and Wright observed that the failure cone developed in their tests appeared to be wedge shaped rather than the symmetrical cone presented in the Hawkins and Mitchell research (see Fig. 1.6). Based on these observations, Lloyd and Wright developed a stud strength relationship dependent on concrete strength and the area of a wedge shaped failure cone. The area of the wedge shaped cone is expressed in Eq. 1.6. The Lloyd and Wright stud strength relationship is presented in Eq. 1.7.

As presented in Chapter 1, Lloyd and Wright (1990) also investigated rib shear failure. A relationship developed to determine the critical specimen width, below which rib shear failure will govern, is presented in Eq. 1.9. The slab width of all specimens tested in this study was sufficient to prevent rib shear from governing failure.

Normalized average experimental results are compared to results obtained by applying the Lloyd and Wright wedged-shear-cone failure model in Table 4.5. The application of the Lloyd and Wright model is illustrated in the sample calculations contained in Appendix C.

Based on a comparison of the experimental and predicted results, a poor correlation is observed. In all cases, the Lloyd and Wright model overpredicts the strength of the standoff screw.

Table 4.5 Normalized Avg. Results vs. Lloyd & Wright Results

Test Series-Group	Connector Type	Normalized Shear Load/Screw (kips)	Lloyd and Wright Shear Load (kips)	Normalized/Predicted Strength
2-1	1.5" Elco, gr.8	2.37	7.43	0.32
2-2	1.5" Elco, gr.8	2.66	7.43	0.36
2-3	1.5" Elco, gr.8	2.69	7.43	0.36
2-4	1.5" Elco, gr.8	2.55	7.43	0.34
3-1	2" Elco, gr.8	2.72	9.76	0.28
3-2	2" Elco, gr.8	3.40	9.76	0.35
3-3	2" Elco, gr.8	3.74	9.76	0.38
3-4	2" Elco, gr.8	3.31	9.76	0.34
4-1	2" Elco, gr.8	3.13	9.92	0.89
4-2	2" Elco, gr.8	3.74	9.92	1.07
4-3	2" Elco, gr.8	3.57	9.92	1.02
4-4	2" Elco, gr.8	3.69	9.92	1.05
5-1	2.5" Elco, gr.8	4.09	10.21	0.40
5-2	2.5" Elco, gr.8	4.55	10.21	0.45
5-3	2.5" Elco, gr.8	4.34	10.21	0.43

4.6 Summary

Based on the application of the analytical models presented in Chapter 1, several conclusions as to the predictability of the strength of the Elco standoff screw may be drawn.

The Ollgaard et al. research, while useful in predicting the strength of the welded shear stud, is not applicable in predicting the strength of the standoff screw. The empirical nature of the Ollgaard et al. equation limits its application to a range of test configurations. The Ollgaard et al. equation is not sensitive to the effects of test parameters such as base angle thickness, deck geometry, and connector embedment depth. The relatively large size of the welded stud connector may result in shear strength being less dependent on some test variables, however, this is not the case for the standoff screw connector. Small

changes in test parameters may result in relatively large changes in connector strength. Use of the Ollgaard et al. method for predicting shear strength is not recommended for applications utilizing the Elco standoff screw connector.

Oehlers research appears applicable in predicting the strength of standoff connectors in specimens configured with solid slabs. Rather than predicting the strength of the connector directly, Oehlers' research predicts the splitting strength of the concrete which may, in turn, limit the connector strength. Despite providing a reasonable approximation of connector strength in specimens configured with solid slabs, the use of the Oehlers model is questionable. In most instances, the Elco standoff screw connector will be utilized in building applications configured with profiled steel deck. As discussed in section 4.3, longitudinal splitting does not typically occur in configurations utilizing steel deck.

Hawkins and Mitchell (1984) developed a limit state approach to predicting connector strength in test configurations utilizing steel deck. They proposed that predicted stud strength be taken as the lesser of the values obtained by applying the Ollgaard et al. shear strength equation and their own cone pullout model (Hawkins and Mitchell 1984). Rather than developing an equation to fit specific test data, Hawkins and Mitchell developed a model which attempted to explain stud behavior. The Hawkins and Mitchell cone pullout model provides an adequate prediction of standoff screw strength in test configurations using profiled steel deck. However, the model appears to lose accuracy as screw height decreases. Decreasing screw height may tend to amplify errors in the model.

Lloyd and Wright (1990), following the work of Hawkins and Mitchell, developed a stud strength model based on the area of a wedge shaped concrete failure surface. This wedged surface is consistent with the pullout failure surfaces observed in this research. In comparing normalized experimental results with the results obtained by applying the Lloyd and Wright model, a poor correlation is noted.

Although the physical appearance of the installed Elco screw is similar to that of a shear stud, the system as a whole is different. The small size of the screw, significant flexibility of the base material associated with lightweight joist applications, and ductility of the screw itself, make many of the existing stud models inaccurate. For this reason, a new prediction model is needed.

4.7 Strength of the Elco Standoff Screw

Based on a review of the results obtained for the 65 pushout tests conducted in this study utilizing the Elco grade 8 standoff screw, it is evident that the prediction of connector strength is a complex problem depending on several variables. Base angle thickness, embedment depth, deck geometry, and concrete strength all influence the strength of the Elco connector. It is apparent, from comparing test results to the results obtained by applying several existing stud strength models, that no adequate model exists to accurately predict the strength of the standoff screw functioning as a mechanical shear connector in configurations utilizing cold rolled steel deck.

While the Lloyd and Wright wedged cone pullout model did not accurately predict the strength of the standoff screw, the failure mechanism proposed in their research (Fig. 4.1), based on a shear path of least resistance, most

accurately models observed test behavior. Due to the above observation, this section presents an equation to predict the strength of the standoff screw connector in configurations utilizing steel deck based on a rederivation of the Lloyd and Wright research.

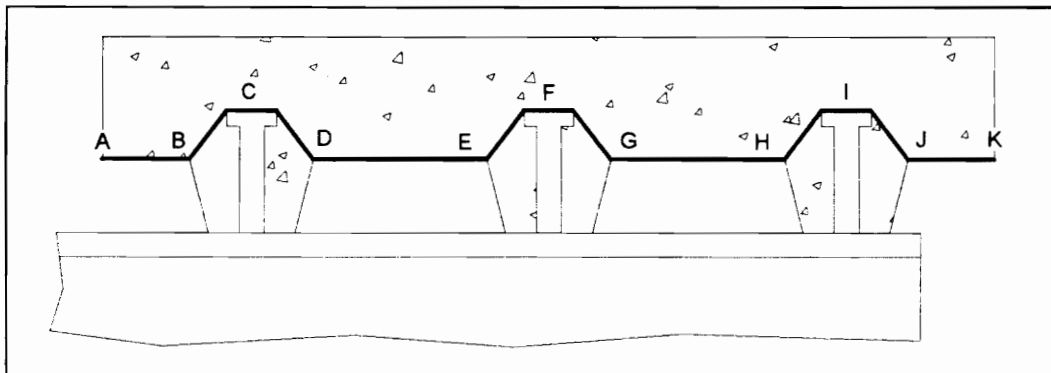


Fig. 4.1 Longitudinal Shear Path (after Lloyd and Wright 1990)

Assuming the wedge shaped failure surface presented in figure 4.2 is a suitable representation of the failure surfaces observed in the series 2 through series 5 tests, the failure surface area, A_{WC} , is given by:

$$A_{WC} = 2w_{r2}\sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} + w_{r2}\sqrt{w_{r2}^2 + 2(H_s - h_r)^2} + 2w_{r1}\sqrt{3h_r^2} \quad (4.2)$$

where:

A_{WC} = Surface area of wedge shaped tensile concrete pullout cone, in.²

h_r = Nominal rib height of steel deck, in.

H_s = Total length of shear connector, in.

w_{r1} = Concrete rib width at bottom flange of steel deck, in.

w_{r2} = Concrete rib width at top flange of steel deck, in.

Equation 4.2 is identical to the equation presented in section 1.2.1 (Eq. 1.6) with the exception that the variables have been expressed here in the English system of units.

By plotting the logarithm of the normalized average test results for the four test series utilizing steel deck (series 2-5) versus the logarithm of the wedged cone pullout area, A_{WC} (as determined by Eq. 4.2) multiplied by the square root of the normalized concrete compressive strength (3000 psi), f'_c , a linear relationship is apparent (Fig. 4.3). It should be noted that, in an attempt to increase the accuracy of the prediction model, the tests that failed by angle buckling (series 3 and 4, group 1) were ignored.

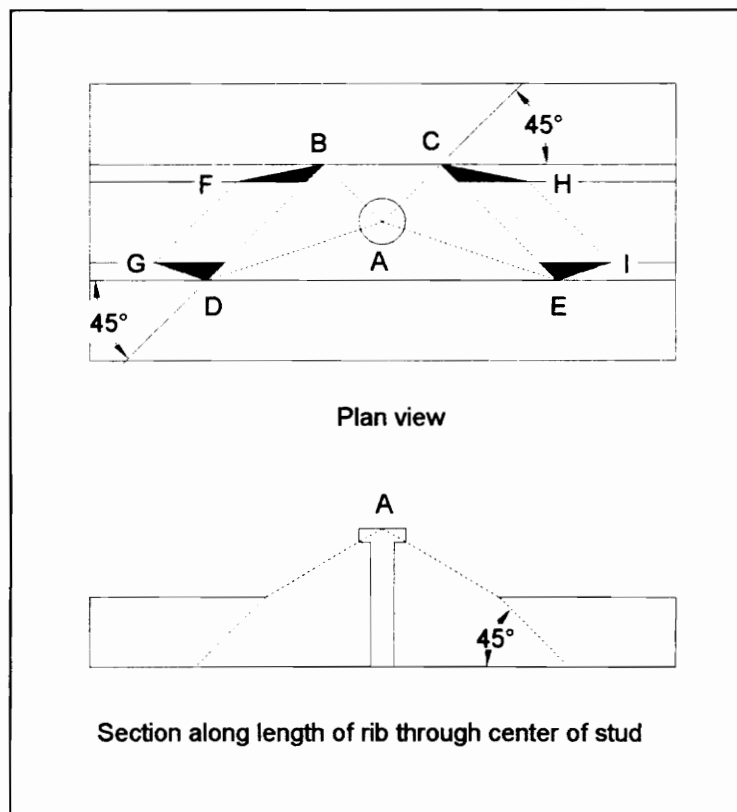


Fig. 4.2 Wedged Shear Cone (after Lloyd and Wright 1990)

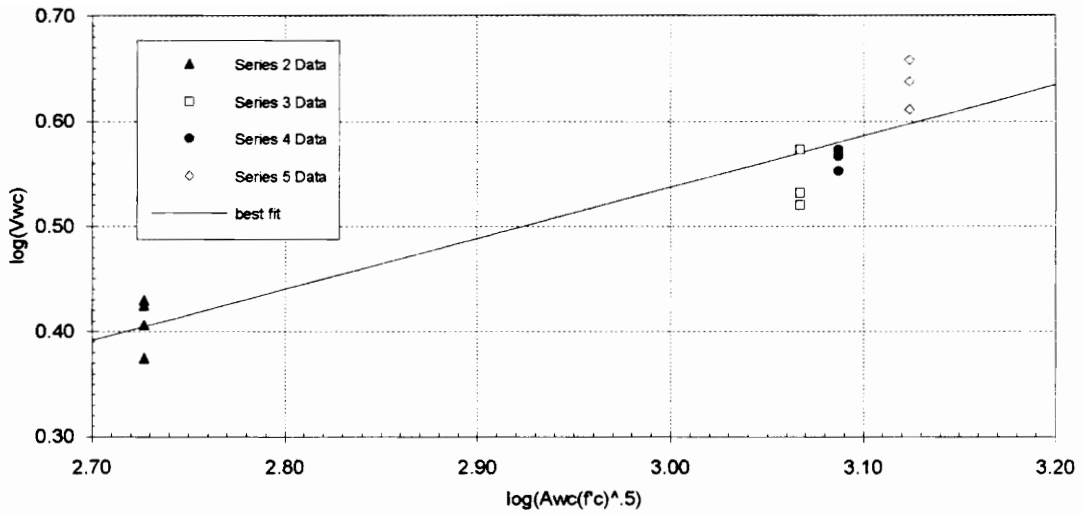


Fig. 4.3 Best Fit of Average Normalized Test Data

Using linear regression techniques, the line of best fit through the experimental data is given by the following equation:

$$\log(V_{wc}) = 0.4852(\log(A_{wc}\sqrt{f'_c})) - 0.9184 \quad (4.3)$$

where:

V_{wc} = Connector strength, kips

A_{wc} = Surface area of wedge shaped tensile concrete pullout cone, in.²

f'_c = Concrete compressive strength, psi

The coefficient of correlation (Pearson's r) associated with Eq. 4.3 is 0.94, the coefficient of determination (r^2) is 0.88. A coefficient of correlation close to 1.00 indicates that a linear prediction model yields a good approximation of the experimental data. The coefficient of determination indicates that 88% of the variation in connector strength can be explained by the variation in the area of the wedge shaped cone and the root of concrete compressive strength.

Through mathematical manipulation of Eq. 4.3, the prediction equation is presented as:

$$V_{WC} = 0.1207(A_{WC}\sqrt{f'_C})^{0.4852} \quad (4.4)$$

where:

V_{WC} = Connector strength, kips

A_{WC} = Surface area of wedge shaped tensile concrete pullout cone, in.²

f'_C = Concrete compressive strength, psi

Equation 4.4 can be simplified, by rounding of the exponents, to arrive at the following equation suitable for design purposes:

$$V_{WC} = 0.11\sqrt{A_{WC}\sqrt{f'_C}} \quad (4.5)$$

The normalized average test results are compared to the results obtained from the rederivation of the Lloyd and Wright wedged cone pullout model in Table 4.6. As can be seen in Table 4.6, no considerable loss in prediction accuracy is obtained in using the design equation (Eq. 4.5). The application of the modified Lloyd and Wright model is illustrated in the sample calculations contained in Appendix C.

Based on the results presented in Table 4.6, a strong correlation between the experimental and predicted results is noted. In most cases, the modified Lloyd and Wright model predicts the strength of the standoff screw system with acceptable accuracy. The largest errors occur in the prediction of the series 3 and 4, group 1 results. These errors can be explained by the fact that the tests in these groups failed by angle buckling. Substantial rotation at the base of the screw resulted in the formation of local buckles in the thin base angle, and consequently, failure of the system at a load lower than that calculated by

buckling theory. The unbraced length of the base angle is a controllable test variable affecting the buckling strength of the base angle, for this reason angle buckling should not be considered an ultimate limit state for the failure of a pushout test specimen. Thus, the modified Lloyd and Wright model should not be expected to accurately predict angle buckling failure.

Table 4.6 Normalized Avg. Results vs. Modified Lloyd & Wright Results

Test Series-Group	Connector Type	Normalized Shear Load/Screw (kips)	Eq. 4.4 Results (kips)	Normalized/ Eq. 4.4	Eq. 4.5 Results (kips)	Normalized/ Eq. 4.5
2-1	1.5" Elco, gr.8	2.37	2.54	0.93	2.54	0.93
2-2	1.5" Elco, gr.8	2.66	2.54	1.05	2.54	1.05
2-3	1.5" Elco, gr.8	2.69	2.54	1.06	2.54	1.06
2-4	1.5" Elco, gr.8	2.55	2.54	1.00	2.54	1.00
3-1	2" Elco, gr.8	2.72	3.71	0.73	3.76	0.72
3-2	2" Elco, gr.8	3.40	3.71	0.92	3.76	0.90
3-3	2" Elco, gr.8	3.74	3.71	1.01	3.76	0.99
3-4	2" Elco, gr.8	3.31	3.71	0.89	3.76	0.88
4-1	2" Elco, gr.8	3.13	3.80	0.82	3.85	0.81
4-2	2" Elco, gr.8	3.74	3.80	0.98	3.85	0.97
4-3	2" Elco, gr.8	3.57	3.80	0.94	3.85	0.93
4-4	2" Elco, gr.8	3.69	3.80	0.97	3.85	0.96
5-1	2.5" Elco, gr.8	4.09	3.96	1.03	4.01	1.02
5-2	2.5" Elco, gr.8	4.55	3.96	1.15	4.01	1.13
5-3	2.5" Elco, gr.8	4.34	3.96	1.10	4.01	1.08

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Summary

The purpose of this study is to evaluate the performance of the Elco grade 8 standoff screw functioning as a mechanical shear connector in composite steel joist applications. A total of sixty-five pushout tests were conducted to determine the strength and slip characteristics of the standoff screw in various geometric configurations. The pushout test was the chosen test method due to its cost effectiveness (compared to full scale tests) and the relative ease with which test configurations could be varied. Test variables included steel deck geometry, base angle thickness, embedment depth, slab width, and slab thickness.

To provide insight into the predictability of standoff screw strength, several existing shear stud strength prediction models were examined for applicability. A prediction model based on a rederivation of work performed by Lloyd and Wright (1990) is presented which predicts the ultimate strength of the Elco, grade 8, standoff screw in configurations utilizing cold rolled steel deck with acceptable accuracy.

5.2 Conclusions

Based on the results of the pushout test program, as well as the results of the analytical study, several conclusions can be drawn:

1. The Elco, grade 8, standoff screw can be used effectively to provide adequate mechanical shear connection in composite joist applications. The small diameter of the screw (0.280 in.) and means of attachment (screwing rather than welding) allow the standoff screw to be used in lightweight joist applications where conventional headed shear studs cannot be used.

2. Based on a comparison of the results of the pushout tests conducted in this study with the results obtained through the application of several existing stud strength prediction models, it is concluded that none predict the strength of the standoff screw connector in configurations utilizing steel deck with acceptable accuracy. As a result of this conclusion, a strength prediction equation based on a rederivation of a wedge shaped shear cone model (Lloyd and Wright 1990) is presented below which yields the design strength of the standoff screw with acceptable accuracy.

$$V_{WC} = 0.11\sqrt{A_{WC}\sqrt{f'_c}} \quad (5.1)$$

where:

V_{WC} = Connector strength, kips

A_{WC} = Surface area of wedge shaped tensile concrete pullout cone, in.²

$$= 2w_{r2}\sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} + w_{r2}\sqrt{w_{r2}^2 + 2(H_s - h_r)^2} + 2w_{r1}\sqrt{3h_r^2}$$

f'_c = Concrete compressive strength, psi

h_r = Nominal rib height of steel deck, in.

H_s = Total length of shear connector, in.

w_{r1} = Concrete rib width at bottom flange of steel deck, in.

w_{r2} = Concrete rib width at top flange of steel deck, in.

3. The load versus slip plots, presented in Appendix A, illustrate the great ductility of the Elco grade 8 standoff screw.

4. Plastic deformation, induced in the base angle by screw rotation, lowers the buckling strength of the top chord angle section as calculated by buckling theory.

5. As base angle thickness increases, ultimate connector strength increases up to an optimal thickness above which strength decreases. This suggests that for a given geometry an interaction between shear and tension exists.

In tests configured with thin angle sections, the flexible base allowed significant screw rotation to occur. This rotation results in a primarily tensile loading of the connector. Thus, tests configured with thin top chord sections tended to fail by tensile concrete pullout, pullout of the screw from the base angle, or angle buckling. As angle thickness was increased, base rotation decreased, thereby loading the connector in a combination of shear and tension. The test results indicate that as base angle thickness is varied, an optimal thickness can be determined that will maximize connector resistance. For the tests conducted in this study, the optimum base angle thickness appears to be approximately 0.2 in. Tests conducted with base angle thickness greater than 0.2 in. were observed to allow less screw rotation which resulted in connector failure at a lower ultimate load.

6. The concrete splitting model developed by Oehlers (1989) predicts the strength of the standoff screw in flat slab (i.e. no deck) test specimens with acceptable accuracy provided that the indirect tensile strength of concrete (f_t in Eq. 1.12) is taken as $6\sqrt{f'_c}$.

5.3 Recommendations

1. Attention should be given to the size and unbraced length of top chord angle sections in future pushout tests to ensure that an adequate factor of safety is provided against buckling failure. Considerable rotation at the base of the standoff screw connector results in plastic deformation in the base angle, which in turn, results in a lower buckling strength than that calculated by buckling theory.

2. Results of existing full scale composite joist tests should be compared to the results of the companion pushout tests conducted in this study. Further full scale joist tests should be conducted modeling pushout geometries for which no corroborating tests exist.

3. Results of full scale tests should be used to confirm the accuracy of the prediction model presented in section 4.7 based on the rederivation of the wedge shaped shear cone model proposed by Lloyd and Wright (1990).

4. Cyclic loading studies should be undertaken to gain an understanding of the performance of the standoff screw connector over a reasonable service life.

5. In order to provide greater confidence in the analytical model presented in section 4.7 (modification of Lloyd & Wright (1990)), further pushout tests should be conducted to fill in "holes" in the data. As can be seen in Fig. 4.3, no tests were conducted with geometries yielding data in the independent variable range of 2.80 to 3.00. Tests should be conducted utilizing the 2 in. screw in 0.6C deck, the 2.5 in. screw in 0.6C deck, and the 1.5 in. screw in 1.0C deck, resulting in "x" values of 2.82, 2.90, and 3.02 respectively.

6. A study should be undertaken to investigate the interaction between shear and tension in connector loading. Direct tensile pullout tests should be

conducted to determine the cone pullout strength of the standoff screw system. Withdrawal tests should be conducted to determine the pullout strength of the Elco connector from base material of varying thickness.

7. Pushout tests should be conducted utilizing welded studs attached to varying thicknesses of base material to determine if an increase in connector strength is attainable due to flexibility in the base.

5.4 Limitations

The results and conclusions presented herein apply to the Elco, grade 8, standoff screw functioning as a mechanical shear connector in configurations as tested only. No attempt should be made to extrapolate the results and conclusions found herein to other connectors and/or configurations without further testing.

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APPENDIX A

PUSHOUT TEST SUMMARY SHEET

Test: 1-1-1
 Test Designation: SC-8-2-0.109-S-4-1

Test Date: 11 JAN 93

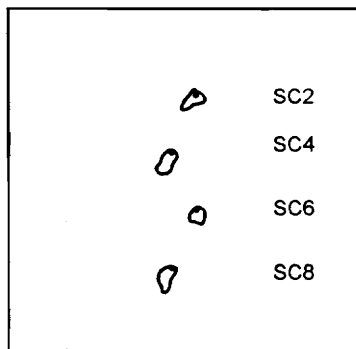
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>		
	F_y : <u>53.8 ksi</u>	F_u : <u>80.9 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3770 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

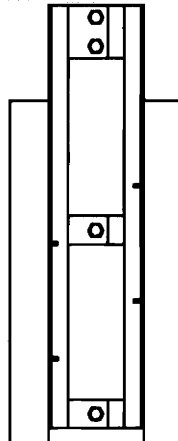
TEST RESULTS

Peak Shear Load:	<u>41.65 kips</u>		
Peak Shear Load Per Fastener:	<u>5.21 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.371 in.</u>	SC2: <u>0.245 in.</u>	
	SC3: <u>0.388 in.</u>	SC4: <u>0.258 in.</u>	
	SC5: <u>0.366 in.</u>	SC6: <u>0.210 in.</u>	
	SC7: <u>0.347 in.</u>	SC8: <u>0.224 in.</u>	

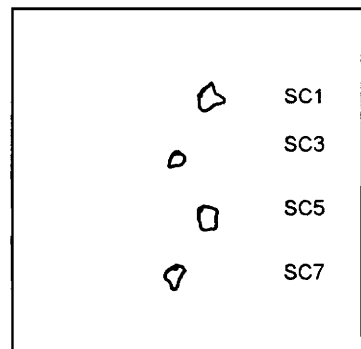
DAMAGE



South Inside



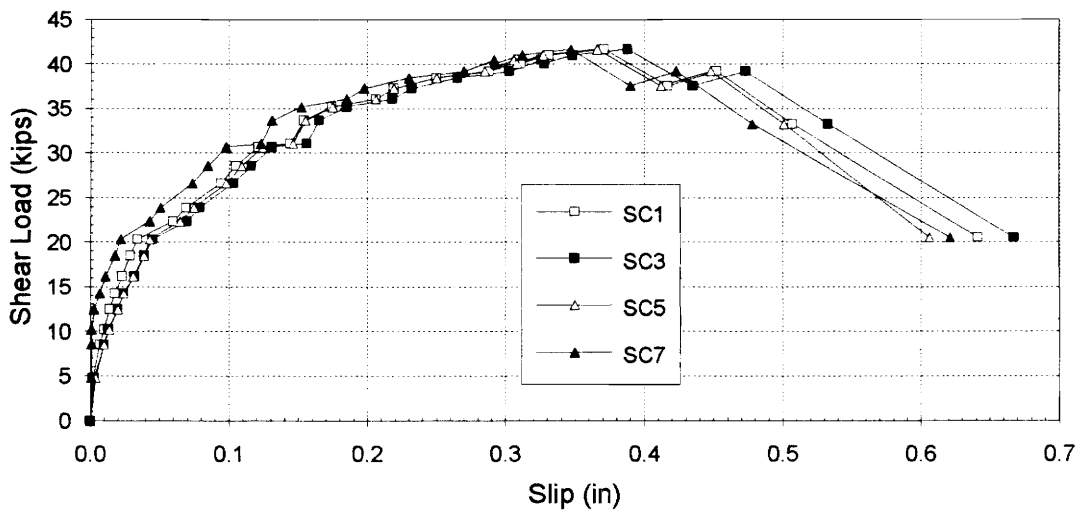
Profile



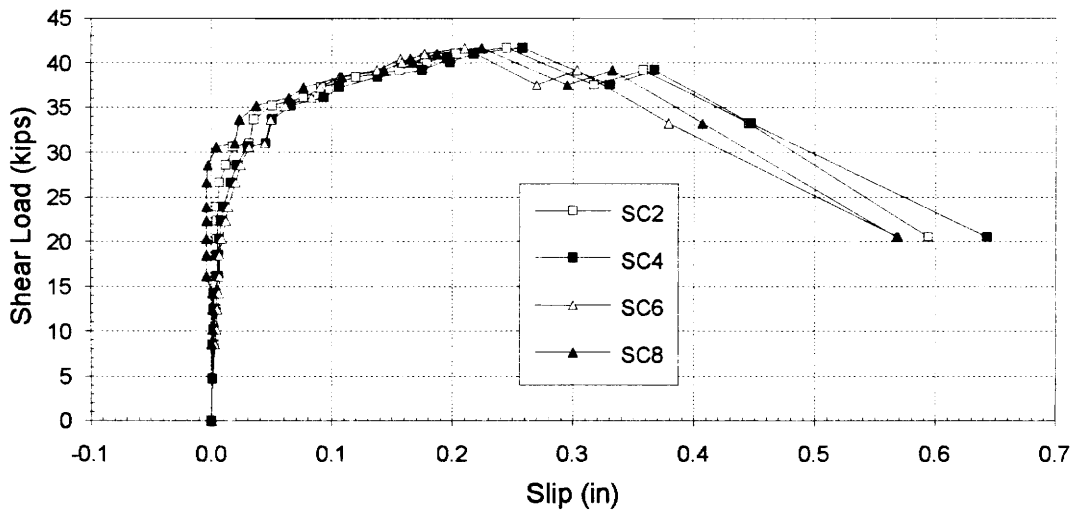
North Inside

COMMENTS

Spacer plate full length at top unbraced length, at middle in bottom
 SC2, SC4, SC6 sheared off; Minor lateral buckling
 Base angle deformed at all screw locations; Screw rotation $\geq 45^\circ$



(a) Test 1-1-1 - Load vs. North Slip



(b) Test 1-1-1 - Load vs. South Slip

Fig. A.1 Test 1-1-1 Load vs. Slip Plots

Table A.1 Test 1-1-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.79	-0.48	0.002	0.001	0.003	0.001	0.004	0.001	0.001	0.001
-8.54	-0.86	0.007	0.002	0.010	0.001	0.010	0.003	0.001	0.000
-10.22	-1.02	0.010	0.002	0.013	0.002	0.014	0.004	0.001	0.001
-12.42	-1.22	0.014	0.004	0.020	0.002	0.020	0.005	0.003	0.001
-14.23	-1.42	0.018	0.004	0.024	0.002	0.024	0.006	0.007	0.001
-16.17	-1.61	0.023	0.005	0.032	0.006	0.031	0.007	0.011	-0.004
-18.49	-1.85	0.029	0.005	0.039	0.006	0.039	0.007	0.018	-0.004
-20.31	-2.02	0.034	0.005	0.045	0.007	0.043	0.009	0.022	-0.004
-10.35	-1.08	0.035	0.006	0.044	0.007	0.044	0.009	0.023	-0.004
-5.82	-0.58	0.031	0.004	0.034	0.005	0.032	0.006	0.022	-0.004
-11.38	-1.15	0.035	0.004	0.040	0.005	0.039	0.007	0.022	-0.004
-15.78	-1.57	0.038	0.005	0.045	0.006	0.043	0.008	0.024	-0.004
-20.18	-2.02	0.049	0.005	0.057	0.007	0.054	0.009	0.033	-0.004
-22.37	-2.23	0.060	0.005	0.070	0.008	0.065	0.012	0.043	-0.004
-23.93	-2.40	0.069	0.005	0.079	0.010	0.075	0.014	0.051	-0.004
-26.64	-2.66	0.094	0.007	0.103	0.016	0.098	0.020	0.074	-0.004
-28.58	-2.87	0.105	0.012	0.116	0.021	0.109	0.024	0.085	-0.003
-30.65	-3.07	0.121	0.018	0.131	0.030	0.124	0.031	0.098	0.004
-31.04	-3.10	0.144	0.031	0.156	0.045	0.146	0.044	0.123	0.019
-33.63	-3.36	0.154	0.035	0.165	0.050	0.155	0.049	0.131	0.023
-35.18	-3.54	0.174	0.050	0.185	0.066	0.175	0.061	0.152	0.037
-36.08	-3.65	0.206	0.076	0.218	0.093	0.206	0.083	0.185	0.064
-37.25	-3.76	0.219	0.091	0.232	0.106	0.219	0.090	0.198	0.076
-38.41	-3.86	0.250	0.120	0.265	0.138	0.250	0.106	0.230	0.108
-39.19	-3.92	0.288	0.156	0.303	0.175	0.285	0.137	0.270	0.143
-40.48	-4.05	0.310	0.177	0.326	0.196	0.306	0.157	0.292	0.165
-40.09	-4.03	0.311	0.179	0.328	0.198	0.308	0.158	0.293	0.167
-41.00	-4.11	0.331	0.203	0.348	0.218	0.327	0.177	0.312	0.187
-41.65	-4.15	0.371	0.245	0.388	0.258	0.366	0.210	0.347	0.224
-37.51	-3.79	0.417	0.317	0.435	0.330	0.412	0.270	0.390	0.295
-39.19	-3.93	0.452	0.358	0.473	0.367	0.448	0.303	0.423	0.332
-33.24	-3.37	0.507	0.445	0.533	0.447	0.501	0.379	0.478	0.407
-20.56	-2.11	0.641	0.594	0.667	0.643	0.606	0.569	0.621	0.568

PUSHOUT TEST SUMMARY SHEET

Test: 1-1-2
Test Designation: SC-8-2-0.109-S-4-2

Test Date: 12 JAN 93

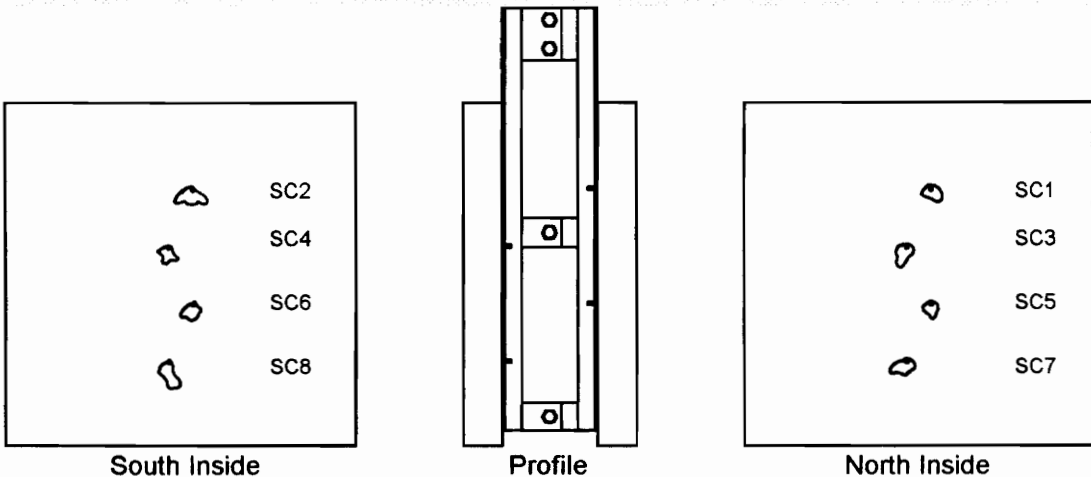
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>		
	F_y : <u>53.8 ksi</u>	F_u : <u>80.9 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3770 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

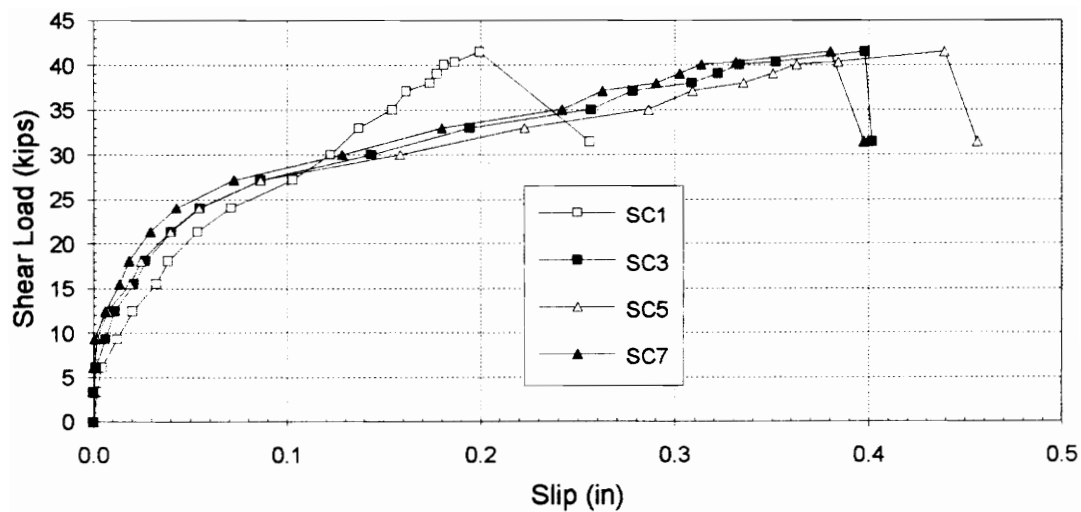
Peak Shear Load:	<u>41.52 kips</u>		
Peak Shear Load Per Fastener:	<u>5.19 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.199 in.</u>	SC2: <u>0.353 in.</u>	
	SC3: <u>0.398 in.</u>	SC4: <u>0.395 in.</u>	
	SC5: <u>0.439 in.</u>	SC6: <u>0.333 in.</u>	
	SC7: <u>0.380 in.</u>	SC8: <u>0.316 in.</u>	

DAMAGE

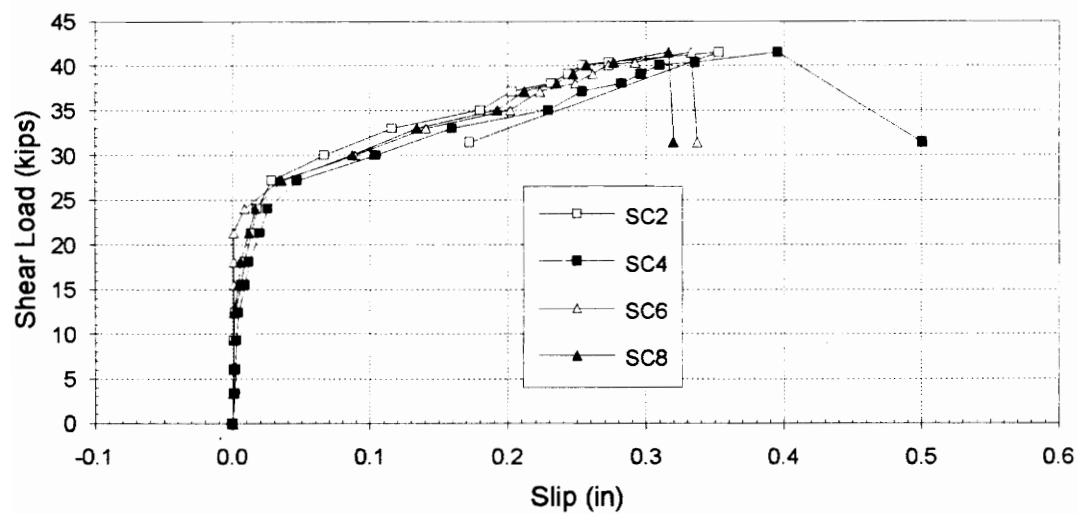


COMMENTS

Spacer plate full length at top unbraced length, at middle in bottom
South angle assembly buckled laterally above SC2
Base angle deformed at all screw locations; Screw rotation $\approx 30^\circ$ - 45°



(a) Test 1-1-2 - Load vs. North Slip



(b) Test 1-1-2 - Load vs. South Slip

Fig. A.2 Test 1-1-2 Load vs. Slip Plots

Table A.2 Test 1-1-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
-3.36	-0.35	0.002	0.001	0.000	0.001	0.001	0.000	0.000	0.000
-6.08	-0.62	0.004	0.001	0.001	0.002	0.001	0.001	0.000	0.001
-9.31	-0.93	0.012	0.001	0.006	0.002	0.002	0.001	0.001	0.001
-12.42	-1.23	0.020	0.001	0.011	0.004	0.007	0.001	0.006	0.001
-15.52	-1.55	0.032	0.006	0.021	0.009	0.019	0.001	0.013	0.004
-18.11	-1.81	0.039	0.009	0.027	0.012	0.024	0.001	0.018	0.006
-21.34	-2.12	0.054	0.013	0.040	0.020	0.040	0.001	0.029	0.012
-24.06	-2.41	0.071	0.018	0.055	0.026	0.054	0.009	0.043	0.017
-27.16	-2.72	0.103	0.028	0.086	0.047	0.086	0.034	0.072	0.036
-30.01	-3.01	0.122	0.067	0.144	0.104	0.158	0.089	0.129	0.087
-32.98	-3.31	0.137	0.116	0.195	0.159	0.223	0.141	0.180	0.134
-35.05	-3.50	0.154	0.180	0.257	0.229	0.286	0.202	0.242	0.192
-37.12	-3.71	0.162	0.203	0.278	0.254	0.309	0.223	0.263	0.212
-38.02	-3.80	0.174	0.231	0.309	0.282	0.335	0.248	0.290	0.235
-39.06	-3.91	0.177	0.243	0.322	0.296	0.351	0.261	0.303	0.247
-40.09	-4.01	0.181	0.254	0.333	0.310	0.363	0.273	0.314	0.257
-40.35	-4.05	0.187	0.273	0.352	0.335	0.384	0.292	0.331	0.276
-41.52	-4.15	0.199	0.353	0.398	0.395	0.439	0.333	0.380	0.316
-31.43	-3.16	0.256	0.172	0.402	0.500	0.456	0.337	0.398	0.320

PUSHOUT TEST SUMMARY SHEET

Test: 1-1-3
 Test Designation: SC-8-2-0.109-S-4-3

Test Date: 12 JAN 93

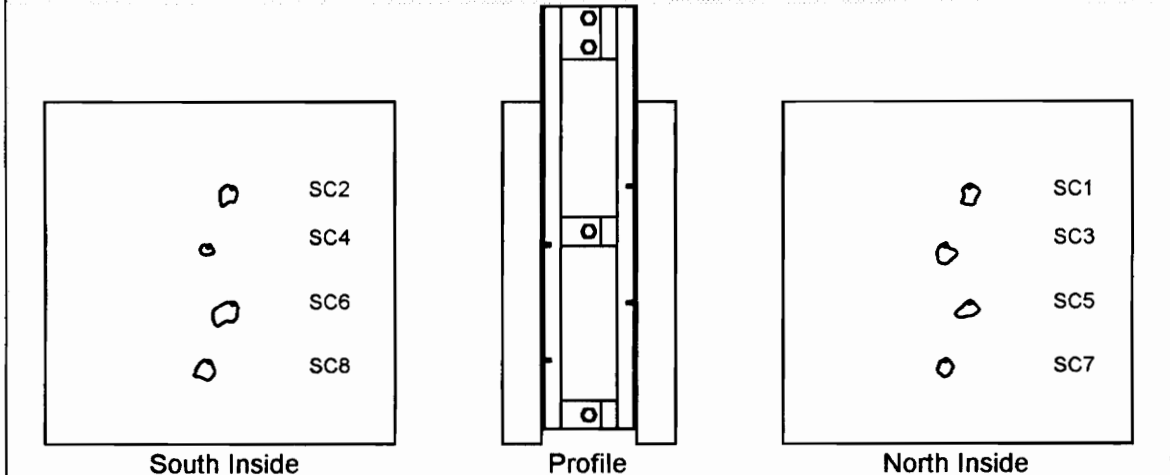
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>		
	F_y : <u>53.8 ksi</u>	F_u : <u>80.9 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3770 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

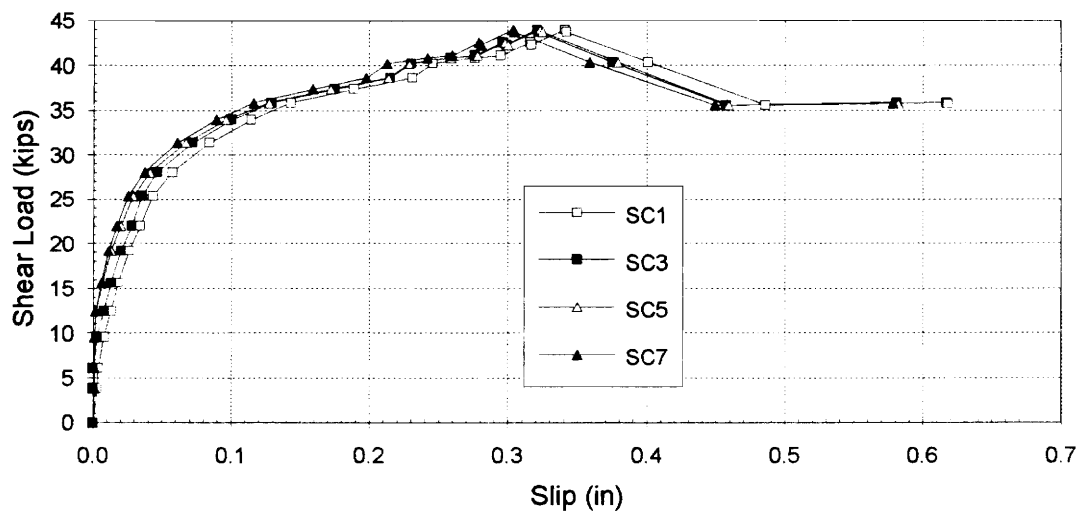
Peak Shear Load:	<u>43.97 kips</u>		
Peak Shear Load Per Fastener:	<u>5.50 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.341 in.</u>	SC2: <u>0.254 in.</u>	
	SC3: <u>0.321 in.</u>	SC4: <u>0.281 in.</u>	
	SC5: <u>0.323 in.</u>	SC6: <u>0.326 in.</u>	
	SC7: <u>0.304 in.</u>	SC8: <u>0.276 in.</u>	

DAMAGE

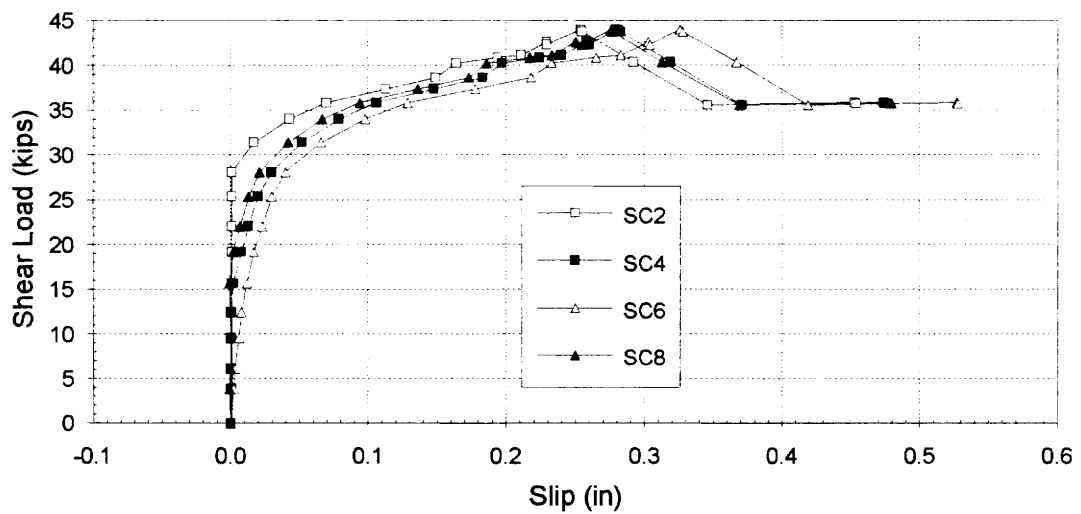


COMMENTS

Spacer plate full length at top unbraced length, at middle in bottom
 SC1, SC5, SC7 sheared off, SC3 pulled out of base angle
 Base angle deformed at all screw locations; Screw rotation $\geq 45^\circ$



(a) Test 1-1-3 - Load vs. North Slip



(b) Test 1-1-3 - Load vs. South Slip

Fig. A.3 Test 1-1-3 Load vs. Slip Plots

Table A.3 Test 1-1-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-3.88	-0.39	0.003	0.001	0.000	0.000	0.000	0.002	0.001	-0.001
-6.08	-0.61	0.004	0.001	0.000	0.000	0.000	0.003	0.001	0.000
-9.57	-0.96	0.008	0.001	0.003	0.000	0.001	0.006	0.001	0.000
-12.42	-1.24	0.013	0.001	0.008	0.000	0.002	0.008	0.002	0.000
-15.65	-1.56	0.018	0.001	0.013	0.002	0.007	0.012	0.006	-0.001
-19.14	-1.91	0.026	0.001	0.020	0.008	0.013	0.017	0.011	0.002
-21.99	-2.21	0.034	0.001	0.028	0.013	0.020	0.023	0.017	0.007
-25.35	-2.53	0.043	0.001	0.035	0.020	0.029	0.030	0.025	0.013
-28.07	-2.82	0.057	0.001	0.046	0.030	0.041	0.040	0.037	0.021
-31.43	-3.14	0.084	0.017	0.072	0.052	0.067	0.066	0.061	0.042
-34.01	-3.40	0.114	0.043	0.100	0.079	0.096	0.098	0.089	0.067
-35.83	-3.60	0.143	0.070	0.129	0.106	0.127	0.129	0.116	0.094
-37.38	-3.75	0.189	0.113	0.175	0.148	0.172	0.178	0.159	0.136
-38.67	-3.87	0.231	0.149	0.215	0.183	0.214	0.218	0.198	0.173
-40.22	-4.02	0.246	0.164	0.230	0.197	0.229	0.233	0.213	0.186
-40.87	-4.10	0.276	0.194	0.259	0.224	0.259	0.265	0.242	0.217
-41.13	-4.10	0.295	0.211	0.276	0.240	0.278	0.283	0.260	0.233
-42.55	-4.27	0.316	0.229	0.296	0.258	0.298	0.303	0.279	0.250
-42.29	-4.23	0.317	0.229	0.299	0.260	0.300	0.304	0.281	0.255
-43.97	-4.39	0.341	0.254	0.321	0.281	0.323	0.326	0.304	0.276
-43.71	-4.38	0.342	0.255	0.322	0.283	0.325	0.328	0.305	0.277
-40.35	-4.05	0.401	0.292	0.375	0.319	0.379	0.367	0.359	0.313
-35.57	-3.56	0.486	0.346	0.457	0.371	0.459	0.419	0.449	0.369
-35.83	-3.56	0.617	0.453	0.581	0.474	0.582	0.527	0.578	0.479
-35.70	-3.58	0.618	0.454	0.581	0.475	0.582	0.528	0.579	0.480

PUSHOUT TEST SUMMARY SHEET

Test: 1-2-1
Test Designation: SC-8-2-0.123-S-4-1

Test Date: 05 JAN 93

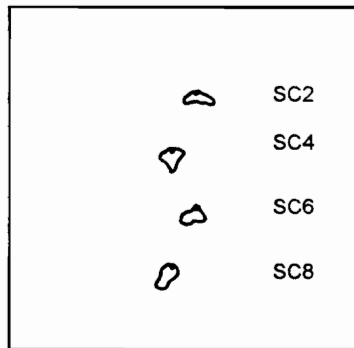
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.123</u>		
	F_y : <u>58.1 ksi</u>	F_u : <u>87.5 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3870 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

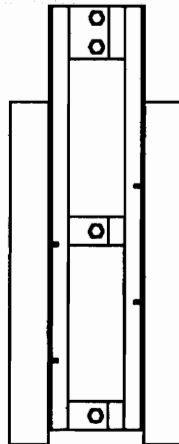
TEST RESULTS

Peak Shear Load:	<u>51.99 kips</u>		
Peak Shear Load Per Fastener:	<u>6.50 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.606 in.</u>	SC2: <u>0.498 in.</u>	
	SC3: <u>0.458 in.</u>	SC4: <u>0.538 in.</u>	
	SC5: <u>0.417 in.</u>	SC6: <u>0.488 in.</u>	
	SC7: <u>0.453 in.</u>	SC8: <u>xxx in.</u>	

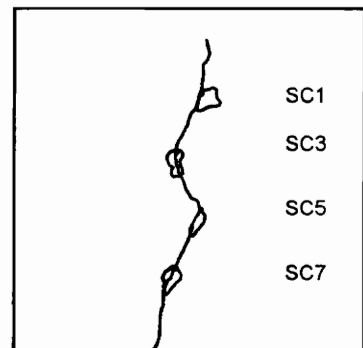
DAMAGE



South Inside



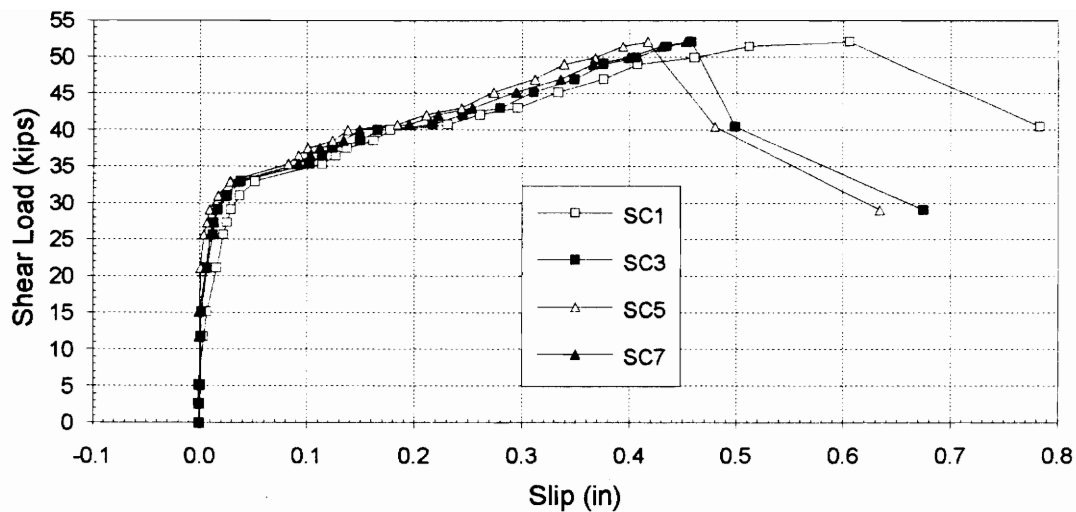
Profile



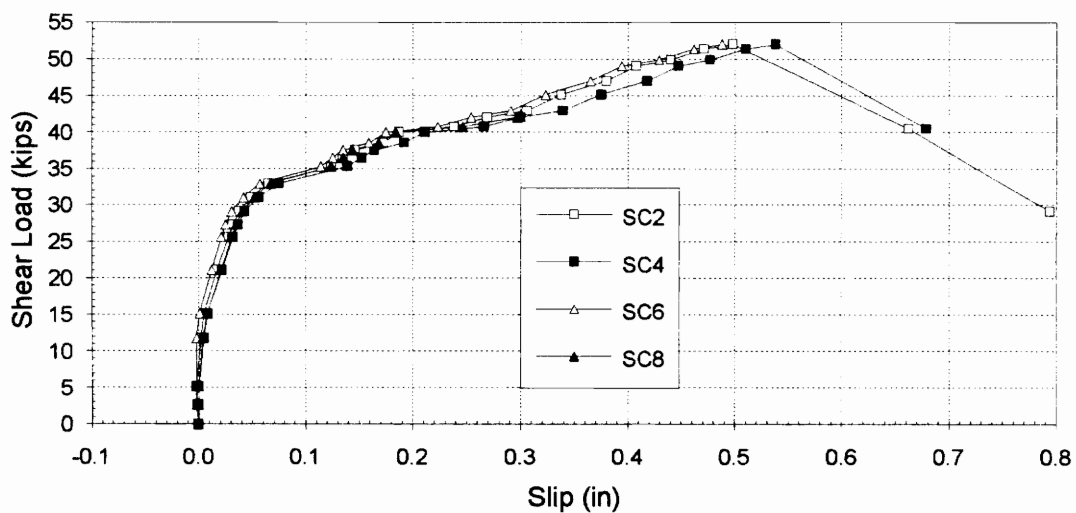
North Inside

COMMENTS

Longitudinal splitting of north slab; SC2 sheared off, SC6 pulled out of base angle
Base angle deformed at all screw locations; Screw rotation $\geq 45^\circ$
Base angles buckled laterally between plates; Potentiometers slipped



(a) Test 1-2-1 - Load vs. North Slip



(b) Test 1-2-1 - Load vs. South Slip

Fig. A.4 Test 1-2-1 Load vs. Slip Plots

Table A.4 Test 1-2-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-2.59	-0.26	-0.001	-0.001	0.000	0.000	0.000	-0.002	0.000	0.000
-5.17	-0.53	-0.001	-0.002	0.001	0.000	0.000	-0.002	0.000	0.000
-11.77	-1.18	0.004	0.002	0.001	0.005	0.000	-0.002	0.000	0.004
-15.13	-1.52	0.007	0.005	0.002	0.008	0.000	0.001	0.000	0.008
-21.08	-2.13	0.016	0.017	0.007	0.022	0.001	0.012	0.006	0.021
-25.61	-2.56	0.022	0.028	0.012	0.032	0.004	0.021	0.010	0.031
-27.29	-2.73	0.025	0.032	0.013	0.037	0.007	0.025	0.013	0.035
-29.10	-2.93	0.029	0.038	0.017	0.043	0.009	0.031	0.016	0.041
-31.04	-3.11	0.037	0.049	0.025	0.056	0.017	0.042	0.024	0.052
-32.98	-3.31	0.051	0.065	0.038	0.075	0.028	0.057	0.035	0.067
-35.31	-3.51	0.114	0.124	0.102	0.139	0.082	0.114	0.092	0.124
-36.47	-3.67	0.127	0.135	0.114	0.152	0.092	0.125	0.103	0.135
-37.51	-3.78	0.137	0.146	0.124	0.164	0.101	0.135	0.112	0.144
-38.54	-3.87	0.162	0.172	0.150	0.192	0.124	0.159	0.134	0.168
-39.96	-4.02	0.178	0.187	0.166	0.211	0.138	0.175	0.149	0.184
-40.74	-4.07	0.231	0.238	0.217	0.266	0.184	0.223	0.195	0.246
-42.03	-4.27	0.261	0.269	0.245	0.300	0.211	0.254	0.222	0.297
-42.94	-4.31	0.296	0.306	0.280	0.339	0.244	0.291	0.254	xxx
-45.14	-4.51	0.334	0.338	0.311	0.375	0.274	0.323	0.295	xxx
-46.95	-4.69	0.376	0.380	0.349	0.418	0.312	0.365	0.336	xxx
-49.02	-4.88	0.408	0.408	0.376	0.447	0.339	0.394	0.366	xxx
-49.92	-4.98	0.461	0.440	0.406	0.477	0.368	0.429	0.399	xxx
-51.35	-5.15	0.512	0.471	0.435	0.510	0.394	0.462	0.430	xxx
-51.99	-5.22	0.606	0.498	0.458	0.538	0.417	0.488	0.453	xxx
-40.48	-4.05	0.783	0.662	0.499	0.679	0.480	0.685	0.837	xxx
-29.10	-3.17	2.074	0.794	0.675	1.781	0.634	0.810	0.997	xxx

PUSHOUT TEST SUMMARY SHEET

Test: 1-2-2
 Test Designation: SC-8-2-0.123-S-4-2

Test Date: 06 JAN 93

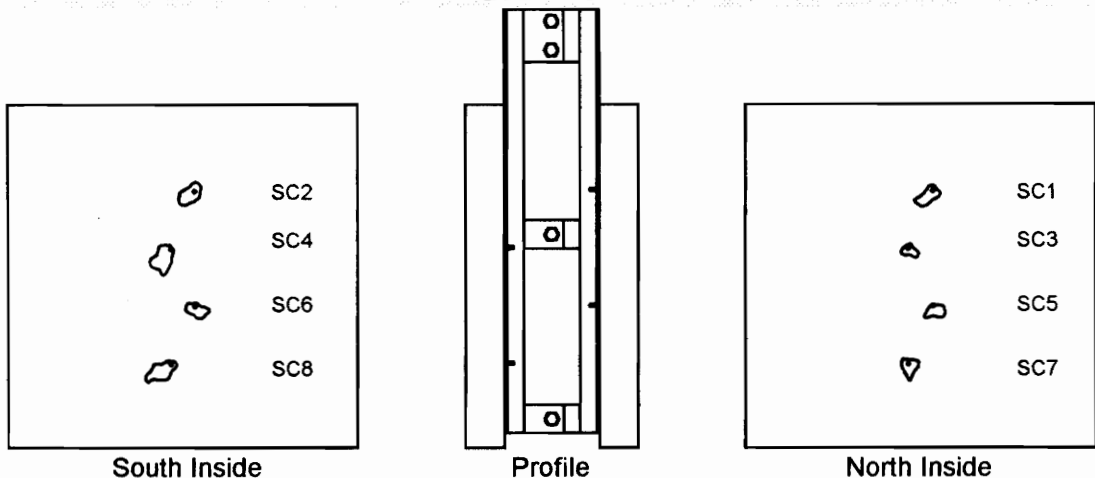
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.123</u>		
	F_y : <u>58.1 ksi</u>	F_u : <u>87.5 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3805 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

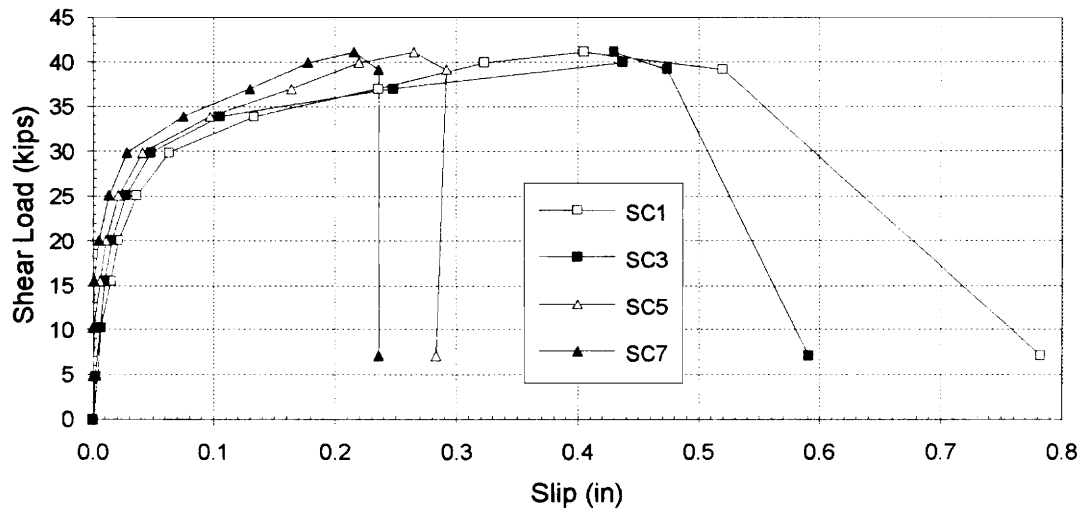
Peak Shear Load: <u>41.13 kips</u>		
Peak Shear Load Per Fastener: <u>5.14 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.405 in.</u>	SC2: <u>0.242 in.</u>
	SC3: <u>0.430 in.</u>	SC4: <u>0.335 in.</u>
	SC5: <u>0.265 in.</u>	SC6: <u>0.294 in.</u>
	SC7: <u>0.216 in.</u>	SC8: <u>0.278 in.</u>

DAMAGE

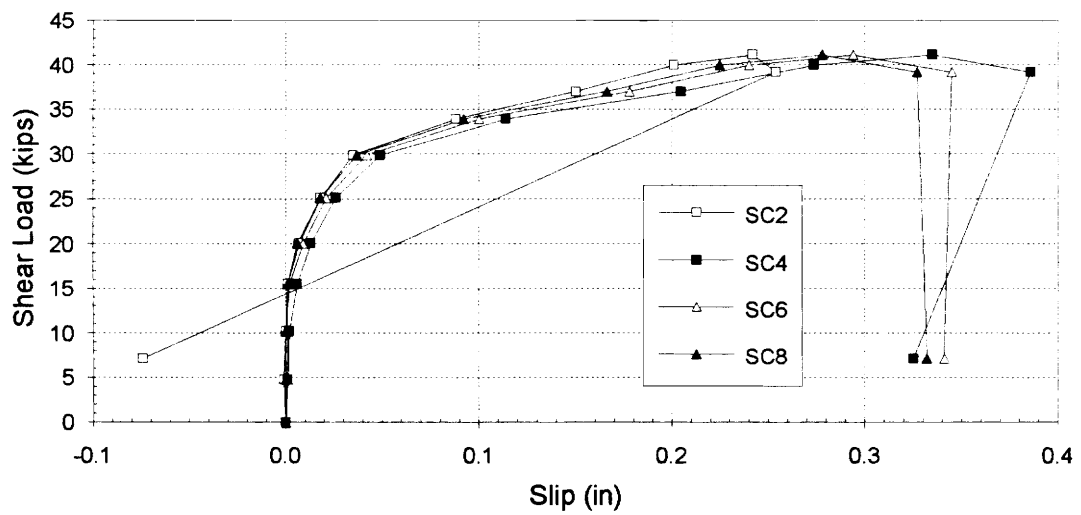


COMMENTS

Spacer plates at middle of unbraced lengths, top and bottom
 Entire angle assembly buckled laterally above SC1; Screw rotation $\approx 30^\circ$
 Base angle deformed at all screw locations; Potentiometer at SC3 Loose



(a) Test 1-2-2 - Load vs. North Slip



(b) Test 1-2-2 - Load vs. South Slip

Fig. A.5 Test 1-2-2 Load vs. Slip Plots

Table A.5 Test 1-2-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.79	-0.53	0.004	-0.001	0.002	0.001	0.000	0.000	0.000	0.001
-10.22	-1.02	0.007	0.000	0.006	0.002	0.001	0.000	0.000	0.001
-15.52	-1.55	0.015	0.001	0.010	0.006	0.006	0.002	0.001	0.001
-20.05	-2.04	0.021	0.007	0.016	0.013	0.011	0.009	0.005	0.006
-25.09	-2.52	0.036	0.018	0.027	0.026	0.021	0.021	0.013	0.018
-29.88	-3.01	0.063	0.035	0.048	0.049	0.041	0.042	0.028	0.037
-33.89	-3.42	0.133	0.088	0.105	0.114	0.097	0.100	0.075	0.092
-36.99	-3.75	0.236	0.150	0.248	0.205	0.164	0.178	0.130	0.166
-39.96	-4.01	0.323	0.201	0.437	0.274	0.220	0.240	0.178	0.225
-41.13	-4.12	0.405	0.242	0.430	0.335	0.265	0.294	0.216	0.278
-39.19	-3.93	0.520	0.254	0.474	0.386	0.292	0.345	0.236	0.327
-7.11	-3.89	0.782	-0.074	0.591	0.325	0.283	0.341	0.236	0.332

PUSHOUT TEST SUMMARY SHEET

Test: 1-2-3
 Test Designation: SC-8-2-0.123-S-4-3

Test Date: 07 JAN 93

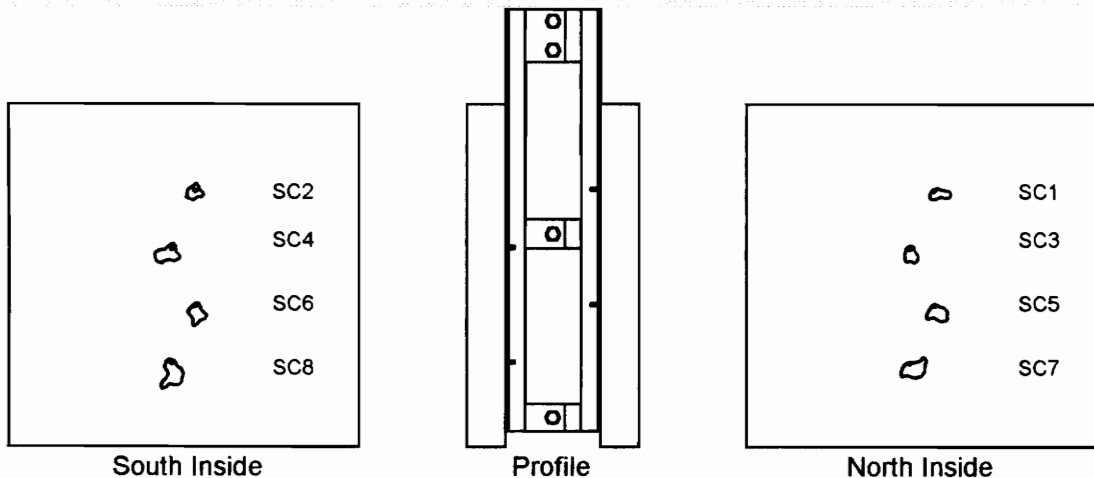
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.123</u>		
	F_y : <u>58.1 ksi</u>	F_u : <u>87.5 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3740 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

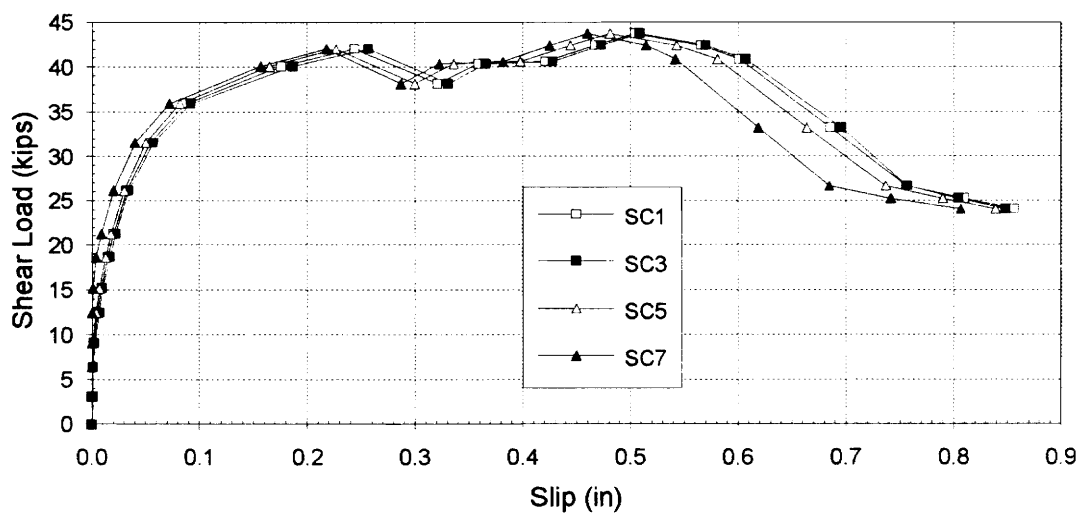
Peak Shear Load: <u>43.71 kips</u>									
Peak Shear Load Per Fastener: <u>5.46 kips</u>									
Slip at Peak Shear Load:	<table border="0" style="width: 100%;"> <tr> <td>SC1: <u>0.504 in.</u></td> <td>SC2: <u>0.463 in.</u></td> </tr> <tr> <td>SC3: <u>0.509 in.</u></td> <td>SC4: <u>0.470 in.</u></td> </tr> <tr> <td>SC5: <u>0.481 in.</u></td> <td>SC6: <u>0.397 in.</u></td> </tr> <tr> <td>SC7: <u>0.460 in.</u></td> <td>SC8: <u>0.395 in.</u></td> </tr> </table>	SC1: <u>0.504 in.</u>	SC2: <u>0.463 in.</u>	SC3: <u>0.509 in.</u>	SC4: <u>0.470 in.</u>	SC5: <u>0.481 in.</u>	SC6: <u>0.397 in.</u>	SC7: <u>0.460 in.</u>	SC8: <u>0.395 in.</u>
SC1: <u>0.504 in.</u>	SC2: <u>0.463 in.</u>								
SC3: <u>0.509 in.</u>	SC4: <u>0.470 in.</u>								
SC5: <u>0.481 in.</u>	SC6: <u>0.397 in.</u>								
SC7: <u>0.460 in.</u>	SC8: <u>0.395 in.</u>								

DAMAGE

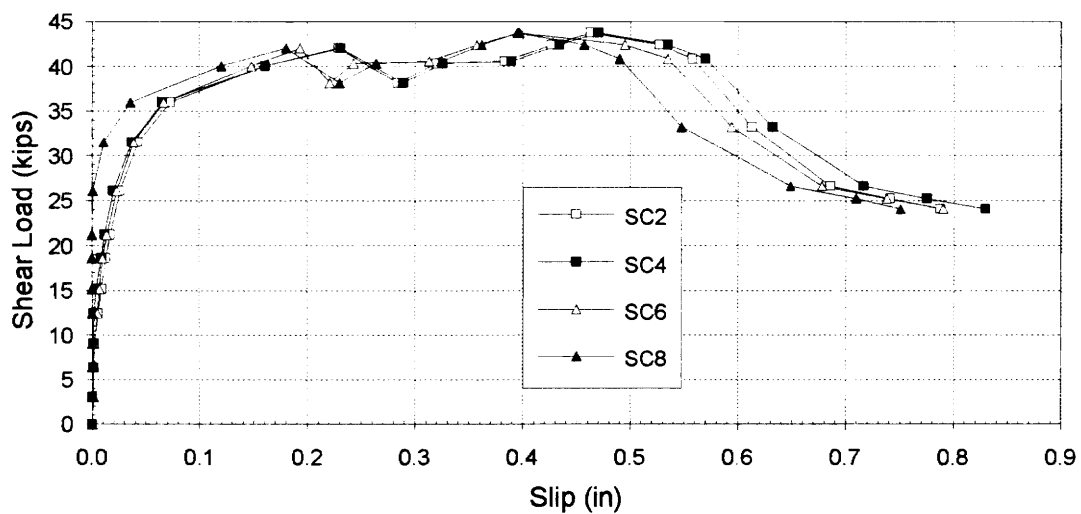


COMMENTS

Spacer plate full length at top unbraced length, at middle in bottom
 SC1 and SC2 sheared off; minor lateral buckling between plates in bottom
 Base angle deformed at all screw locations; Rotation $\geq 45^\circ$



(a) Test 1-2-3 - Load vs. North Slip



(b) Test 1-2-3 - Load vs. South Slip

Fig. A.6 Test 1-2-3 Load vs. Slip Plots

Table A.6 Test 1-2-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-3.10	-0.32	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000
-6.34	-0.64	0.001	0.001	0.001	0.001	0.000	0.001	0.000	0.000
-9.05	-0.91	0.002	0.002	0.003	0.001	0.001	0.002	0.000	0.000
-12.42	-1.25	0.005	0.006	0.007	0.002	0.004	0.005	0.000	0.000
-15.13	-1.51	0.009	0.009	0.010	0.004	0.007	0.007	0.001	0.000
-18.62	-1.86	0.015	0.013	0.017	0.009	0.013	0.010	0.004	0.000
-21.21	-2.16	0.020	0.017	0.022	0.012	0.018	0.014	0.009	0.000
-26.13	-2.60	0.032	0.026	0.034	0.020	0.030	0.023	0.020	0.001
-31.56	-3.15	0.054	0.043	0.057	0.037	0.050	0.039	0.040	0.011
-35.95	-3.60	0.087	0.073	0.092	0.066	0.082	0.067	0.072	0.036
-40.09	-4.03	0.176	0.161	0.187	0.161	0.165	0.148	0.157	0.120
-42.03	-4.21	0.244	0.229	0.257	0.231	0.227	0.193	0.218	0.180
-38.15	-3.84	0.321	0.284	0.331	0.289	0.300	0.221	0.287	0.230
-40.35	-4.04	0.359	0.320	0.366	0.326	0.336	0.243	0.323	0.264
-40.61	-4.06	0.421	0.383	0.428	0.390	0.398	0.313	0.382	0.324
-42.42	-4.24	0.467	0.427	0.473	0.434	0.444	0.357	0.425	0.362
-43.71	-4.38	0.504	0.463	0.509	0.470	0.481	0.397	0.460	0.395
-42.42	-4.24	0.566	0.527	0.570	0.535	0.543	0.495	0.515	0.457
-40.87	-4.11	0.601	0.558	0.607	0.570	0.581	0.535	0.542	0.490
-33.24	-3.33	0.686	0.613	0.696	0.632	0.664	0.594	0.619	0.548
-26.64	-2.69	0.756	0.686	0.757	0.717	0.737	0.678	0.685	0.649
-25.22	-2.59	0.810	0.741	0.805	0.775	0.790	0.738	0.742	0.710
-24.06	-2.40	0.857	0.788	0.849	0.830	0.839	0.790	0.807	0.751

PUSHOUT TEST SUMMARY SHEET

Test: 1-3-1
Test Designation: SC-8-2-0.170-S-4-1

Test Date: 19 NOV 92

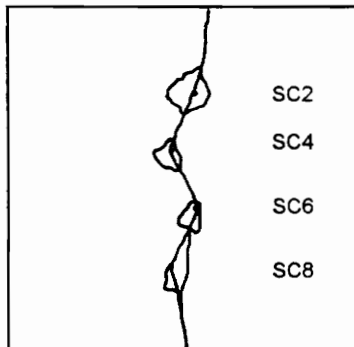
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.170</u>		
	F_y : <u>55.6 ksi</u>	F_u : <u>83.8 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3500 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

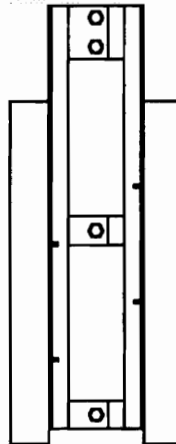
TEST RESULTS

Peak Shear Load:	<u>48.76 kips</u>	
Peak Shear Load Per Fastener:	<u>6.09 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.365 in.</u>	SC2: <u>0.428 in.</u>
	SC3: <u>0.377 in.</u>	SC4: <u>0.437 in.</u>
	SC5: <u>0.308 in.</u>	SC6: <u>0.428 in.</u>
	SC7: <u>0.340 in.</u>	SC8: <u>0.413 in.</u>

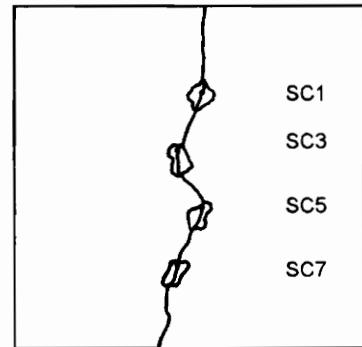
DAMAGE



South Inside



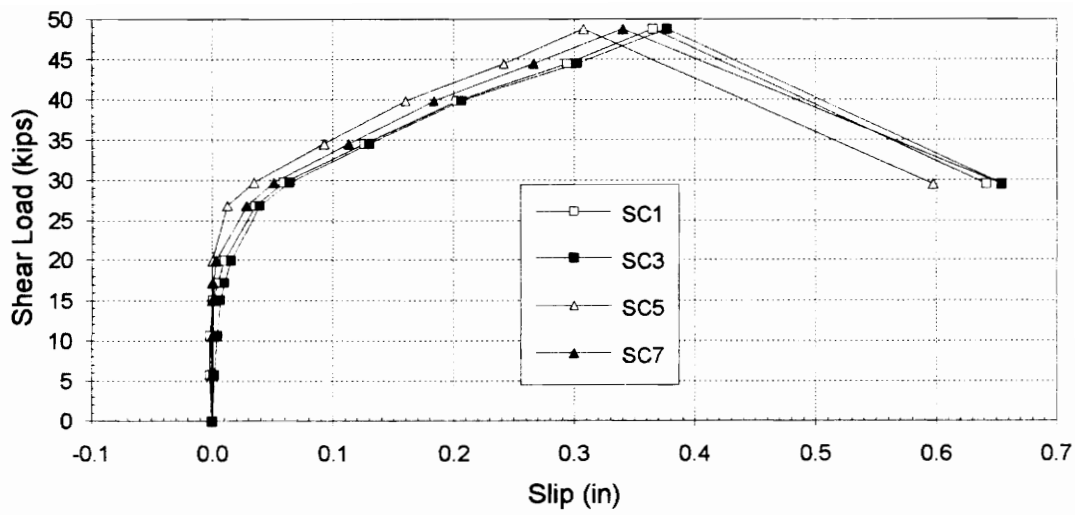
Profile



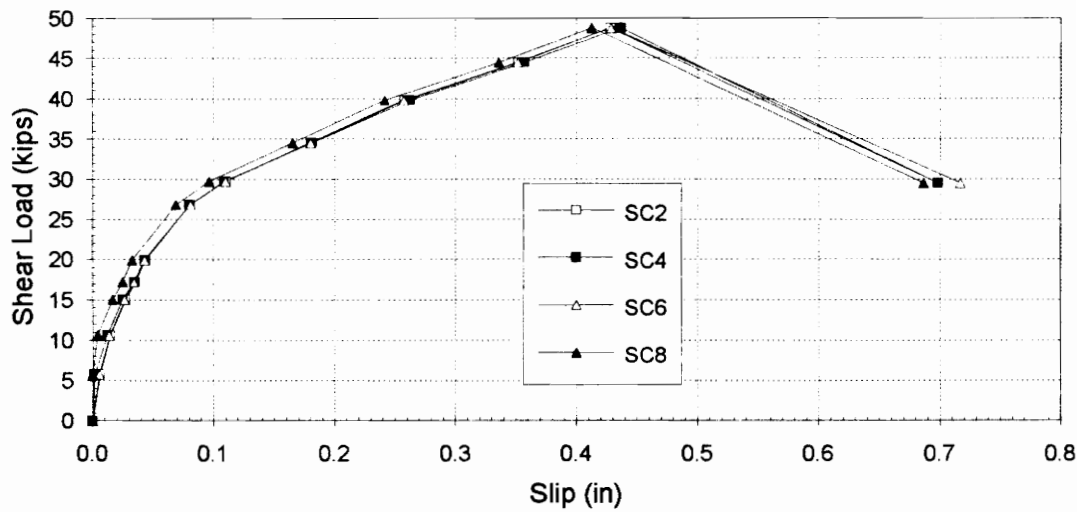
North Inside

COMMENTS

Longitudinal splitting, bottom to top, both slabs; SC1 Sheared Off
Base angle deformed at all screw locations; Screw rotation $\geq 45^\circ$



(a) Test 1-3-1 - Load vs. North Slip



(b) Test 1-3-1 - Load vs. South Slip

Fig. A.7 Test 1-3-1 Load vs. Slip Plots

Table A.7 Test 1-3-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.69	-0.52	-0.002	0.006	0.002	0.002	0.000	0.005	0.001	0.000
-10.61	-1.01	-0.002	0.015	0.004	0.012	0.000	0.014	0.001	0.004
-15.00	-1.52	0.001	0.028	0.007	0.025	0.000	0.027	0.001	0.017
-17.20	-1.78	0.004	0.036	0.010	0.035	0.000	0.035	0.001	0.025
-19.92	-2.04	0.010	0.044	0.015	0.043	0.000	0.043	0.003	0.033
-26.77	-2.55	0.035	0.081	0.039	0.081	0.012	0.081	0.028	0.069
-29.75	-2.96	0.059	0.110	0.064	0.109	0.034	0.110	0.051	0.097
-34.53	-3.50	0.126	0.181	0.130	0.181	0.093	0.180	0.113	0.165
-39.83	-4.01	0.203	0.258	0.206	0.263	0.160	0.257	0.184	0.241
-44.49	-4.42	0.294	0.352	0.302	0.357	0.242	0.352	0.266	0.336
-48.76	-4.91	0.365	0.428	0.377	0.437	0.308	0.428	0.340	0.413
-29.49	-4.57	0.641	0.698	0.655	0.698	0.597	0.716	0.654	0.686

PUSHOUT TEST SUMMARY SHEET

Test: 1-3-2
Test Designation: SC-8-2-0.170-S-4-2

Test Date: 12 JAN 93

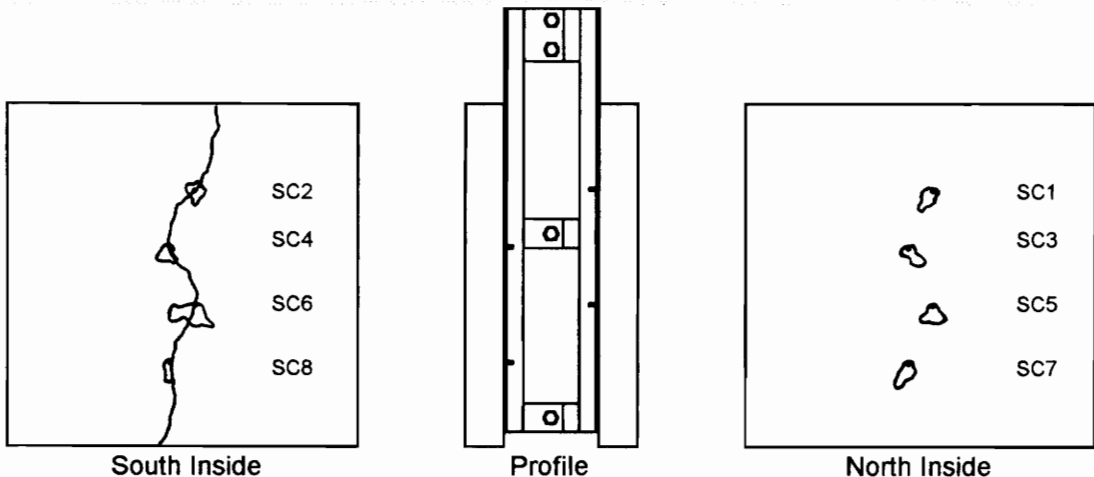
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.170</u>		
	F_y : <u>55.6 ksi</u>	F_u : <u>83.8 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f_c : <u>3770 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

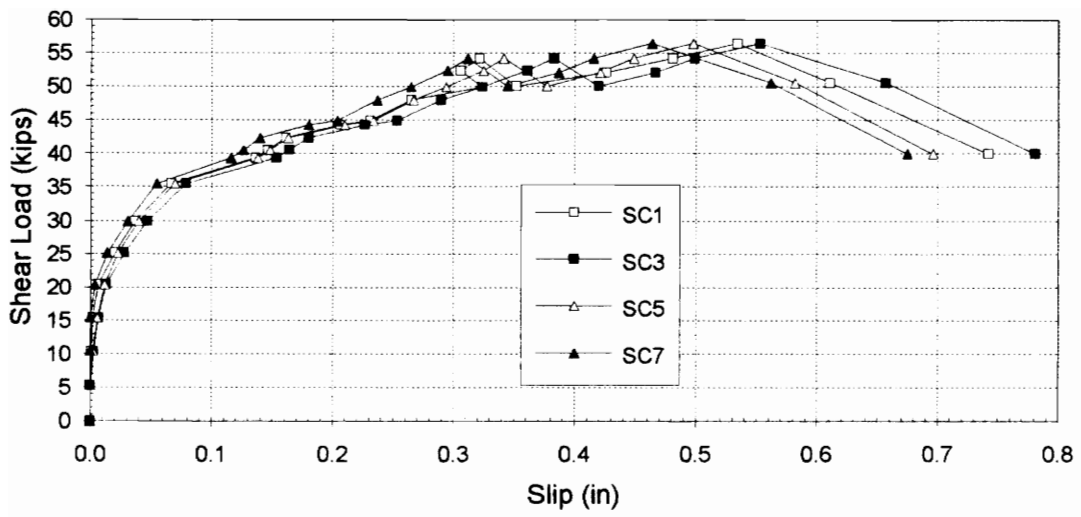
Peak Shear Load:	<u>56.39 kips</u>	
Peak Shear Load Per Fastener:	<u>7.05 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.534 in.</u>	SC2: <u>0.581 in.</u>
	SC3: <u>0.553 in.</u>	SC4: <u>0.551 in.</u>
	SC5: <u>0.498 in.</u>	SC6: <u>0.541 in.</u>
	SC7: <u>0.464 in.</u>	SC8: <u>0.557 in.</u>

DAMAGE

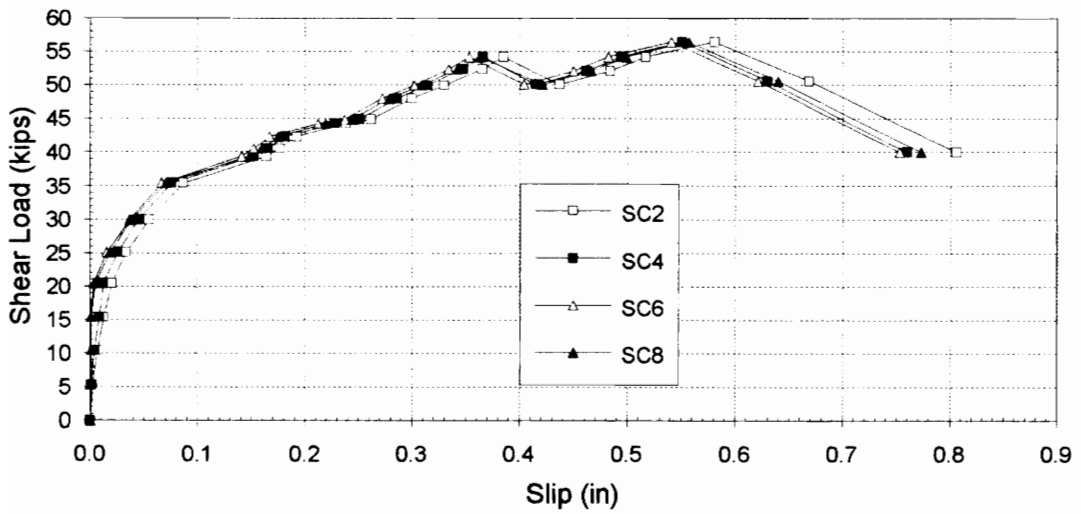


COMMENTS

Spacer plate full length at top unbraced length, at middle in bottom
Longitudinal splitting south slab; SC5, SC7, SC8 Sheared Off
Base angle deformed at all screw locations; Screw rotation $\approx 45^\circ$



(a) Test 1-3-2 - Load vs. North Slip



(b) Test 1-3-2 - Load vs. South Slip

Fig. A.8 Test 1-3-2 Load vs. Slip Plots

Table A.8 Test 1-3-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.30	-0.54	0.000	0.002	0.000	0.001	0.000	0.000	0.000	0.000
-10.35	-1.03	0.001	0.007	0.003	0.004	0.002	0.001	0.000	0.001
-15.39	-1.55	0.002	0.013	0.007	0.009	0.006	0.001	0.000	0.001
-20.43	-2.03	0.007	0.021	0.013	0.013	0.012	0.004	0.004	0.006
-25.09	-2.50	0.020	0.034	0.028	0.026	0.023	0.016	0.014	0.019
-29.88	-2.97	0.037	0.055	0.047	0.045	0.040	0.037	0.031	0.039
-35.44	-3.54	0.067	0.087	0.079	0.076	0.070	0.067	0.055	0.071
-39.32	-3.93	0.136	0.164	0.153	0.152	0.138	0.141	0.116	0.148
-40.48	-4.05	0.146	0.176	0.164	0.165	0.148	0.152	0.126	0.160
-42.29	-4.24	0.161	0.192	0.180	0.181	0.163	0.167	0.140	0.175
-44.23	-4.44	0.206	0.238	0.227	0.228	0.210	0.212	0.180	0.219
-44.88	-4.49	0.231	0.262	0.253	0.251	0.234	0.237	0.204	0.244
-47.98	-4.81	0.265	0.300	0.290	0.286	0.267	0.272	0.237	0.279
-49.92	-4.99	0.324	0.330	0.324	0.314	0.294	0.302	0.265	0.309
-52.38	-5.24	0.306	0.365	0.361	0.347	0.325	0.334	0.295	0.342
-54.19	-5.44	0.322	0.385	0.383	0.366	0.342	0.353	0.312	0.363
-50.05	-5.01	0.352	0.437	0.420	0.415	0.377	0.404	0.345	0.421
-52.12	-5.23	0.426	0.484	0.467	0.462	0.421	0.450	0.387	0.466
-54.19	-5.42	0.481	0.517	0.499	0.494	0.449	0.482	0.416	0.499
-56.39	-5.63	0.534	0.581	0.553	0.551	0.498	0.541	0.464	0.557
-50.57	-5.04	0.611	0.669	0.657	0.630	0.582	0.621	0.562	0.640
-39.96	-4.05	0.742	0.806	0.781	0.760	0.696	0.753	0.675	0.773
-21.34	-2.11	0.932	0.903	0.936	0.847	0.901	0.851	0.854	0.872

PUSHOUT TEST SUMMARY SHEET

Test: 1-3-3
 Test Designation: SC-8-2-0.170-S-4-3

Test Date: 13 JAN 93

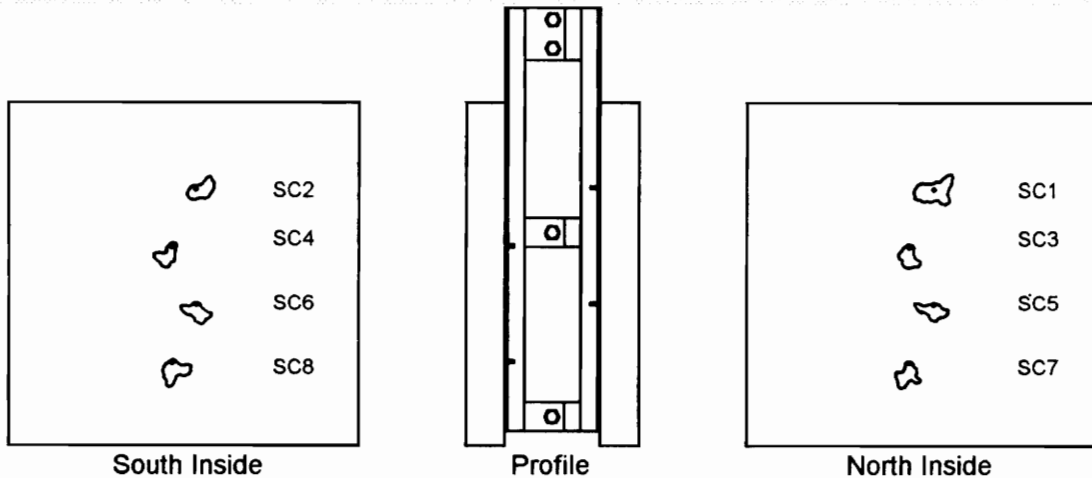
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.170</u>		
	F_y : <u>55.6 ksi</u>	F_u : <u>83.8 ksi</u>	
Slab:	Thickness: <u>4 in.</u>		
		f'_c : <u>3780 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

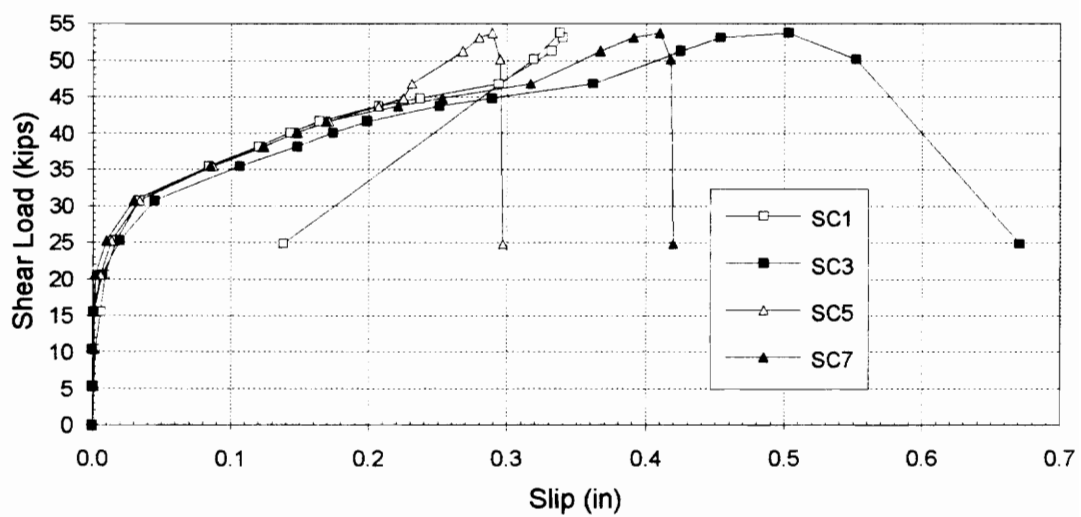
Peak Shear Load: <u>53.67 kips</u>		
Peak Shear Load Per Fastener: <u>6.71 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.338 in.</u>	SC2: <u>0.555 in.</u>
	SC3: <u>0.503 in.</u>	SC4: <u>0.396 in.</u>
	SC5: <u>0.289 in.</u>	SC6: <u>0.426 in.</u>
	SC7: <u>0.410 in.</u>	SC8: <u>0.418 in.</u>

DAMAGE

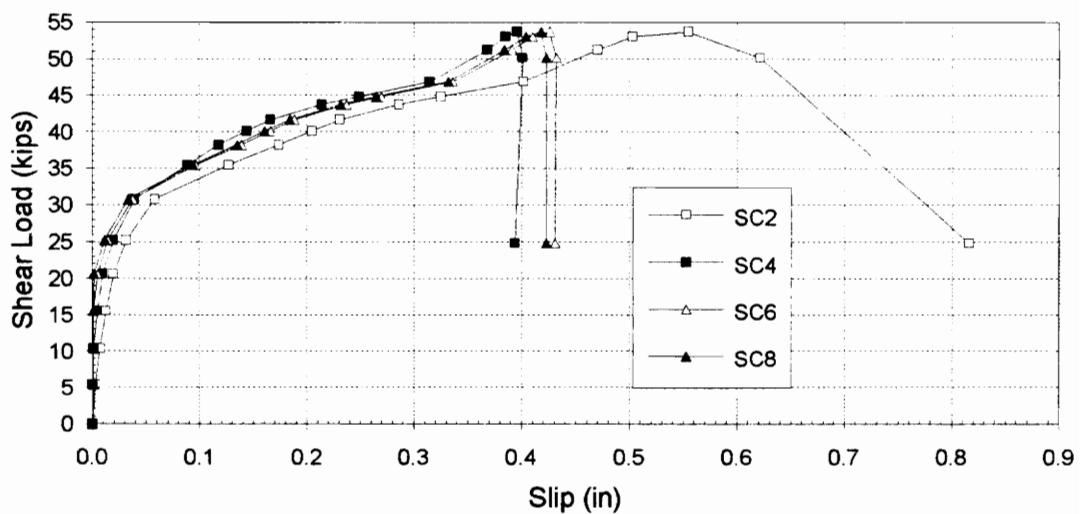


COMMENTS

Spacer plate full length at top unbraced length, at middle in bottom
 Entire angle assembly buckled laterally above SC2
 Base angle deformed at all screw locations; Screw rotation $\approx 35^\circ$ - 40°



(a) Test 1-3-3 - Load vs. North Slip



(b) Test 1-3-3 - Load vs. South Slip

Fig. A.9 Test 1-3-3 Load vs. Slip Plots

Table A.9 Test 1-3-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.30	-0.53	0.001	0.003	0.000	0.000	0.000	0.001	0.001	0.001
-10.35	-1.03	0.002	0.007	0.000	0.001	0.001	0.001	0.001	0.001
-15.52	-1.55	0.006	0.013	0.001	0.005	0.001	0.001	0.001	0.001
-20.56	-2.07	0.009	0.020	0.007	0.010	0.006	0.006	0.002	0.002
-25.22	-2.52	0.017	0.032	0.020	0.020	0.014	0.015	0.010	0.012
-30.78	-3.08	0.034	0.059	0.045	0.040	0.034	0.038	0.030	0.034
-35.44	-3.54	0.084	0.127	0.106	0.089	0.087	0.097	0.085	0.094
-38.15	-3.82	0.120	0.174	0.148	0.118	0.124	0.139	0.123	0.135
-40.09	-4.01	0.143	0.205	0.174	0.144	0.147	0.166	0.148	0.161
-41.65	-4.17	0.164	0.231	0.199	0.166	0.171	0.188	0.169	0.184
-43.71	-4.37	0.207	0.286	0.251	0.214	0.207	0.237	0.221	0.232
-44.75	-4.48	0.237	0.325	0.289	0.249	0.225	0.270	0.253	0.265
-46.82	-4.69	0.294	0.402	0.362	0.315	0.231	0.336	0.317	0.332
-51.22	-5.12	0.332	0.470	0.425	0.368	0.268	0.391	0.367	0.384
-53.03	-5.30	0.340	0.503	0.454	0.385	0.280	0.410	0.391	0.404
-53.67	-5.37	0.338	0.555	0.503	0.396	0.289	0.426	0.410	0.418
-50.18	-5.03	0.319	0.621	0.552	0.401	0.295	0.432	0.418	0.423
-24.83	-2.49	0.138	0.816	0.671	0.394	0.297	0.431	0.420	0.423

PUSHOUT TEST SUMMARY SHEET

Test: 1-3-4
Test Designation: SC-8-2-0.170-S-4-4

Test Date: 14 JAN 93

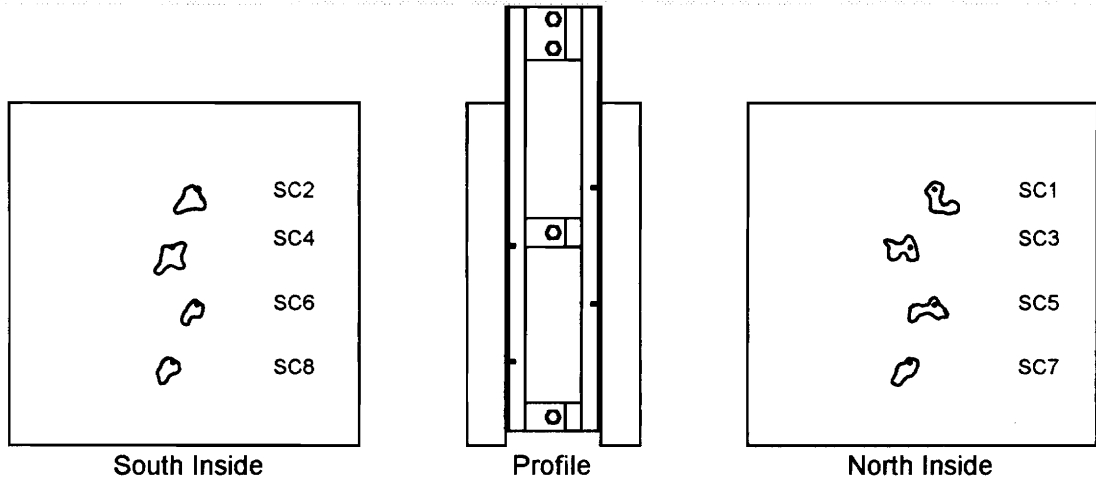
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.170</u>		
	F_y : <u>55.6 ksi</u>	F_u : <u>83.8 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3980 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

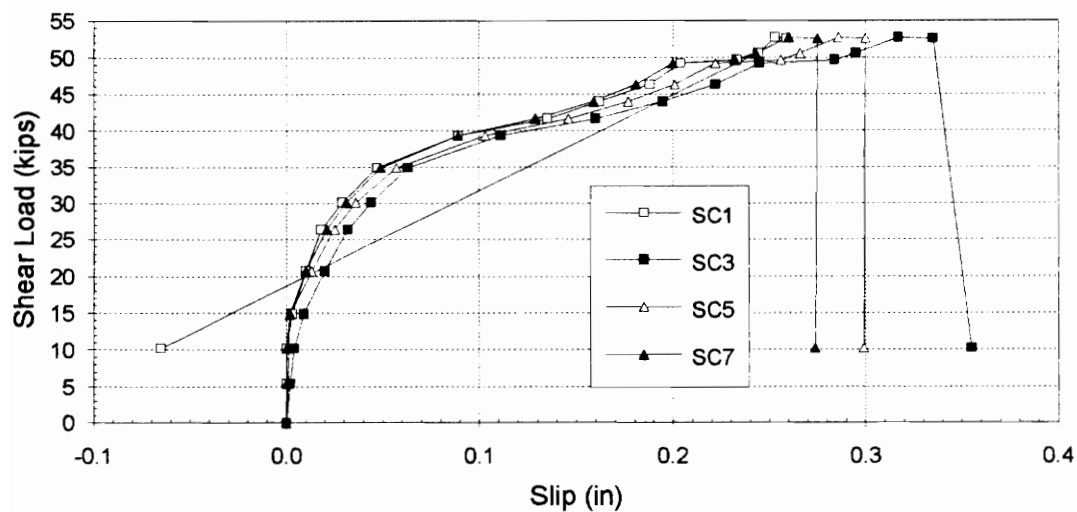
Peak Shear Load:	<u>52.64 kips</u>		
Peak Shear Load Per Fastener:	<u>6.58 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.253 in.</u>	SC2: <u>0.347 in.</u>	
	SC3: <u>0.317 in.</u>	SC4: <u>0.262 in.</u>	
	SC5: <u>0.286 in.</u>	SC6: <u>0.276 in.</u>	
	SC7: <u>0.260 in.</u>	SC8: <u>0.244 in.</u>	

DAMAGE

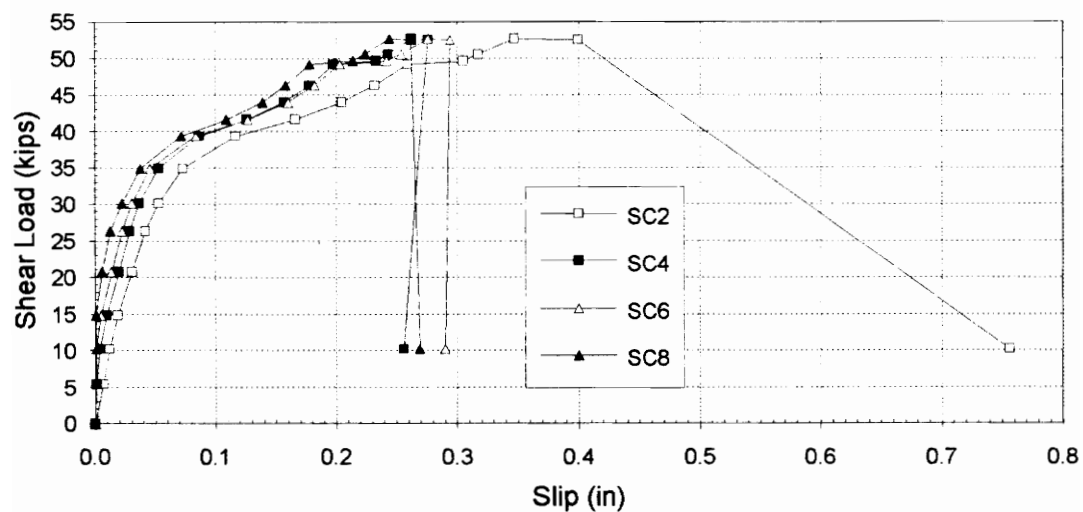


COMMENTS

Spacer plate full length at top unbraced length, at middle in bottom
Entire angle assembly buckled laterally above SC2
Base angle deformed at all screw locations; Screw rotation $\approx 30^\circ$



(a) Test 1-3-4 - Load vs. North Slip



(b) Test 1-3-4 - Load vs. South Slip

Fig. A.10 Test 1-3-4 Load vs. Slip Plots

Table A.10 Test 1-3-4 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.43	-0.54	0.000	0.007	0.002	0.001	0.001	0.001	0.000	0.001
-10.22	-1.03	0.000	0.012	0.004	0.004	0.001	0.001	0.000	0.001
-14.87	-1.51	0.003	0.019	0.009	0.010	0.002	0.005	0.002	0.001
-20.69	-2.06	0.010	0.031	0.020	0.020	0.013	0.014	0.010	0.006
-26.38	-2.64	0.018	0.042	0.032	0.029	0.025	0.023	0.021	0.013
-30.13	-3.01	0.029	0.053	0.044	0.037	0.036	0.031	0.031	0.023
-34.92	-3.49	0.047	0.073	0.063	0.053	0.057	0.046	0.049	0.038
-39.32	-3.93	0.089	0.117	0.111	0.087	0.103	0.084	0.089	0.072
-41.65	-4.16	0.135	0.166	0.160	0.126	0.146	0.127	0.129	0.109
-43.97	-4.41	0.162	0.205	0.195	0.157	0.177	0.160	0.159	0.139
-46.30	-4.63	0.188	0.232	0.222	0.178	0.201	0.182	0.181	0.158
-49.15	-4.90	0.204	0.259	0.245	0.198	0.222	0.203	0.200	0.178
-49.66	-4.95	0.233	0.305	0.284	0.233	0.256	0.242	0.232	0.214
-50.57	-5.07	0.244	0.317	0.295	0.243	0.266	0.254	0.243	0.224
-52.64	-5.25	0.253	0.347	0.317	0.262	0.286	0.276	0.260	0.244
-52.51	-5.25	0.259	0.399	0.335	0.276	0.300	0.294	0.275	0.262
-10.22	-4.39	-0.065	0.756	0.355	0.256	0.299	0.290	0.274	0.269

PUSHOUT TEST SUMMARY SHEET

Test: 1-4-1
Test Designation: SC-8-2-0.205-S-4-1

Test Date: 23 NOV 92

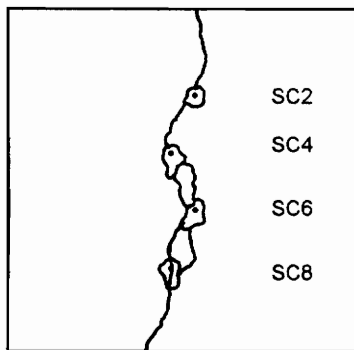
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>		
	F_y : <u>57.7 ksi</u>	F_u : <u>85.3 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3370 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

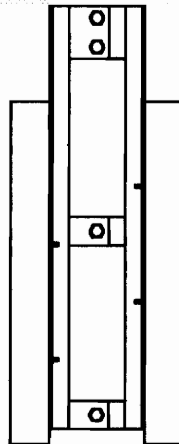
TEST RESULTS

Peak Shear Load:	<u>57.81 kips</u>		
Peak Shear Load Per Fastener:	<u>7.23 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.475 in.</u>	SC2: <u>0.442 in.</u>	
	SC3: <u>0.444 in.</u>	SC4: <u>0.437 in.</u>	
	SC5: <u>0.443 in.</u>	SC6: <u>0.461 in.</u>	
	SC7: <u>0.414 in.</u>	SC8: <u>0.427 in.</u>	

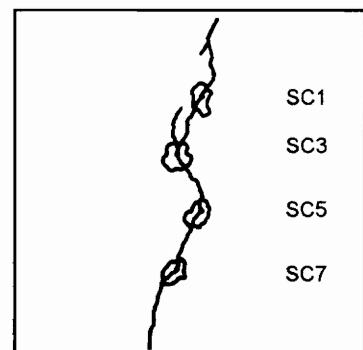
DAMAGE



South Inside



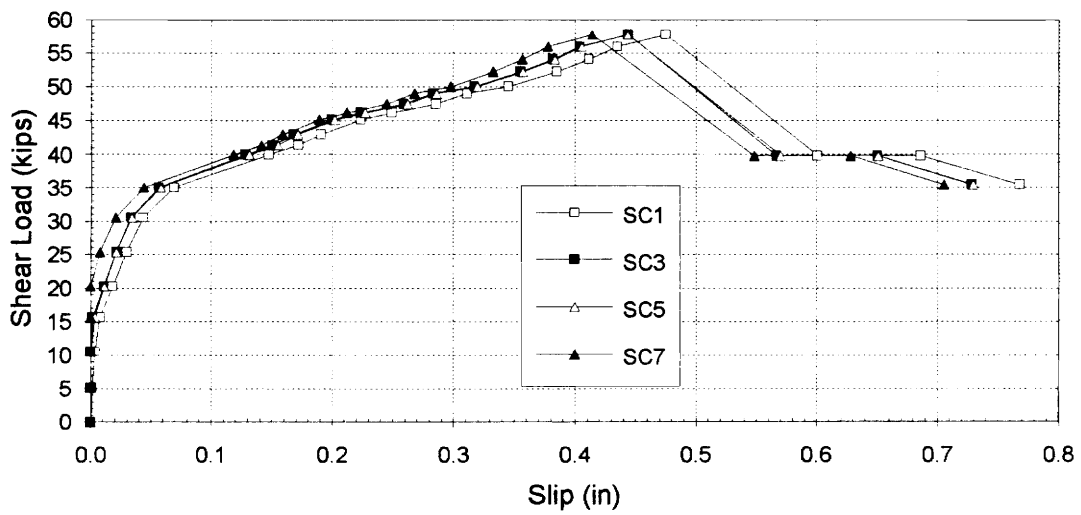
Profile



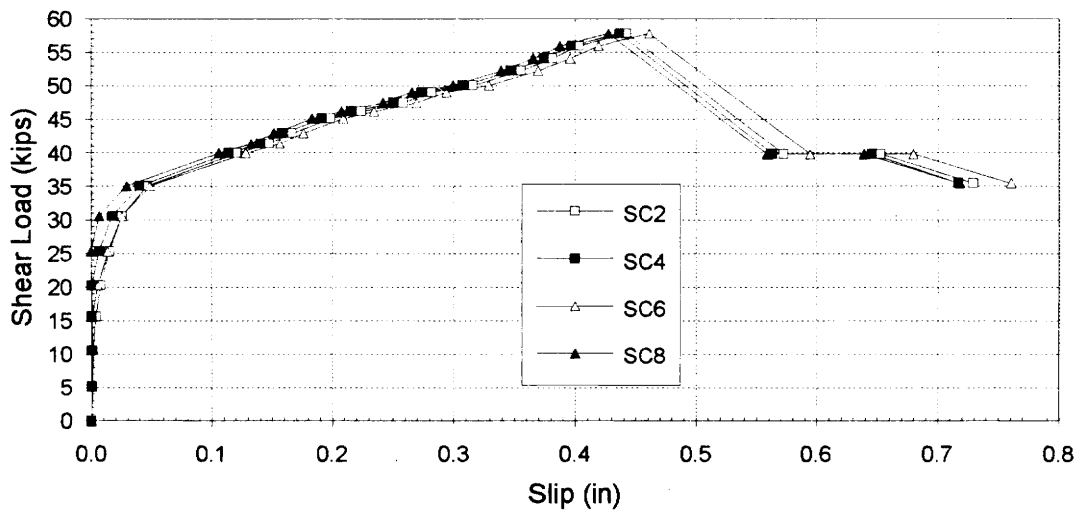
North Inside

COMMENTS

SC1, SC2, SC3, SC4, SC5, SC6, SC8 sheared off
Longitudinal splitting of both north and south slab
Screw rotation $\approx 25^\circ$ - 30°



(a) Test 1-4-1 - Load vs. North Slip



(b) Test 1-4-1 - Load vs. South Slip

Fig. A.11 Test 1-4-1 Load vs. Slip Plots

Table A.11 Test 1-4-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.17	-0.53	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000
-10.61	-1.00	0.004	0.001	0.000	0.001	0.000	0.000	0.000	0.000
-15.65	-1.54	0.008	0.004	0.002	0.001	0.004	0.001	0.000	0.000
-20.31	-2.08	0.018	0.008	0.011	0.001	0.012	0.005	0.000	0.000
-25.35	-2.49	0.030	0.015	0.021	0.007	0.021	0.014	0.008	0.000
-30.52	-3.16	0.043	0.026	0.034	0.018	0.034	0.026	0.021	0.007
-35.05	-3.67	0.069	0.047	0.057	0.040	0.058	0.049	0.044	0.029
-39.96	-4.09	0.147	0.121	0.128	0.114	0.131	0.128	0.118	0.106
-41.39	-4.15	0.172	0.148	0.151	0.140	0.155	0.156	0.141	0.133
-42.94	-4.31	0.191	0.167	0.169	0.158	0.171	0.176	0.159	0.151
-45.14	-4.50	0.224	0.198	0.200	0.191	0.202	0.209	0.190	0.183
-46.17	-4.62	0.249	0.224	0.224	0.216	0.227	0.234	0.212	0.208
-47.47	-4.75	0.285	0.258	0.259	0.250	0.262	0.269	0.245	0.242
-49.02	-4.97	0.311	0.282	0.283	0.274	0.286	0.294	0.268	0.266
-50.05	-5.03	0.345	0.316	0.318	0.308	0.320	0.329	0.298	0.299
-52.25	-5.29	0.385	0.355	0.355	0.347	0.357	0.369	0.333	0.339
-54.06	-5.44	0.411	0.381	0.382	0.374	0.383	0.395	0.357	0.365
-56.00	-5.67	0.435	0.403	0.404	0.397	0.405	0.419	0.378	0.387
-57.81	-5.80	0.475	0.442	0.444	0.437	0.443	0.461	0.414	0.427
-39.83	-4.02	0.601	0.573	0.567	0.563	0.570	0.594	0.548	0.559
-39.83	-4.44	0.686	0.653	0.650	0.645	0.651	0.680	0.628	0.639
-35.44	-3.36	0.768	0.729	0.728	0.717	0.729	0.760	0.705	0.718

PUSHOUT TEST SUMMARY SHEET

Test: 1-4-2
 Test Designation: SC-8-2-0.205-S-4-2

Test Date: 23 JAN 93

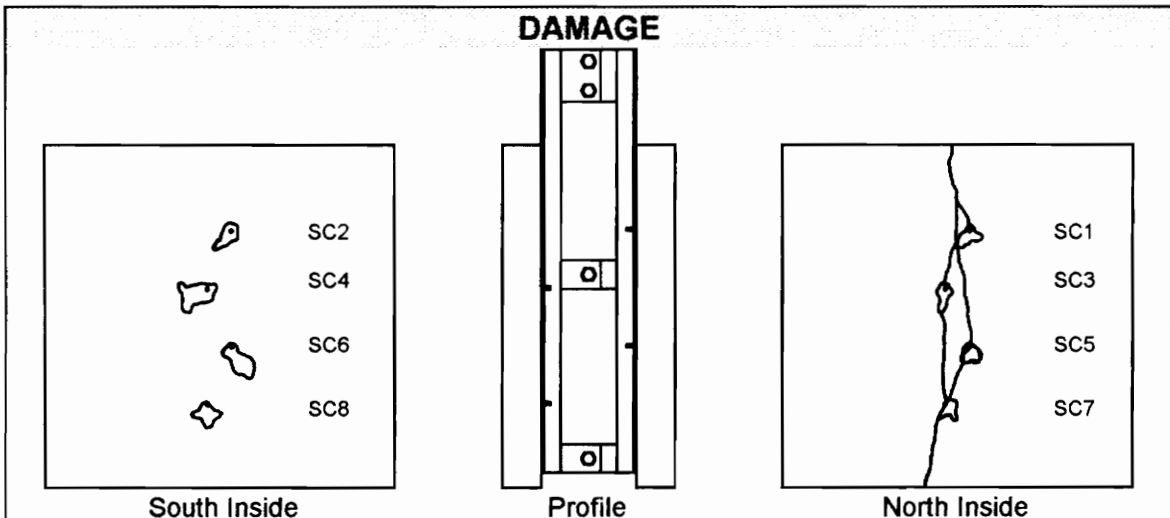
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>		
	F_y : <u>57.7 ksi</u>	F_u : <u>85.3 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3800 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

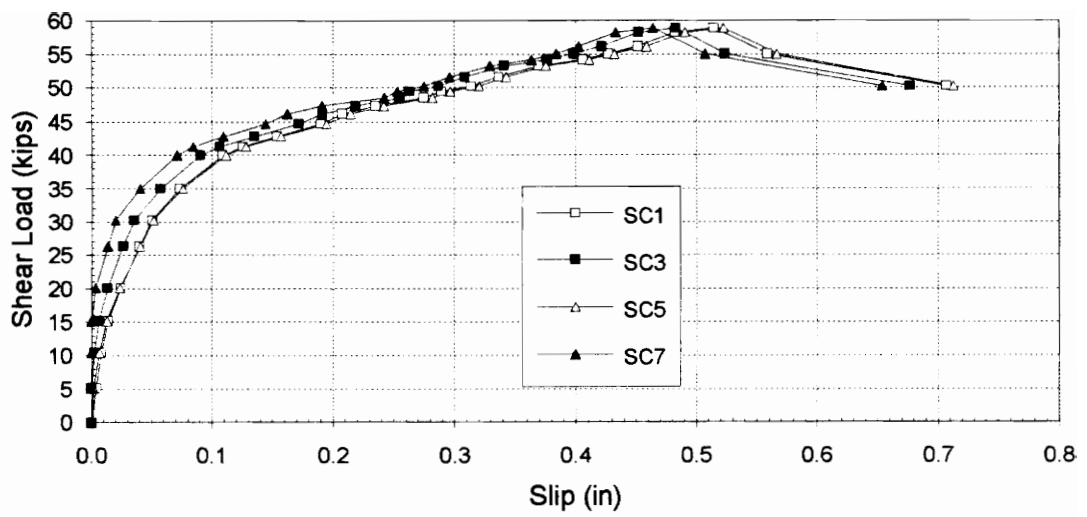
Peak Shear Load:	<u>58.85 kips</u>		
Peak Shear Load Per Fastener:	<u>7.36 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.475 in.</u>	SC2: <u>0.442 in.</u>	
	SC3: <u>0.444 in.</u>	SC4: <u>0.437 in.</u>	
	SC5: <u>0.443 in.</u>	SC6: <u>0.461 in.</u>	
	SC7: <u>0.414 in.</u>	SC8: <u>0.427 in.</u>	

DAMAGE

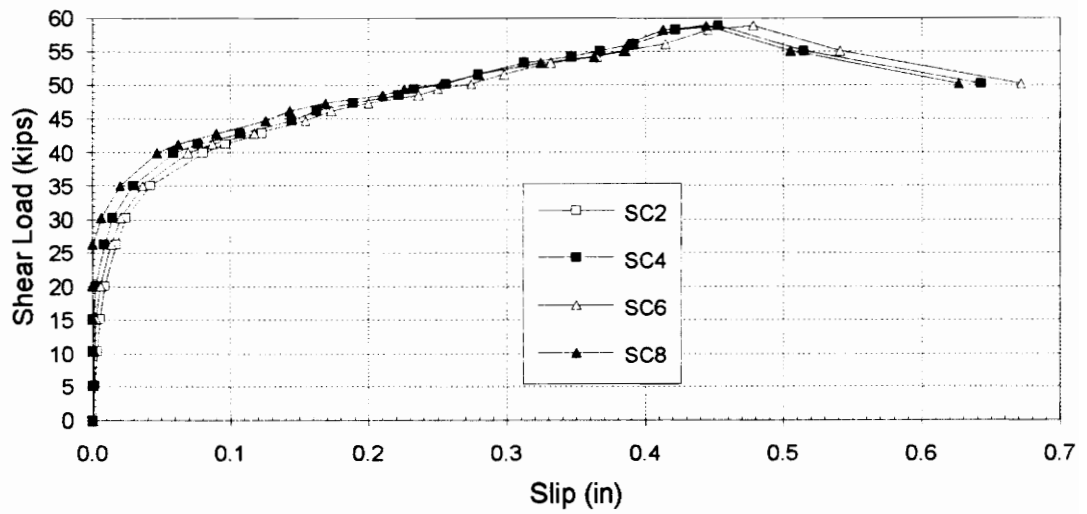


COMMENTS

SC2 sheared off
 Longitudinal splitting of north slab
 Screw rotation $\approx 25^\circ$ - 30°



(a) Test 1-4-2 - Load vs. North Slip



(b) Test 1-4-2 - Load vs. South Slip

Fig. A.12 Test 1-4-2 Load vs. Slip Plots

Table A.12 Test 1-4-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.17	-0.52	0.004	0.001	0.000	0.000	0.002	0.000	0.000	0.000
-10.48	-1.04	0.009	0.004	0.002	0.000	0.007	0.001	0.000	0.000
-15.13	-1.51	0.014	0.006	0.006	0.001	0.013	0.002	0.000	0.000
-20.05	-2.00	0.024	0.009	0.013	0.002	0.024	0.006	0.004	0.000
-26.25	-2.62	0.040	0.018	0.026	0.009	0.040	0.014	0.013	0.001
-30.26	-3.03	0.050	0.024	0.035	0.015	0.051	0.021	0.020	0.007
-35.05	-3.50	0.073	0.042	0.057	0.030	0.076	0.037	0.040	0.020
-39.96	-4.01	0.109	0.081	0.091	0.059	0.111	0.070	0.071	0.047
-41.26	-4.13	0.125	0.097	0.106	0.077	0.128	0.087	0.085	0.062
-42.81	-4.28	0.154	0.123	0.135	0.108	0.157	0.117	0.110	0.090
-44.75	-4.49	0.190	0.508	0.172	0.145	0.195	0.155	0.145	0.126
-46.17	-4.62	0.208	0.596	0.191	0.162	0.215	0.173	0.162	0.143
-47.34	-4.73	0.235	0.650	0.219	0.189	0.242	0.200	0.191	0.169
-48.50	-4.85	0.275	3.063	0.255	0.222	0.282	0.236	0.243	0.210
-49.41	-4.94	0.289	3.062	0.263	0.233	0.297	0.250	0.253	0.226
-50.18	-5.02	0.314	3.063	0.287	0.256	0.321	0.274	0.275	0.252
-51.60	-5.16	0.337	3.062	0.309	0.279	0.343	0.298	0.296	0.279
-53.29	-5.33	0.370	3.063	0.341	0.312	0.376	0.331	0.330	0.324
-54.19	-5.41	0.406	3.063	0.377	0.346	0.411	0.365	0.364	0.363
-55.10	-5.50	0.427	3.063	0.398	0.367	0.432	0.385	0.384	0.384
-56.13	-5.61	0.452	3.062	0.422	0.392	0.459	0.415	0.402	0.387
-58.20	-5.82	0.482	3.063	0.452	0.422	0.491	0.446	0.433	0.413
-58.85	-5.88	0.515	3.063	0.483	0.453	0.522	0.478	0.464	0.444
-55.10	-5.52	0.559	3.063	0.524	0.515	0.566	0.541	0.507	0.505
-50.18	-5.03	0.707	3.063	0.677	0.643	0.713	0.671	0.654	0.627
0.00	0.01	0.642	3.063	0.629	0.597	0.646	0.628	0.636	0.599

PUSHOUT TEST SUMMARY SHEET

Test: 1-4-3
Test Designation: SC-8-2-0.205-S-4-3

Test Date: 23 JAN 93

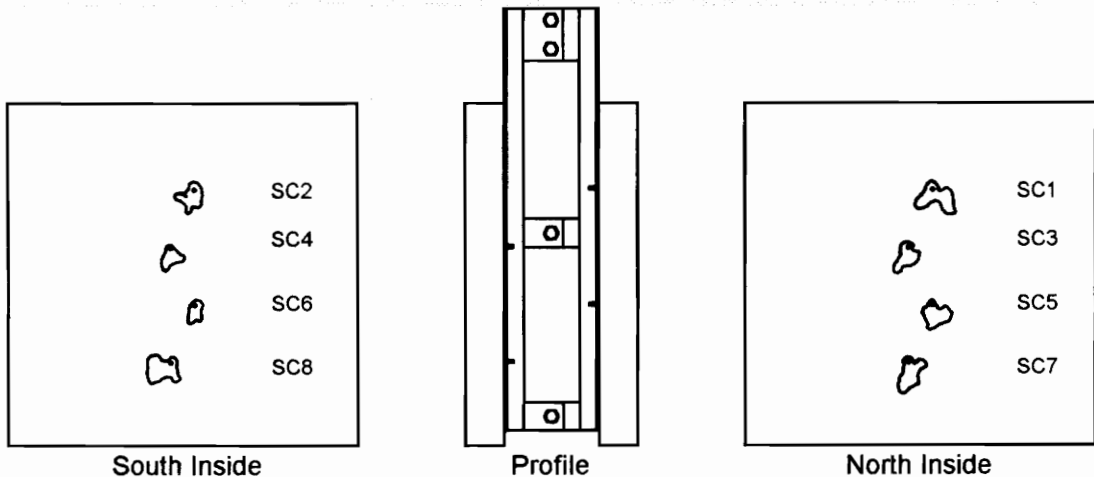
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>		
	F_y : <u>57.7 ksi</u>	F_u : <u>85.3 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3800 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

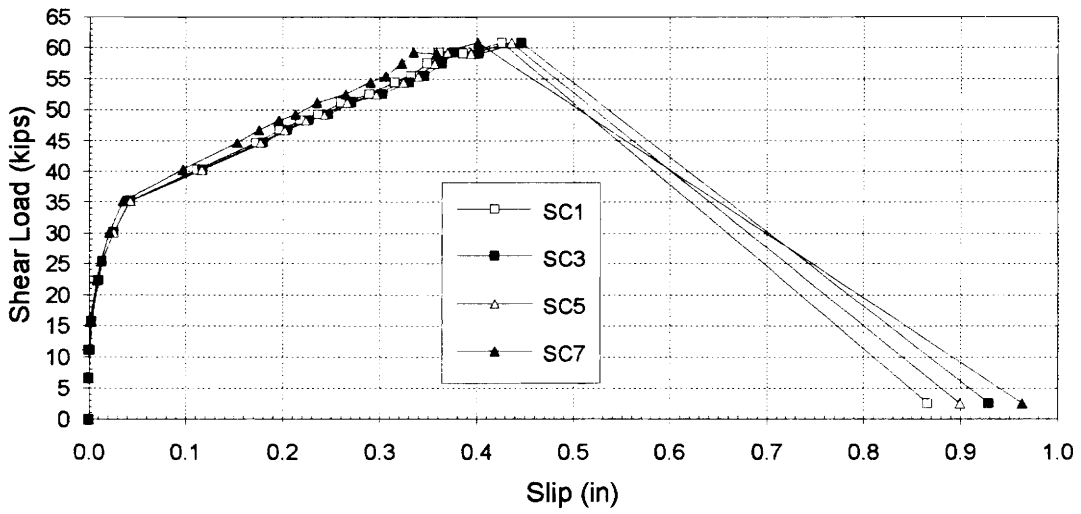
Peak Shear Load:	<u>60.79 kips</u>	
Peak Shear Load Per Fastener:	<u>7.60 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.475 in.</u>	SC2: <u>0.442 in.</u>
	SC3: <u>0.444 in.</u>	SC4: <u>0.437 in.</u>
	SC5: <u>0.443 in.</u>	SC6: <u>0.461 in.</u>
	SC7: <u>0.414 in.</u>	SC8: <u>0.427 in.</u>

DAMAGE

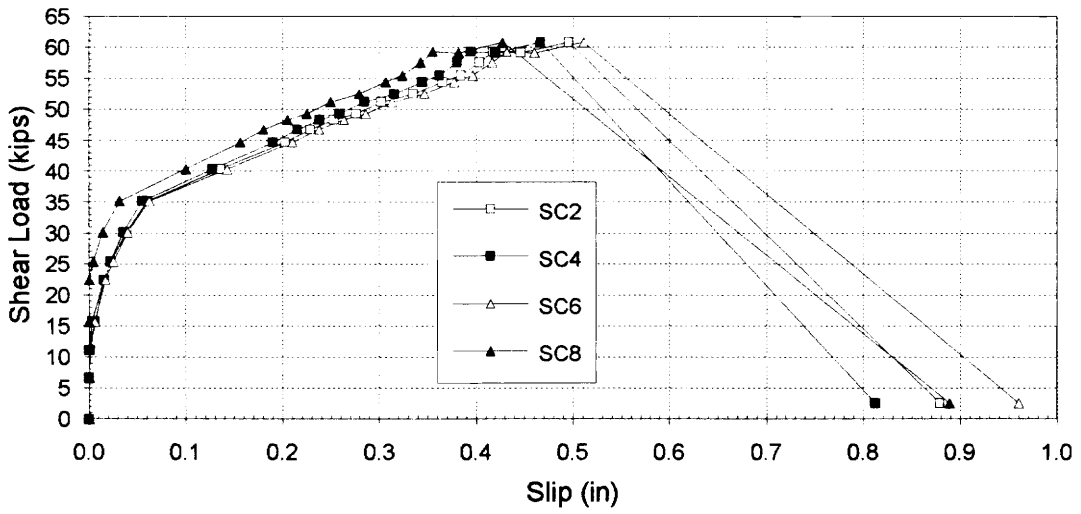


COMMENTS

SC1, SC2, SC3, SC4, SC5, SC6, SC7 sheared off
Screw rotation $\approx 25^\circ$



(a) Test 1-4-3 - Load vs. North Slip



(b) Test 1-4-3 - Load vs. South Slip

Fig. A.13 Test 1-4-3 Load vs. Slip Plots

Table A.13 Test 1-4-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-6.60	-0.65	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
-11.12	-1.11	0.001	0.000	0.000	0.001	0.000	0.001	0.001	0.000
-15.65	-1.56	0.003	0.003	0.002	0.006	0.001	0.006	0.002	0.000
-22.37	-2.25	0.010	0.016	0.010	0.016	0.009	0.017	0.009	0.001
-25.35	-2.53	0.014	0.023	0.014	0.023	0.013	0.026	0.012	0.005
-30.13	-3.01	0.026	0.039	0.026	0.036	0.026	0.040	0.021	0.015
-35.18	-3.52	0.042	0.061	0.043	0.056	0.043	0.063	0.036	0.032
-40.35	-4.05	0.112	0.136	0.117	0.128	0.116	0.143	0.097	0.100
-44.75	-4.49	0.172	0.202	0.180	0.190	0.177	0.210	0.152	0.157
-46.82	-4.68	0.196	0.229	0.205	0.216	0.202	0.238	0.175	0.181
-48.37	-4.85	0.218	0.253	0.227	0.239	0.223	0.263	0.196	0.205
-49.28	-4.93	0.237	0.276	0.247	0.259	0.243	0.286	0.213	0.225
-51.22	-5.11	0.260	0.302	0.271	0.285	0.267	0.313	0.236	0.250
-52.51	-5.25	0.289	0.335	0.303	0.316	0.297	0.347	0.265	0.279
-54.45	-5.44	0.316	0.365	0.330	0.344	0.324	0.377	0.290	0.307
-55.48	-5.56	0.332	0.384	0.346	0.362	0.340	0.396	0.306	0.324
-57.55	-5.75	0.349	0.403	0.364	0.380	0.357	0.416	0.323	0.342
-59.23	-5.92	0.361	0.418	0.377	0.394	0.370	0.432	0.335	0.355
-59.11	-5.91	0.386	0.446	0.403	0.420	0.394	0.460	0.359	0.382
-60.79	-6.08	0.426	0.495	0.446	0.466	0.436	0.510	0.402	0.427
-2.59	-0.24	0.866	0.878	0.929	0.812	0.900	0.960	0.963	0.889

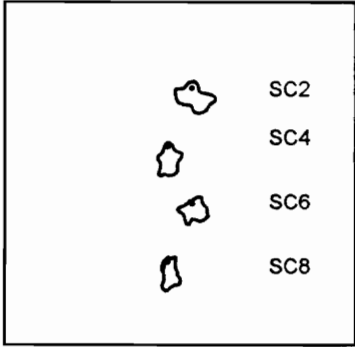
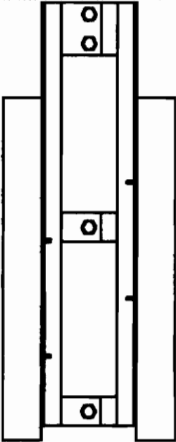
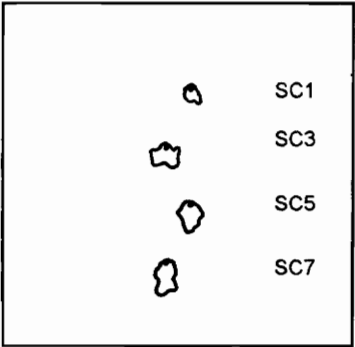
PUSHOUT TEST SUMMARY SHEET

Test: 1-5-1
Test Designation: SC-8-2-0.238-S-4-1

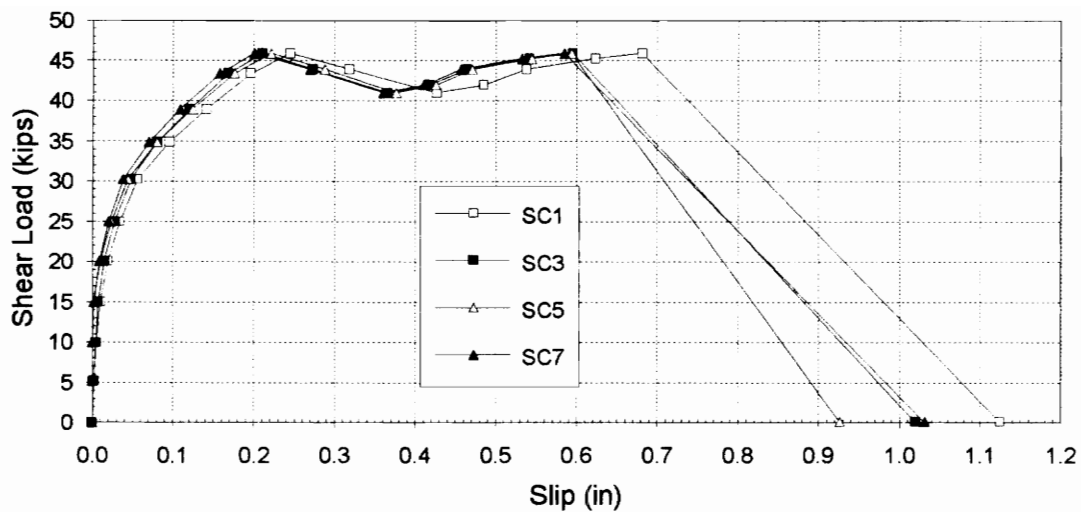
Test Date: 02 DEC 92

SPECIMEN DESCRIPTION			
Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F _y : <u>N/A</u>	F _u : <u>N/A</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.238</u>		
	F _y : <u>57.7 ksi</u>	F _u : <u>83.6 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f _c : <u>3660 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

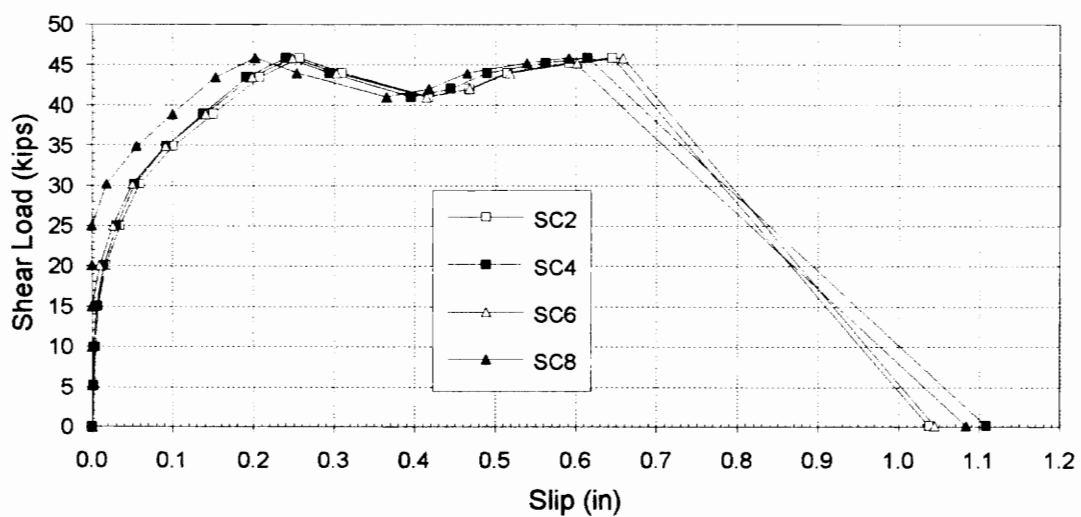
TEST RESULTS			
Peak Shear Load: <u>45.91 kips</u>			
Peak Shear Load Per Fastener: <u>5.74 kips</u>			
Slip at Peak Shear Load:			
	SC1: <u>0.475 in.</u>	SC2: <u>0.442 in.</u>	
	SC3: <u>0.444 in.</u>	SC4: <u>0.437 in.</u>	
	SC5: <u>0.443 in.</u>	SC6: <u>0.461 in.</u>	
	SC7: <u>0.414 in.</u>	SC8: <u>0.427 in.</u>	

DAMAGE		
		
South Inside	Profile	North Inside

COMMENTS
All screws sheared off Screw rotation $\approx 10^{\circ}$ - 15°



(a) Test 1-5-1 - Load vs. North Slip



(b) Test 1-5-1 - Load vs. South Slip

Fig. A.14 Test 1-5-1 Load vs. Slip Plots

Table A.14 Test 1-5-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.17	-0.54	0.002	0.002	0.002	0.001	0.000	0.000	0.000	0.000
-9.96	-0.99	0.006	0.004	0.004	0.002	0.001	0.000	0.000	0.000
-15.00	-1.50	0.010	0.008	0.008	0.006	0.002	0.001	0.002	0.000
-20.05	-1.98	0.020	0.018	0.015	0.015	0.010	0.010	0.009	0.000
-24.96	-2.48	0.034	0.035	0.028	0.031	0.024	0.026	0.020	0.000
-30.26	-3.00	0.056	0.059	0.048	0.053	0.044	0.050	0.038	0.018
-34.92	-3.50	0.095	0.101	0.080	0.092	0.080	0.092	0.070	0.056
-38.93	-3.95	0.141	0.151	0.121	0.138	0.124	0.141	0.109	0.100
-43.46	-4.36	0.196	0.208	0.169	0.192	0.176	0.198	0.158	0.153
-45.91	-4.76	0.245	0.257	0.211	0.240	0.222	0.248	0.201	0.202
-43.97	-5.03	0.318	0.310	0.273	0.294	0.288	0.303	0.270	0.253
-41.00	-4.58	0.427	0.418	0.366	0.396	0.376	0.414	0.361	0.365
-42.03	-4.66	0.485	0.468	0.417	0.445	0.426	0.468	0.411	0.418
-43.97	-4.59	0.538	0.515	0.465	0.490	0.471	0.518	0.457	0.465
-45.27	-4.99	0.624	0.591	0.542	0.562	0.545	0.601	0.533	0.539
-45.91	-5.03	0.682	0.645	0.595	0.614	0.594	0.658	0.585	0.591
-0.13	-4.54	1.125	1.037	1.020	1.109	0.926	1.044	1.031	1.084

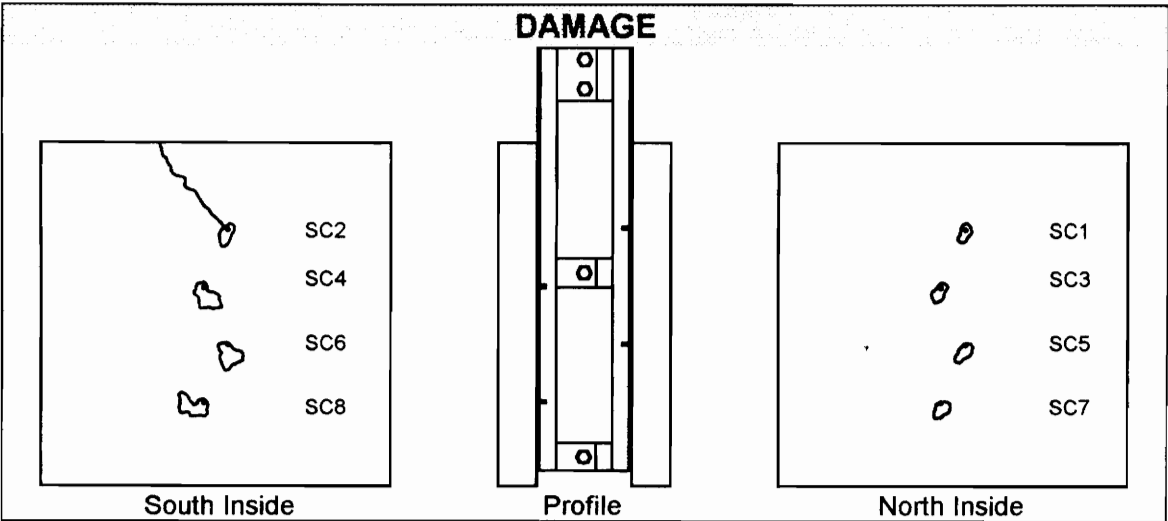
PUSHOUT TEST SUMMARY SHEET

Test: 1-5-2
Test Designation: SC-8-2-0.238-S-4-2

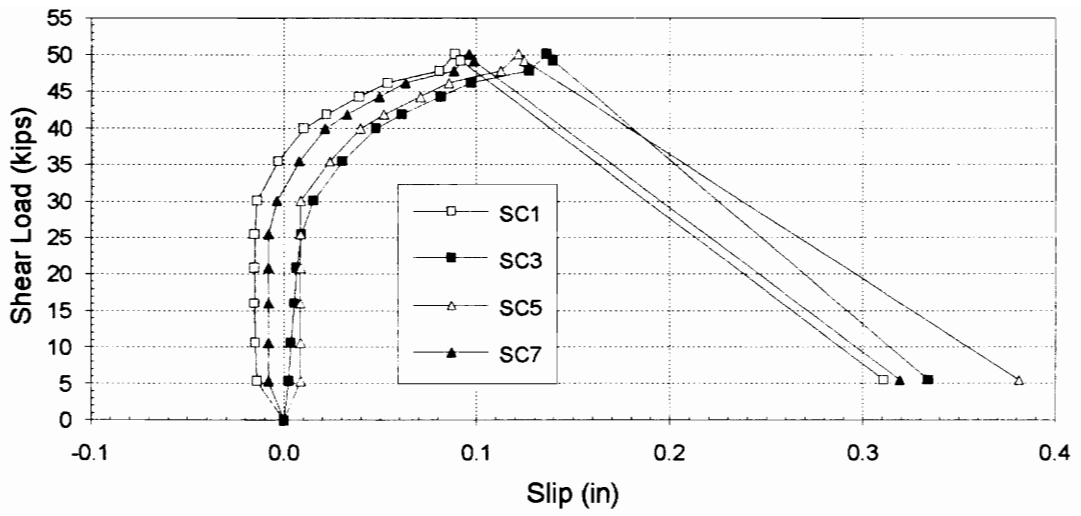
Test Date: 22 JAN 93

SPECIMEN DESCRIPTION			
Fastener:	Type: Elco, grade 8, 5/16 in. ϕ , 2 in. standoff screw		
	# Per Specimen: 8		
Deck:	Type: None	Width: 36 in.	Length: 36 in.
	F_y : N/A	F_u : N/A	
Base Member:	Section: 2L 2.00x2.00x0.238		
	F_y : 57.7 ksi	F_u : 83.6 ksi	
Slab:	Thickness: 4 in.	f'_c : 3820 psi	
Mesh:	Type: WWF 6x6-W1.4xW1.4		

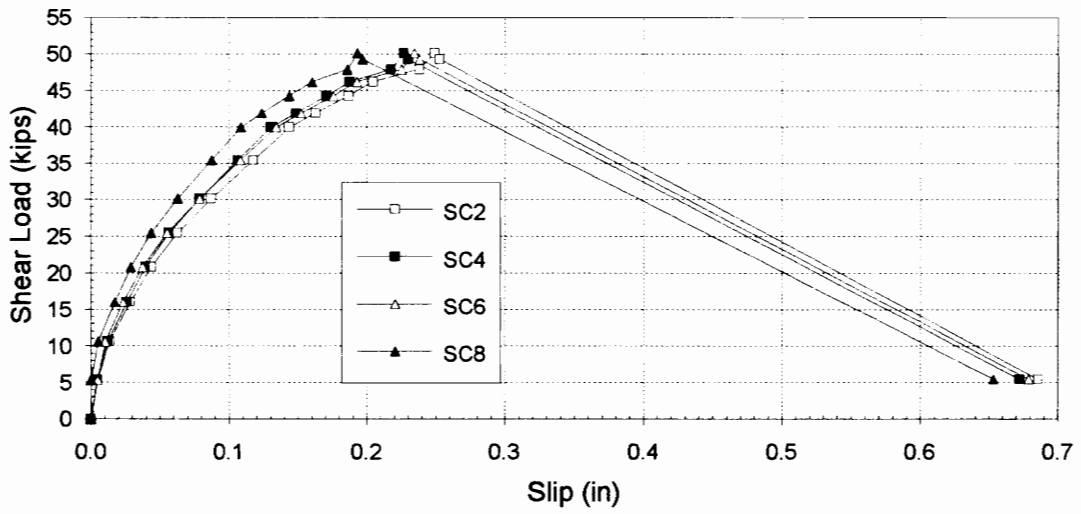
TEST RESULTS			
Peak Shear Load:	50.05 kips		
Peak Shear Load Per Fastener:	6.26 kips		
Slip at Peak Shear Load:	SC1: 0.475 in.	SC2: 0.442 in.	
	SC3: 0.444 in.	SC4: 0.437 in.	
	SC5: 0.443 in.	SC6: 0.461 in.	
	SC7: 0.414 in.	SC8: 0.427 in.	



COMMENTS
SC1, SC2, SC3, SC4, SC5, SC6, SC8 sheared off
Slight crack developed on the south side
Screw rotation $\approx 10^\circ$



(a) Test 1-5-2 - Load vs. North Slip



(b) Test 1-5-2 - Load vs. South Slip

Fig. A.15 Test 1-5-2 Load vs. Slip Plots

Table A.15 Test 1-5-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.30	-0.53	-0.014	0.005	0.002	0.004	0.009	0.005	-0.008	0.000
-10.61	-1.06	-0.015	0.013	0.004	0.012	0.009	0.010	-0.008	0.006
-16.04	-1.60	-0.015	0.029	0.006	0.026	0.009	0.024	-0.008	0.018
-20.82	-2.07	-0.015	0.044	0.007	0.040	0.009	0.038	-0.008	0.029
-25.48	-2.54	-0.015	0.063	0.009	0.057	0.009	0.056	-0.008	0.044
-30.13	-3.01	-0.014	0.087	0.015	0.079	0.009	0.079	-0.004	0.063
-35.44	-3.54	-0.003	0.117	0.031	0.106	0.024	0.108	0.008	0.088
-39.96	-4.01	0.010	0.144	0.048	0.130	0.040	0.134	0.021	0.108
-41.90	-4.19	0.022	0.163	0.061	0.148	0.052	0.152	0.033	0.124
-44.23	-4.43	0.039	0.187	0.081	0.170	0.071	0.176	0.050	0.143
-46.17	-4.61	0.054	0.204	0.097	0.188	0.086	0.193	0.063	0.160
-47.85	-4.80	0.081	0.238	0.127	0.218	0.113	0.225	0.088	0.186
-50.05	-5.00	0.089	0.249	0.136	0.227	0.122	0.234	0.096	0.193
-49.28	-4.93	0.092	0.253	0.139	0.230	0.125	0.238	0.099	0.197
-5.43	-0.53	0.311	0.685	0.334	0.672	0.381	0.679	0.319	0.653

PUSHOUT TEST SUMMARY SHEET

Test: 1-5-3
 Test Designation: SC-8-2-0.238-S-4-3

Test Date: 22 JAN 93

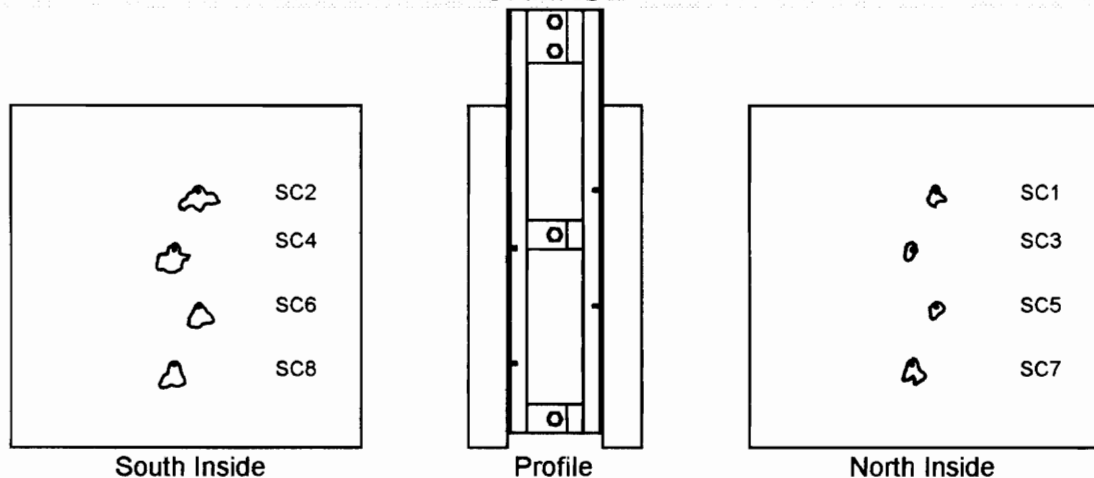
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.238</u>		
	F_y : <u>57.7 ksi</u>	F_u : <u>83.6 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>3820 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

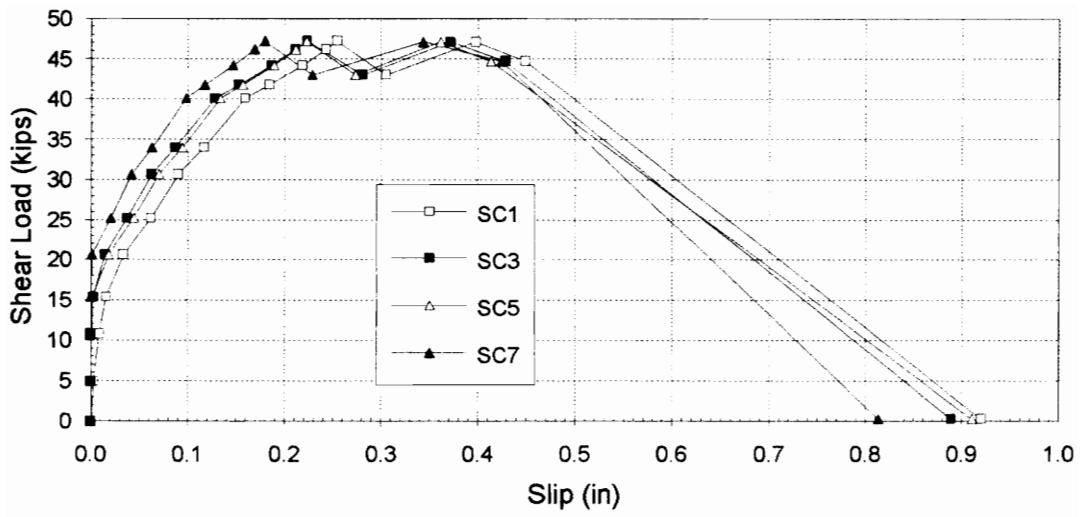
Peak Shear Load: <u>47.21 kips</u>									
Peak Shear Load Per Fastener: <u>5.90 kips</u>									
Slip at Peak Shear Load:	<table border="0" style="width: 100%;"> <tr> <td>SC1: <u>0.475 in.</u></td> <td>SC2: <u>0.442 in.</u></td> </tr> <tr> <td>SC3: <u>0.444 in.</u></td> <td>SC4: <u>0.437 in.</u></td> </tr> <tr> <td>SC5: <u>0.443 in.</u></td> <td>SC6: <u>0.461 in.</u></td> </tr> <tr> <td>SC7: <u>0.414 in.</u></td> <td>SC8: <u>0.427 in.</u></td> </tr> </table>	SC1: <u>0.475 in.</u>	SC2: <u>0.442 in.</u>	SC3: <u>0.444 in.</u>	SC4: <u>0.437 in.</u>	SC5: <u>0.443 in.</u>	SC6: <u>0.461 in.</u>	SC7: <u>0.414 in.</u>	SC8: <u>0.427 in.</u>
SC1: <u>0.475 in.</u>	SC2: <u>0.442 in.</u>								
SC3: <u>0.444 in.</u>	SC4: <u>0.437 in.</u>								
SC5: <u>0.443 in.</u>	SC6: <u>0.461 in.</u>								
SC7: <u>0.414 in.</u>	SC8: <u>0.427 in.</u>								

DAMAGE

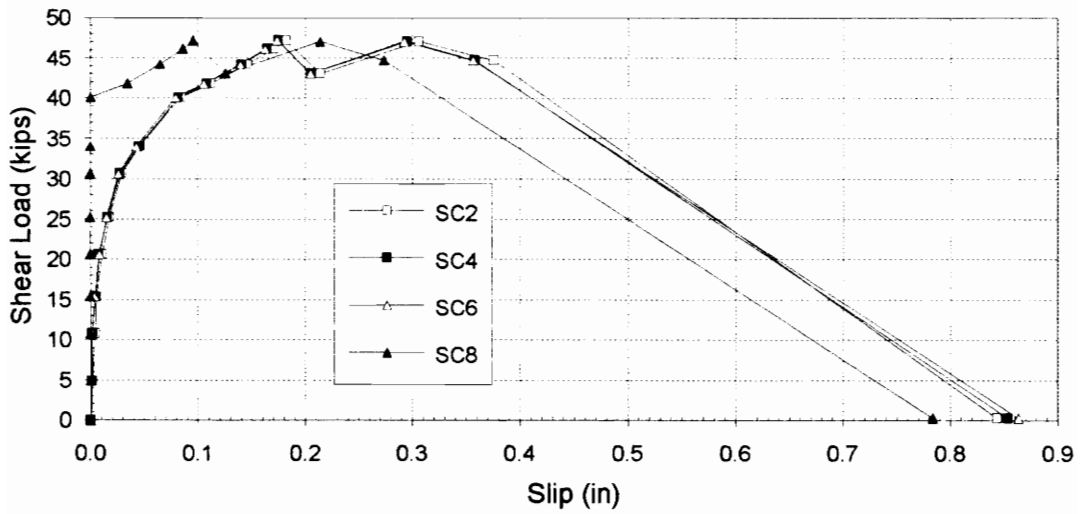


COMMENTS

All screws sheared off
 Screw rotation $\approx 10^\circ$



(a) Test 1-5-3 - Load vs. North Slip



(b) Test 1-5-3 - Load vs. South Slip

Fig. A.16 Test 1-5-3 Load vs. Slip Plots

Table A.16 Test 1-5-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.91	-0.50	0.003	0.001	0.000	0.001	0.000	0.001	0.000	0.000
-10.73	-1.07	0.009	0.004	0.000	0.002	0.000	0.002	0.000	0.000
-15.39	-1.54	0.016	0.006	0.002	0.004	0.002	0.004	0.000	0.000
-20.56	-2.06	0.034	0.011	0.015	0.008	0.018	0.009	0.001	0.000
-25.22	-2.53	0.062	0.018	0.037	0.016	0.044	0.015	0.021	0.000
-30.65	-3.07	0.090	0.029	0.062	0.027	0.070	0.026	0.042	0.000
-34.01	-3.40	0.116	0.046	0.087	0.045	0.094	0.043	0.063	0.000
-40.09	-4.01	0.159	0.084	0.128	0.082	0.133	0.079	0.098	0.001
-41.77	-4.18	0.184	0.112	0.153	0.108	0.157	0.106	0.118	0.034
-44.23	-4.44	0.218	0.146	0.187	0.140	0.189	0.139	0.147	0.065
-46.17	-4.61	0.243	0.170	0.211	0.164	0.212	0.163	0.169	0.086
-47.21	-4.72	0.255	0.182	0.223	0.175	0.223	0.174	0.179	0.096
-43.07	-4.32	0.305	0.214	0.281	0.205	0.273	0.205	0.228	0.126
-47.08	-4.72	0.398	0.306	0.372	0.295	0.361	0.292	0.344	0.214
-44.75	-4.47	0.449	0.376	0.429	0.358	0.413	0.356	0.424	0.273
-0.26	0.03	0.920	0.843	0.889	0.854	0.911	0.863	0.813	0.784

PUSHOUT TEST SUMMARY SHEET

Test: 1-6-1
Test Designation: SC-8-2-0.170-S-2.5-1

Test Date: 19 NOV 92

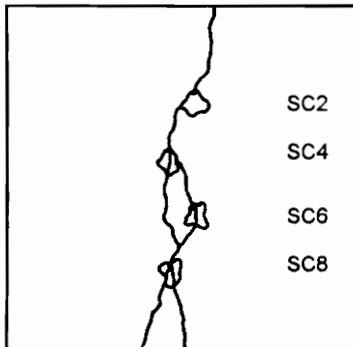
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.170</u>		
	F_y : <u>55.6 ksi</u>	F_u : <u>83.8 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>	f'_c : <u>3500 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

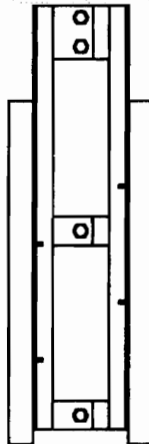
TEST RESULTS

Peak Shear Load:	<u>43.97 kips</u>		
Peak Shear Load Per Fastener:	<u>5.50 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.475 in.</u>	SC2: <u>0.442 in.</u>	
	SC3: <u>0.444 in.</u>	SC4: <u>0.437 in.</u>	
	SC5: <u>0.443 in.</u>	SC6: <u>0.461 in.</u>	
	SC7: <u>0.414 in.</u>	SC8: <u>0.427 in.</u>	

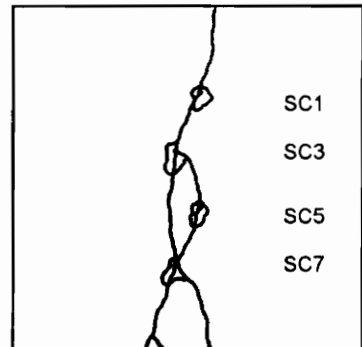
DAMAGE



South Inside



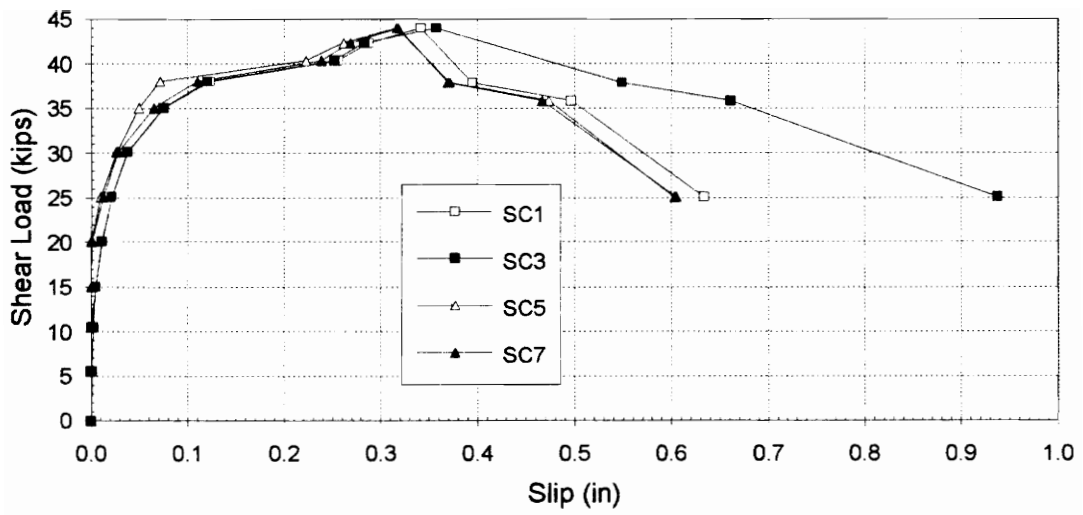
Profile



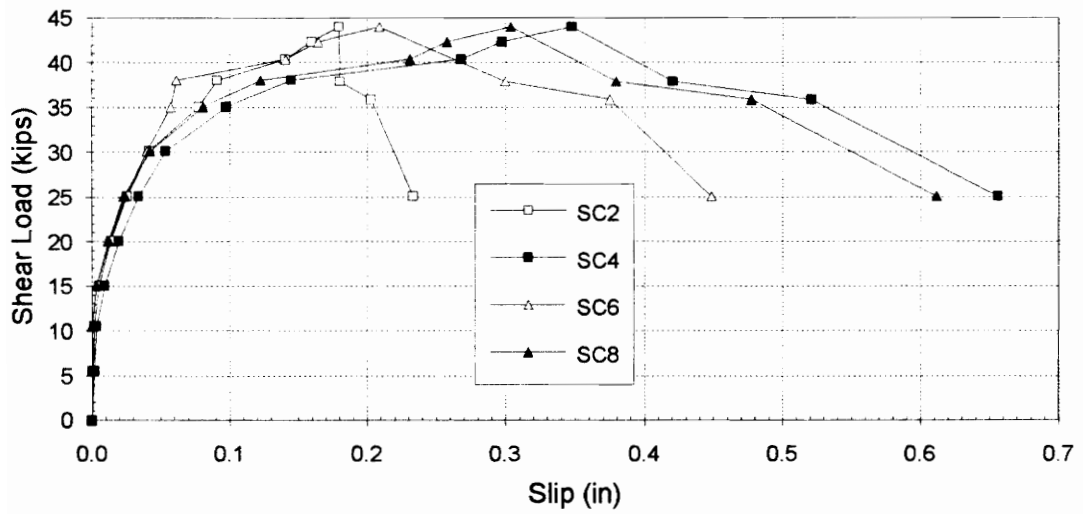
North Inside

COMMENTS

Longitudinal splitting of both slabs
Screw rotation $\approx 30^\circ$



(a) Test 1-6-1 - Load vs. North Slip



(b) Test 1-6-1 - Load vs. South Slip

Fig. A.17 Test 1-6-1 Load vs. Slip Plots

Table A.17 Test 1-6-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.56	-0.67	0.000	0.001	0.001	0.002	0.000	0.000	0.001	0.000
-10.48	-0.97	0.001	0.002	0.002	0.004	0.001	0.000	0.001	0.000
-15.00	-1.47	0.005	0.006	0.005	0.010	0.001	0.004	0.001	0.004
-20.05	-1.97	0.012	0.014	0.011	0.020	0.001	0.013	0.001	0.012
-25.09	-2.43	0.021	0.026	0.021	0.034	0.010	0.024	0.012	0.023
-30.13	-2.98	0.038	0.042	0.037	0.054	0.026	0.040	0.028	0.042
-35.05	-3.44	0.076	0.078	0.075	0.098	0.050	0.057	0.066	0.081
-38.02	-3.81	0.123	0.091	0.120	0.145	0.072	0.062	0.110	0.122
-40.35	-4.05	0.256	0.140	0.253	0.268	0.223	0.140	0.239	0.231
-42.29	-4.29	0.288	0.159	0.283	0.297	0.262	0.164	0.269	0.258
-43.97	-4.39	0.341	0.179	0.358	0.347	0.316	0.209	0.319	0.304
-37.89	-4.35	0.395	0.180	0.549	0.421	0.372	0.300	0.370	0.379
-35.83	-3.67	0.496	0.203	0.661	0.521	0.474	0.375	0.467	0.477
-25.09	-2.65	0.634	0.233	0.938	0.656	0.603	0.448	0.605	0.611

PUSHOUT TEST SUMMARY SHEET

Test: 1-6-2
Test Designation: SC-8-2-0.170-S-2.5-2

Test Date: 24 JAN 93

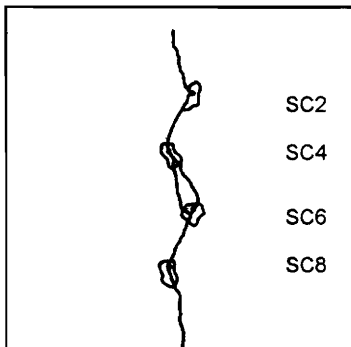
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.170</u>		
	F_y : <u>55.6 ksi</u>	F_u : <u>83.8 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>	f'_c : <u>3900 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

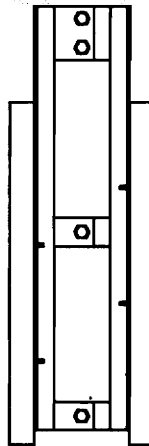
TEST RESULTS

Peak Shear Load:	<u>41.52 kips</u>		
Peak Shear Load Per Fastener:	<u>5.19 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.475 in.</u>	SC2: <u>0.442 in.</u>	
	SC3: <u>0.444 in.</u>	SC4: <u>0.437 in.</u>	
	SC5: <u>0.443 in.</u>	SC6: <u>0.461 in.</u>	
	SC7: <u>0.414 in.</u>	SC8: <u>0.427 in.</u>	

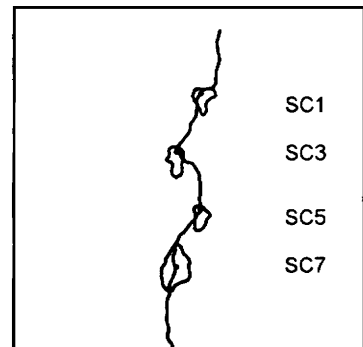
DAMAGE



South Inside



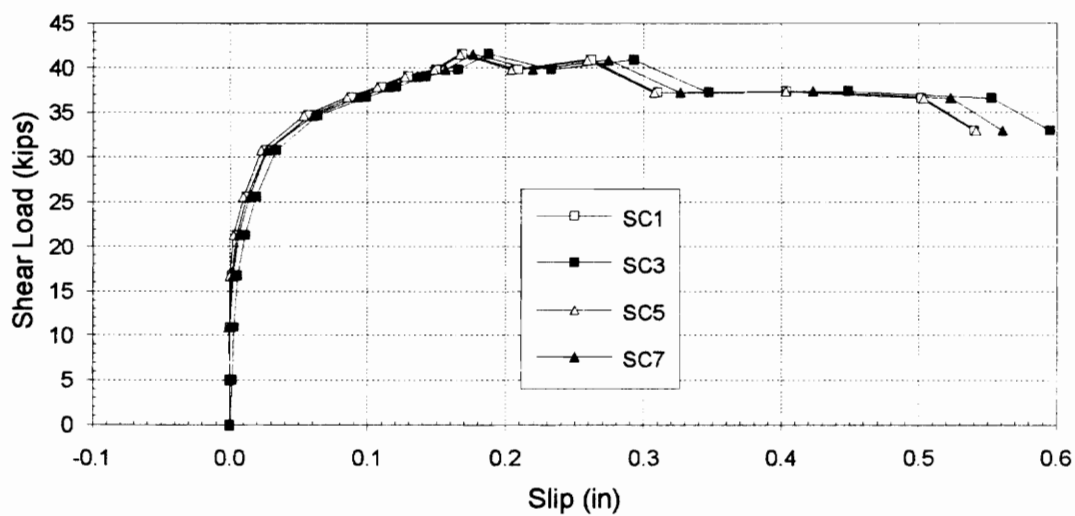
Profile



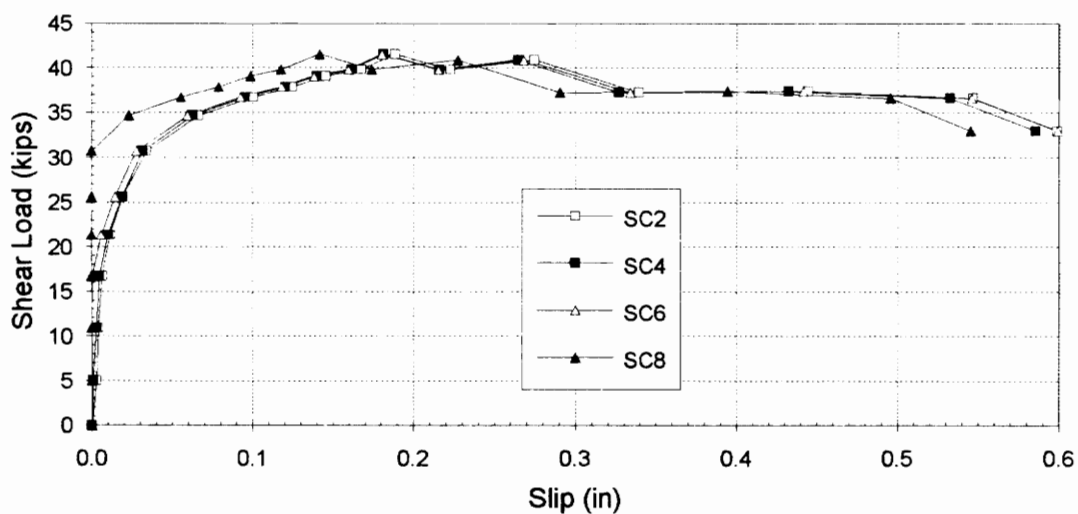
North Inside

COMMENTS

Spacer plate full length at top unbraced length, at middle in bottom
Longitudinal splitting of both slabs
Screw rotation $\approx 30^\circ$



(a) Test 1-6-2 - Load vs. North Slip



(b) Test 1-6-2 - Load vs. South Slip

Fig. A.18 Test 1-6-2 Load vs. Slip Plots

Table A.18 Test 1-6-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.04	-0.50	0.000	0.003	0.002	0.001	0.000	0.000	0.000	0.000
-10.86	-1.09	0.000	0.004	0.003	0.003	0.000	0.000	-0.001	0.000
-16.68	-1.68	0.001	0.007	0.006	0.005	0.000	0.001	0.002	0.000
-21.34	-2.13	0.005	0.012	0.011	0.010	0.002	0.006	0.006	0.000
-25.61	-2.56	0.012	0.020	0.019	0.019	0.010	0.015	0.014	0.000
-30.78	-3.08	0.026	0.034	0.034	0.032	0.023	0.028	0.027	0.000
-34.66	-3.47	0.058	0.067	0.064	0.063	0.054	0.060	0.061	0.023
-36.73	-3.67	0.089	0.100	0.099	0.095	0.085	0.092	0.093	0.056
-37.89	-3.79	0.110	0.125	0.121	0.120	0.107	0.118	0.115	0.079
-39.06	-3.91	0.130	0.146	0.142	0.140	0.127	0.138	0.136	0.099
-39.83	-3.98	0.150	0.168	0.166	0.161	0.148	0.160	0.157	0.118
-41.52	-4.15	0.169	0.188	0.188	0.181	0.167	0.180	0.176	0.142
-39.83	-3.97	0.209	0.223	0.233	0.216	0.204	0.215	0.220	0.174
-40.87	-4.08	0.262	0.275	0.293	0.264	0.259	0.268	0.274	0.227
-37.25	-3.72	0.310	0.339	0.347	0.327	0.308	0.334	0.326	0.290
-37.38	-3.75	0.404	0.445	0.449	0.432	0.403	0.441	0.423	0.395
-36.60	-3.67	0.502	0.547	0.553	0.533	0.503	0.546	0.523	0.496
-32.98	-3.31	0.540	0.599	0.595	0.586	0.541	0.599	0.560	0.545

PUSHOUT TEST SUMMARY SHEET

Test: 1-6-3
 Test Designation: SC-8-2-0.170-S-2.5-3

Test Date: 24 JAN 93

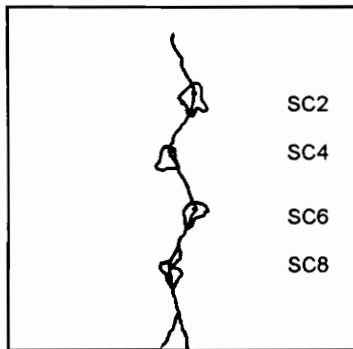
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.170</u>		
	F_y : <u>55.6 ksi</u>	F_u : <u>83.8 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>		f'_c : <u>3900 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

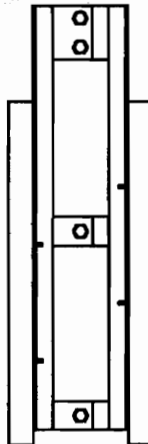
TEST RESULTS

Peak Shear Load: <u>41.39 kips</u>									
Peak Shear Load Per Fastener: <u>5.17 kips</u>									
Slip at Peak Shear Load:	<table border="0" style="width: 100%;"> <tr> <td>SC1: <u>0.475 in.</u></td> <td>SC2: <u>0.442 in.</u></td> </tr> <tr> <td>SC3: <u>0.444 in.</u></td> <td>SC4: <u>0.437 in.</u></td> </tr> <tr> <td>SC5: <u>0.443 in.</u></td> <td>SC6: <u>0.461 in.</u></td> </tr> <tr> <td>SC7: <u>0.414 in.</u></td> <td>SC8: <u>0.427 in.</u></td> </tr> </table>	SC1: <u>0.475 in.</u>	SC2: <u>0.442 in.</u>	SC3: <u>0.444 in.</u>	SC4: <u>0.437 in.</u>	SC5: <u>0.443 in.</u>	SC6: <u>0.461 in.</u>	SC7: <u>0.414 in.</u>	SC8: <u>0.427 in.</u>
SC1: <u>0.475 in.</u>	SC2: <u>0.442 in.</u>								
SC3: <u>0.444 in.</u>	SC4: <u>0.437 in.</u>								
SC5: <u>0.443 in.</u>	SC6: <u>0.461 in.</u>								
SC7: <u>0.414 in.</u>	SC8: <u>0.427 in.</u>								

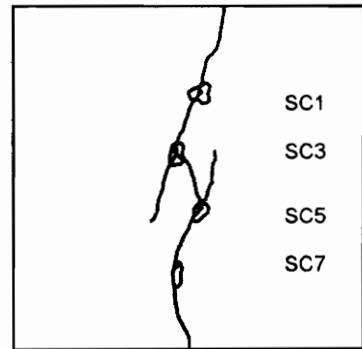
DAMAGE



South Inside



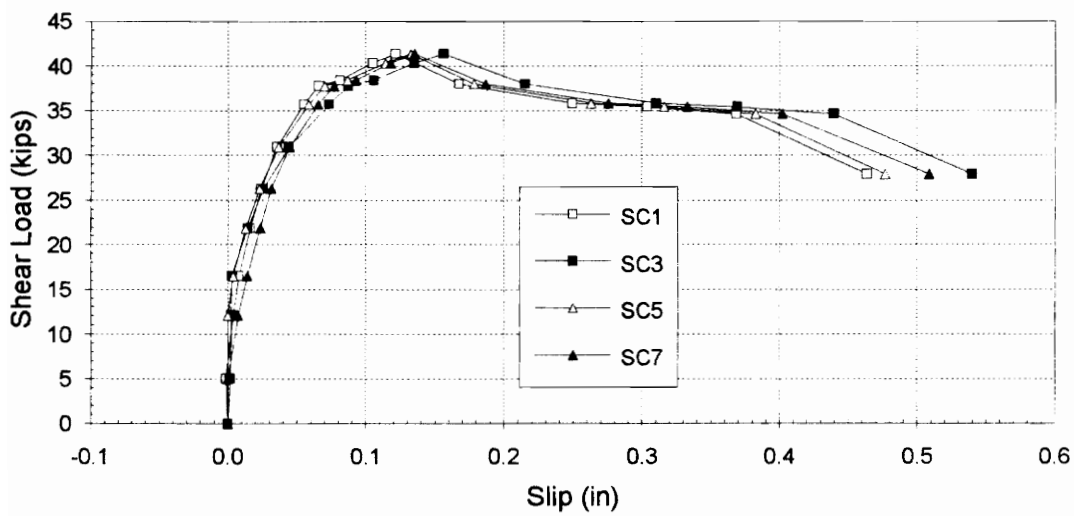
Profile



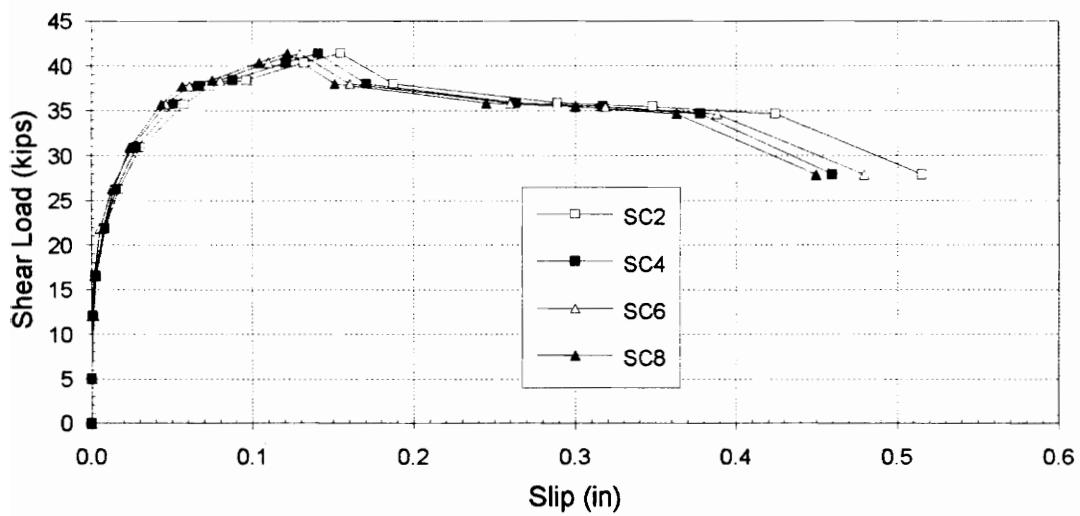
North Inside

COMMENTS

Spacer plate full length at top unbraced length, at middle in bottom
 Longitudinal splitting of both slabs
 Screw rotation $\approx 25^\circ$ - 30°



(a) Test 1-6-3 - Load vs. North Slip



(b) Test 1-6-3 - Load vs. South Slip

Fig. A.19 Test 1-6-3 Load vs. Slip Plots

Table A.19 Test 1-6-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.04	-0.50	-0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.000
-12.03	-1.20	0.004	0.001	0.002	0.001	0.000	0.000	0.007	0.001
-16.55	-1.65	0.008	0.003	0.003	0.002	0.004	0.002	0.014	0.003
-21.86	-2.19	0.016	0.009	0.014	0.008	0.013	0.006	0.023	0.007
-26.25	-2.63	0.024	0.017	0.026	0.015	0.023	0.013	0.031	0.014
-30.91	-3.09	0.035	0.031	0.044	0.028	0.037	0.025	0.045	0.024
-35.70	-3.56	0.055	0.058	0.073	0.051	0.059	0.046	0.066	0.043
-37.77	-3.78	0.066	0.074	0.087	0.067	0.070	0.061	0.077	0.057
-38.41	-3.84	0.081	0.097	0.106	0.088	0.087	0.080	0.093	0.075
-40.35	-4.03	0.105	0.132	0.135	0.121	0.114	0.110	0.118	0.104
-41.39	-4.14	0.122	0.155	0.157	0.141	0.133	0.130	0.135	0.122
-38.02	-3.80	0.168	0.188	0.215	0.171	0.179	0.161	0.187	0.151
-35.83	-3.59	0.250	0.289	0.311	0.263	0.263	0.260	0.276	0.245
-35.44	-3.54	0.304	0.348	0.369	0.317	0.316	0.319	0.333	0.300
-34.66	-3.47	0.369	0.424	0.440	0.378	0.383	0.388	0.402	0.363
-27.94	-2.78	0.464	0.515	0.540	0.460	0.477	0.479	0.509	0.450

PUSHOUT TEST SUMMARY SHEET

Test: 1-6-4
 Test Designation: SC-8-2-0.170-S-2.5-4

Test Date: 24 JAN 93

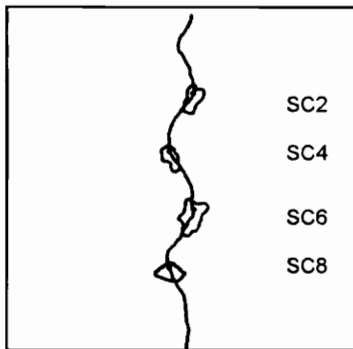
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>None</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.170</u>		
	F_y : <u>55.6 ksi</u>	F_u : <u>83.8 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>		f'_c : <u>3900 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

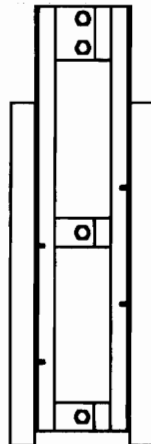
TEST RESULTS

Peak Shear Load: <u>40.61 kips</u>		
Peak Shear Load Per Fastener: <u>5.08 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.475 in.</u>	SC2: <u>0.442 in.</u>
	SC3: <u>0.444 in.</u>	SC4: <u>0.437 in.</u>
	SC5: <u>0.443 in.</u>	SC6: <u>0.461 in.</u>
	SC7: <u>0.414 in.</u>	SC8: <u>0.427 in.</u>

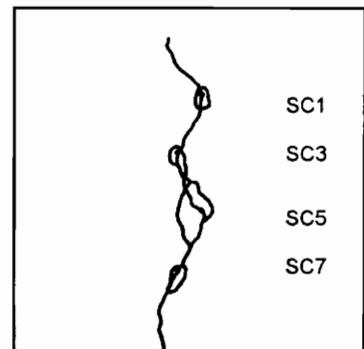
DAMAGE



South Inside



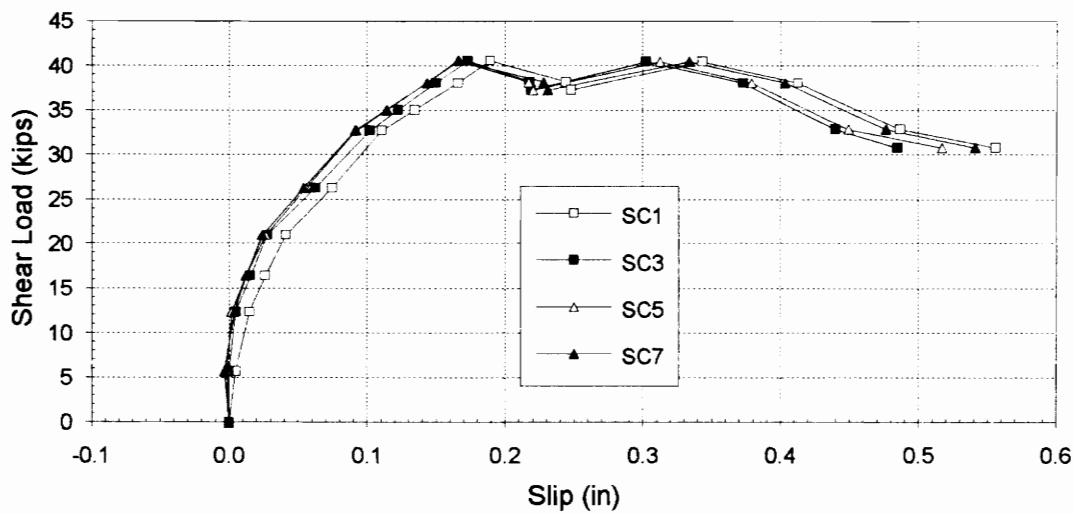
Profile



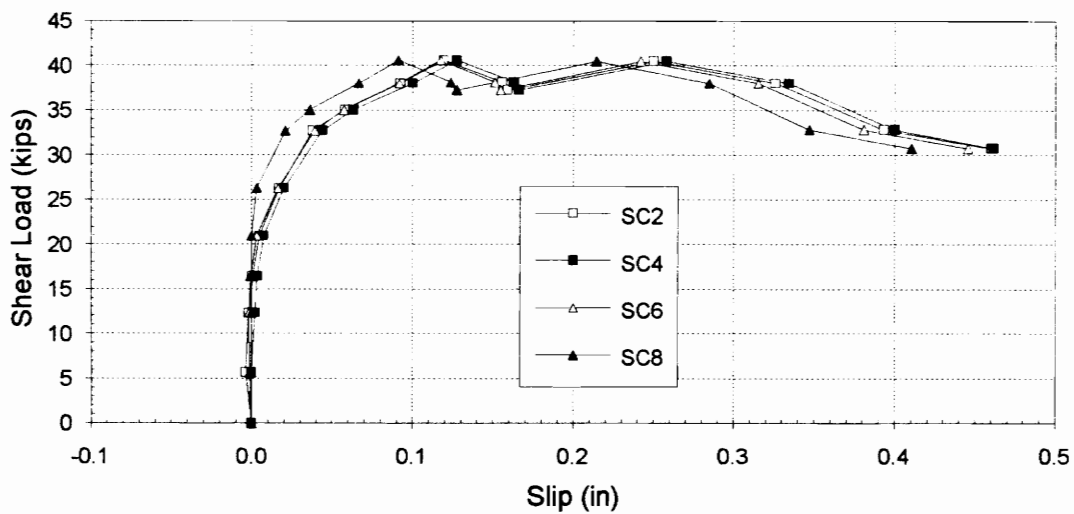
North Inside

COMMENTS

Spacer plate full length at top unbraced length, at middle in bottom
 Longitudinal splitting of both slabs
 Screw rotation $\approx 25^\circ$ - 30°



(a) Test 1-6-4 - Load vs. North Slip



(b) Test 1-6-4 - Load vs. South Slip

Fig. A.20 Test 1-6-4 Load vs. Slip Plots

Table A.20 Test 1-6-4 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.69	-0.57	0.005	-0.004	0.000	0.000	-0.001	-0.001	-0.003	0.000
-12.29	-1.23	0.015	-0.002	0.005	0.002	0.002	-0.002	0.004	0.000
-16.43	-1.63	0.026	0.001	0.015	0.004	0.012	-0.001	0.012	0.000
-20.95	-2.10	0.041	0.005	0.028	0.007	0.026	0.003	0.024	0.000
-26.25	-2.63	0.075	0.017	0.062	0.020	0.056	0.017	0.054	0.003
-32.72	-3.27	0.111	0.038	0.102	0.044	0.092	0.039	0.091	0.021
-35.05	-3.50	0.135	0.058	0.122	0.064	0.114	0.057	0.114	0.036
-38.02	-3.80	0.166	0.092	0.150	0.100	0.143	0.092	0.143	0.067
-40.61	-4.05	0.189	0.119	0.173	0.128	0.166	0.117	0.167	0.091
-38.15	-3.82	0.244	0.156	0.218	0.163	0.217	0.151	0.228	0.124
-37.25	-3.72	0.248	0.159	0.219	0.166	0.220	0.155	0.231	0.127
-40.48	-4.06	0.343	0.250	0.303	0.258	0.313	0.242	0.334	0.214
-38.02	-3.80	0.413	0.326	0.373	0.335	0.379	0.315	0.404	0.285
-32.85	-3.29	0.487	0.393	0.440	0.400	0.449	0.381	0.476	0.347
-30.78	-3.08	0.556	0.460	0.485	0.462	0.517	0.446	0.541	0.410

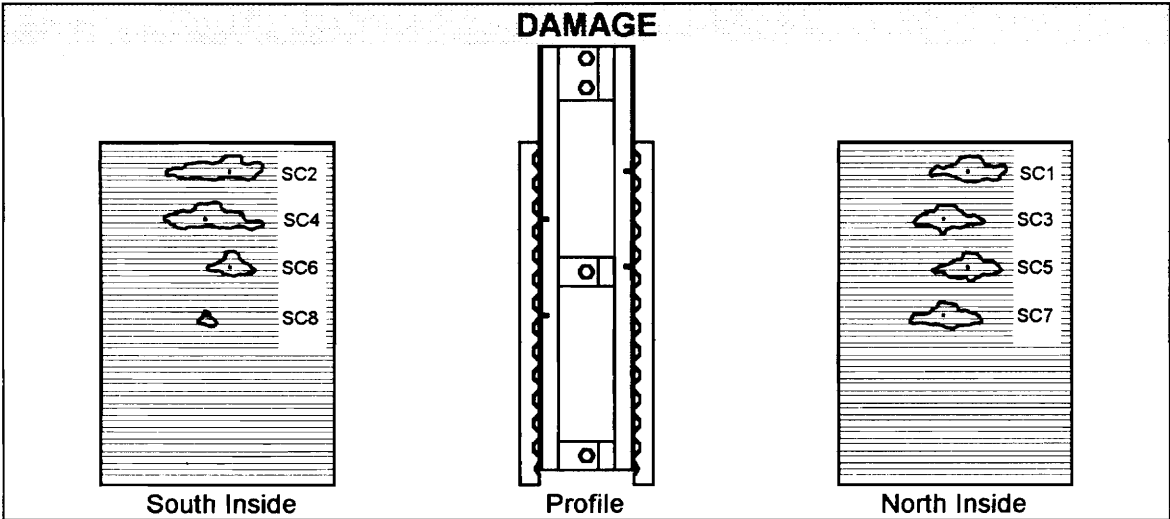
PUSHOUT TEST SUMMARY SHEET

Test: 2-1-1
Test Designation: SC-8-1.5-0.109-0.6C-2-1

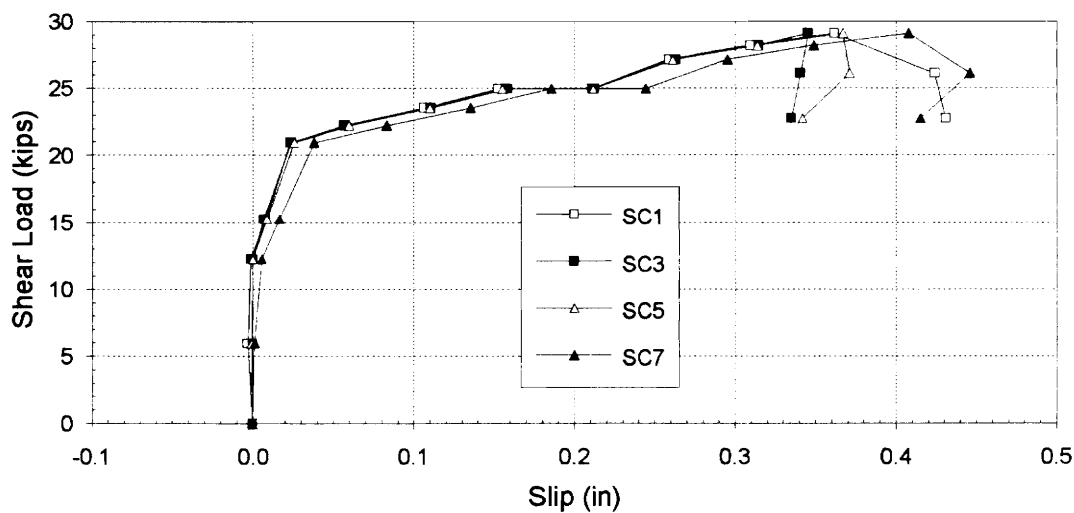
Test Date: 24 MAR 93

SPECIMEN DESCRIPTION			
Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>0.6C, 28 ga</u>	Width: <u>36 in.</u>	Length: <u>24 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>		
	F_y : <u>57.3 ksi</u>	F_u : <u>82.2 ksi</u>	
Slab:	Thickness: <u>2 in.</u>	f'_c : <u>6960 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

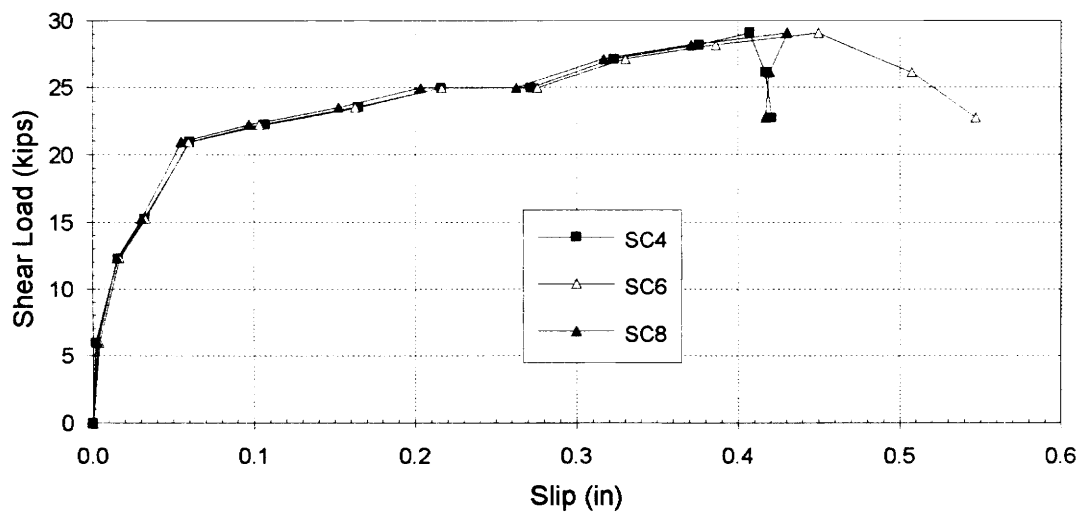
TEST RESULTS			
Peak Shear Load: <u>29.10 kips</u>			
Peak Shear Load Per Fastener: <u>3.64 kips</u>			
Slip at Peak Shear Load:			
	SC1: <u>0.362 in.</u>	SC2: <u>xxx in.</u>	
	SC3: <u>0.345 in.</u>	SC4: <u>0.407 in.</u>	
	SC5: <u>0.367 in.</u>	SC6: <u>0.450 in.</u>	
	SC7: <u>0.408 in.</u>	SC8: <u>0.431 in.</u>	



COMMENTS
Bulges in deck below screw at all locations; Deck debonded
Concrete rib failure at SC1, SC2, SC3, SC4, SC5, SC6, SC7
Angle deformed at all screw locations; Screw rotation $\approx 40^\circ$ - 45°



(a) Test 2-1-1 - Load vs. North Slip



(b) Test 2-1-1 - Load vs. South Slip

Fig. A.21 Test 2-1-1 Load vs. Slip Plots

Table A.21 Test 2-1-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	xxx	0.000	0.000	0.000	0.000	0.000	0.000
-5.95	-0.59	-0.003	xxx	0.000	0.002	-0.001	0.004	0.001	0.003
-12.29	-1.23	-0.001	xxx	0.000	0.016	0.000	0.017	0.006	0.015
-15.26	-1.53	0.008	xxx	0.007	0.032	0.009	0.033	0.017	0.031
-20.95	-2.10	0.023	xxx	0.024	0.060	0.026	0.060	0.038	0.055
-22.25	-2.22	0.057	xxx	0.057	0.107	0.060	0.103	0.083	0.097
-23.54	-2.37	0.106	xxx	0.111	0.165	0.110	0.163	0.135	0.153
-24.96	-2.50	0.153	xxx	0.158	0.216	0.155	0.216	0.186	0.203
-24.96	-2.50	0.211	xxx	0.212	0.272	0.212	0.276	0.244	0.263
-27.16	-2.72	0.259	xxx	0.263	0.323	0.261	0.330	0.295	0.317
-28.19	-2.82	0.310	xxx	0.314	0.376	0.314	0.386	0.349	0.371
-29.10	-2.91	0.362	xxx	0.345	0.407	0.367	0.450	0.408	0.431
-26.13	-2.61	0.424	xxx	0.341	0.417	0.371	0.507	0.446	0.420
-22.76	-2.29	0.431	xxx	0.335	0.421	0.342	0.547	0.415	0.417

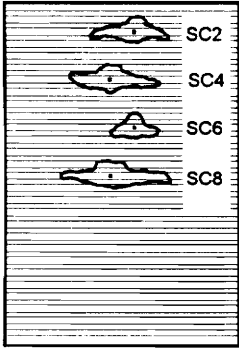
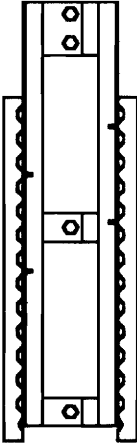
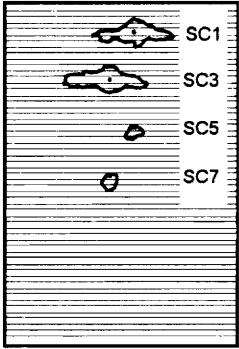
PUSHOUT TEST SUMMARY SHEET

Test: 2-1-2
Test Designation: SC-8-1.5-0.109-0.6C-2-2

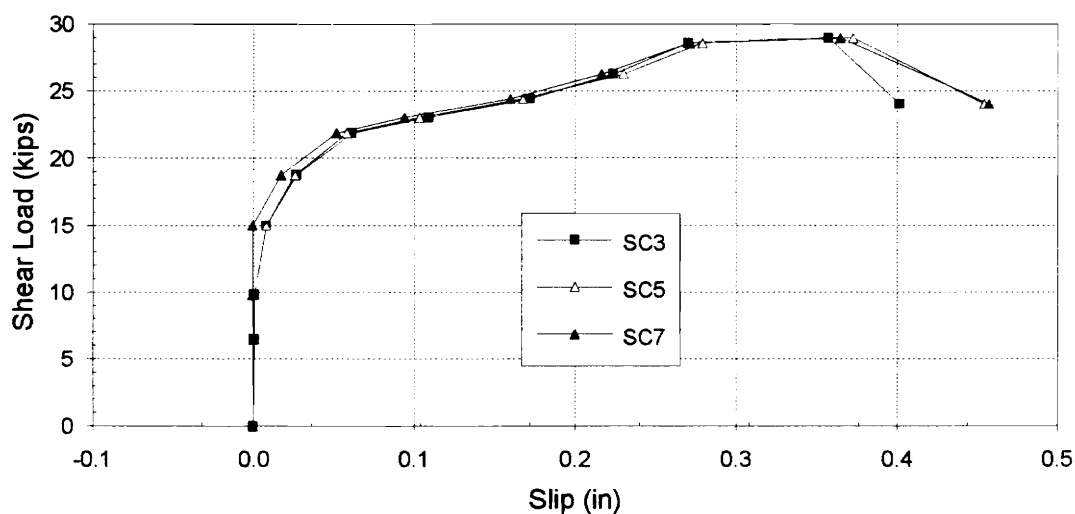
Test Date: 25 MAR 93

SPECIMEN DESCRIPTION			
Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>0.6C, 28 ga</u>	Width: <u>36 in.</u>	Length: <u>24 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>		
	F_y : <u>57.3 ksi</u>	F_u : <u>82.2 ksi</u>	
Slab:	Thickness: <u>2 in.</u>		
	f'_c : <u>6960 psi</u>		
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

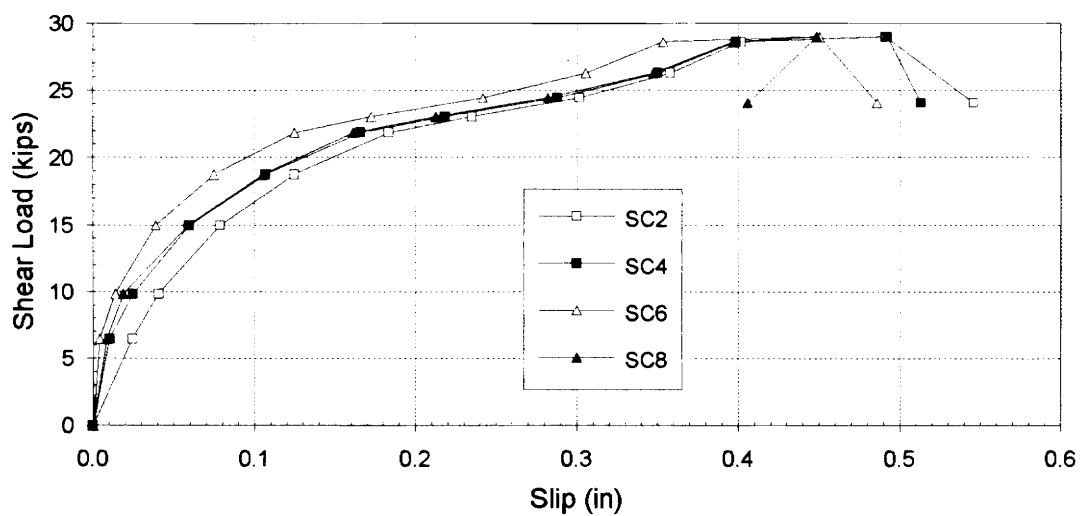
TEST RESULTS			
Peak Shear Load: <u>28.97 kips</u>			
Peak Shear Load Per Fastener: <u>3.62 kips</u>			
Slip at Peak Shear Load:			
	SC1: <u>xxx in.</u>	SC2: <u>0.491 in.</u>	
	SC3: <u>0.357 in.</u>	SC4: <u>0.492 in.</u>	
	SC5: <u>0.373 in.</u>	SC6: <u>0.450 in.</u>	
	SC7: <u>0.365 in.</u>	SC8: <u>0.449 in.</u>	

DAMAGE		
		
South Inside	Profile	North Inside

COMMENTS
Bulges in deck below screw at all locations; Deck debonded
Concrete rib failure at SC1, SC2, SC3, SC4, SC6, SC8
Angle deformed at all screw locations; Screw rotation $\approx 40^{\circ}$ - 45°



(a) Test 2-1-2 - Load vs. North Slip



(b) Test 2-1-2 - Load vs. South Slip

Fig. A.22 Test 2-1-2 Load vs. Slip Plots

Table A.22 Test 2-1-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	xxx	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-6.47	-0.65	xxx	0.024	0.001	0.010	0.001	0.004	0.000	0.009
-9.83	-0.98	xxx	0.041	0.001	0.025	0.001	0.014	-0.001	0.019
-15.00	-1.51	xxx	0.079	0.008	0.060	0.008	0.039	-0.001	0.059
-18.75	-1.88	xxx	0.125	0.027	0.107	0.026	0.075	0.017	0.105
-21.86	-2.19	xxx	0.183	0.061	0.166	0.058	0.125	0.051	0.161
-23.02	-2.29	xxx	0.235	0.109	0.218	0.103	0.172	0.094	0.213
-24.44	-2.47	xxx	0.301	0.172	0.288	0.168	0.242	0.160	0.282
-26.25	-2.65	xxx	0.358	0.224	0.350	0.230	0.305	0.216	0.347
-28.58	-2.85	xxx	0.402	0.270	0.399	0.279	0.354	0.271	0.397
-28.97	-2.91	xxx	0.491	0.357	0.492	0.373	0.450	0.365	0.449
-24.06	-2.42	xxx	0.545	0.401	0.513	0.454	0.486	0.457	0.406

PUSHOUT TEST SUMMARY SHEET

Test: 2-1-3
 Test Designation: SC-8-1.5-0.109-0.6C-2-3

Test Date: 25 MAR 93

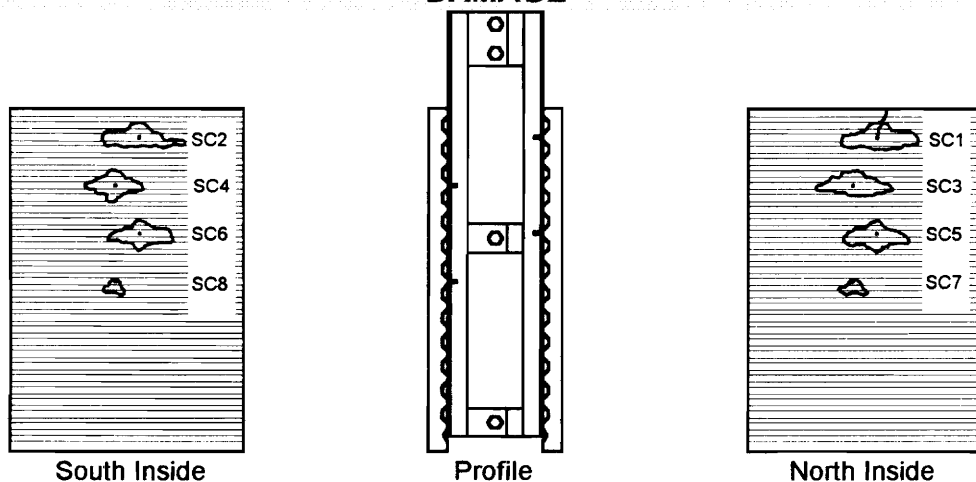
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>0.6C, 28 ga</u>	Width: <u>36 in.</u>	Length: <u>24 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>		
	F_y : <u>57.3 ksi</u>	F_u : <u>82.2 ksi</u>	
Slab:	Thickness: <u>2 in.</u>		f'_c : <u>6960 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

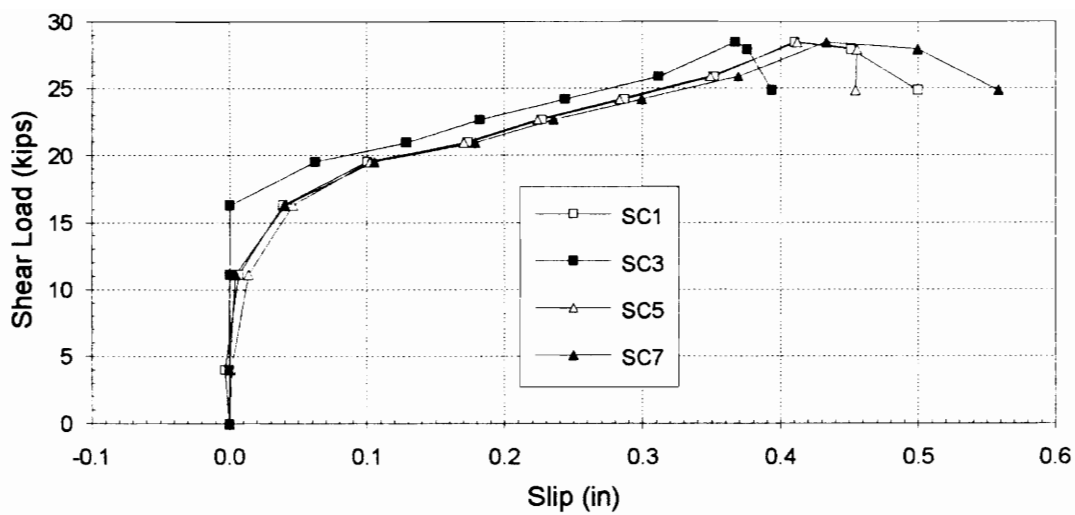
Peak Shear Load: <u>28.45 kips</u>		
Peak Shear Load Per Fastener: <u>3.56 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.410 in.</u>	SC2: <u>0.360 in.</u>
	SC3: <u>0.367 in.</u>	SC4: <u>0.353 in.</u>
	SC5: <u>0.412 in.</u>	SC6: <u>0.365 in.</u>
	SC7: <u>0.434 in.</u>	SC8: <u>0.369 in.</u>

DAMAGE

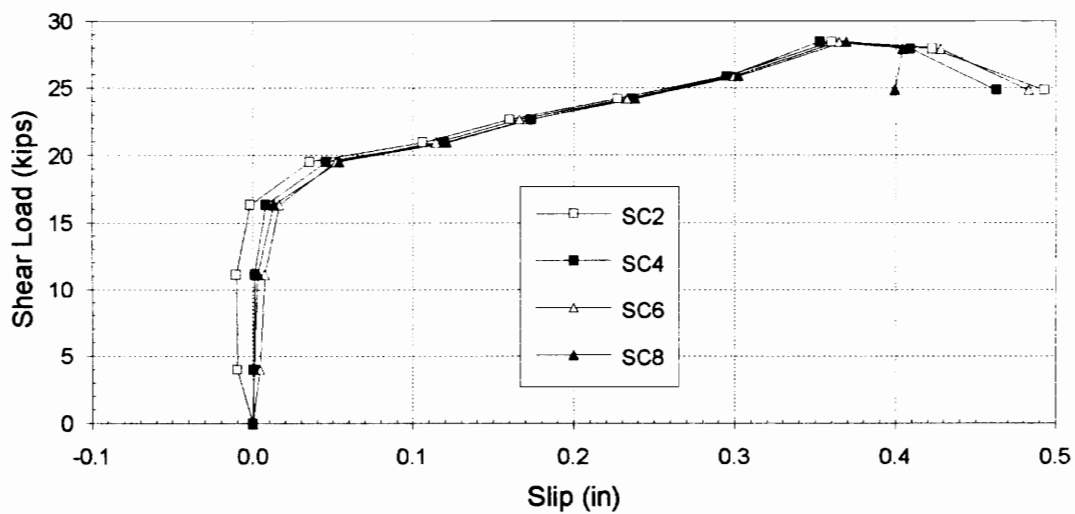


COMMENTS

Bulges in deck below screw at all locations; Deck debonded
 Concrete rib failure at SC1, SC2, SC3, SC4, SC5, SC6; Slight cracking of north slab
 Angle deformed at all screw locations; Screw rotation $\approx 45^\circ$



(a) Test 2-1-3 - Load vs. North Slip



(b) Test 2-1-3 - Load vs. South Slip

Fig. A.23 Test 2-1-3 Load vs. Slip Plots

Table A.23 Test 2-1-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.01	-0.40	-0.003	-0.010	0.000	0.001	0.001	0.004	0.000	0.001
-11.12	-1.13	0.007	-0.010	0.000	0.001	0.013	0.007	0.004	0.003
-16.30	-1.63	0.039	-0.002	0.000	0.008	0.046	0.017	0.040	0.013
-19.53	-1.95	0.100	0.035	0.062	0.046	0.102	0.052	0.105	0.054
-20.95	-2.10	0.173	0.106	0.129	0.119	0.171	0.114	0.179	0.121
-22.63	-2.25	0.227	0.160	0.182	0.173	0.224	0.166	0.236	0.173
-24.19	-2.42	0.287	0.227	0.244	0.236	0.283	0.233	0.299	0.238
-25.87	-2.60	0.352	0.295	0.312	0.296	0.349	0.299	0.369	0.302
-28.45	-2.85	0.410	0.360	0.367	0.353	0.412	0.365	0.434	0.369
-27.94	-2.79	0.451	0.423	0.376	0.409	0.456	0.428	0.500	0.404
-24.83	-2.48	0.500	0.493	0.394	0.463	0.454	0.483	0.559	0.399

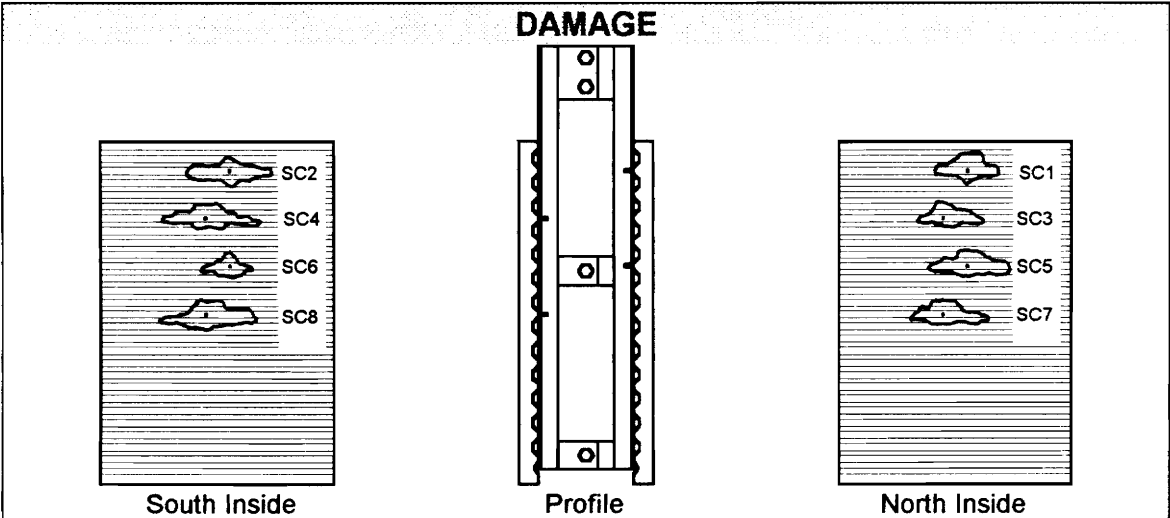
PUSHOUT TEST SUMMARY SHEET

Test: 2-2-1
Test Designation: SC-8-1.5-0.155-0.6C-2-1

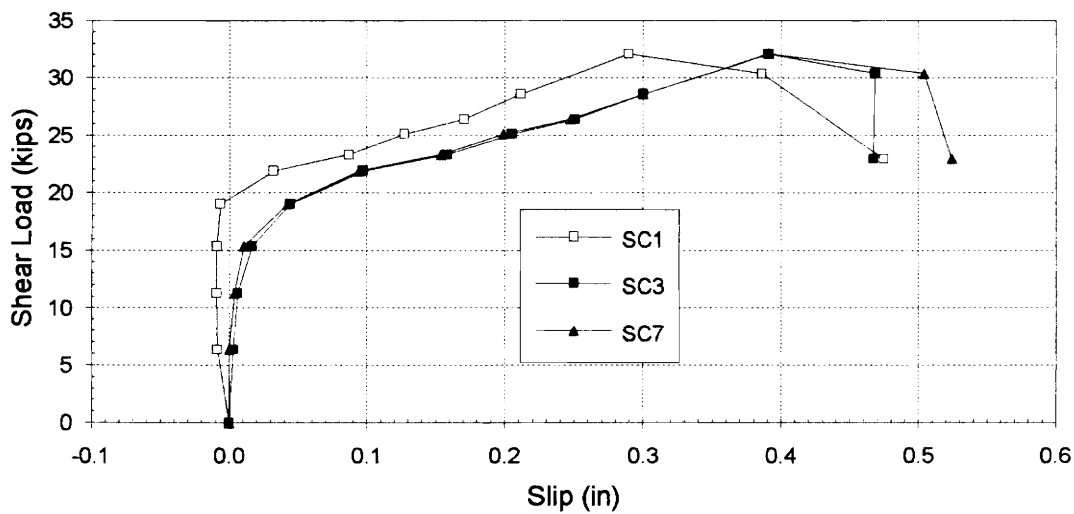
Test Date: 24 MAR 93

SPECIMEN DESCRIPTION			
Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>0.6C, 28 ga</u>	Width: <u>36 in.</u>	Length: <u>24 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.155</u>		
	F_y : <u>54.5 ksi</u>	F_u : <u>79.8 ksi</u>	
Slab:	Thickness: <u>2 in.</u>	f'_c : <u>6960 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

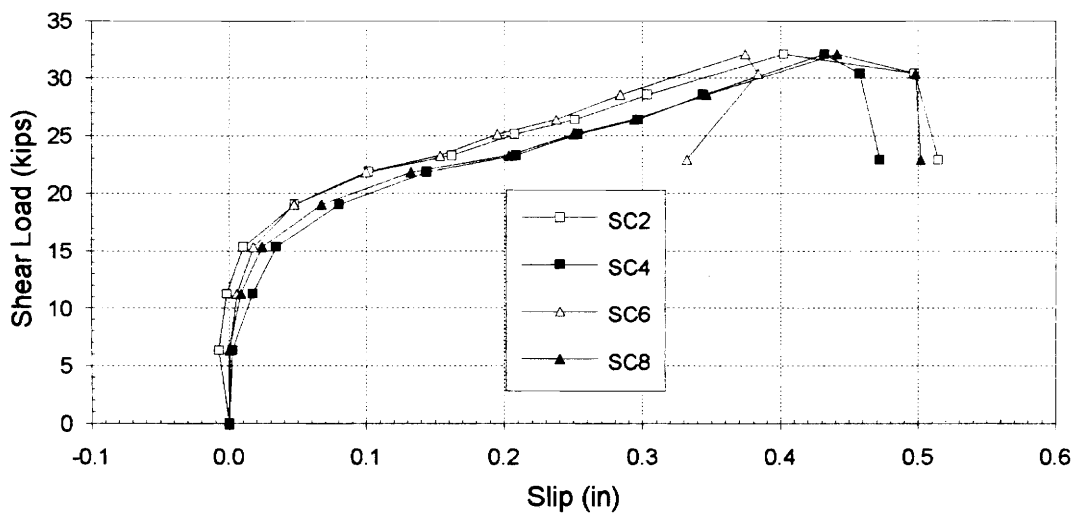
TEST RESULTS			
Peak Shear Load:	<u>32.07 kips</u>		
Peak Shear Load Per Fastener:	<u>4.01 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.289 in.</u>	SC2: <u>0.402 in.</u>	
	SC3: <u>0.391 in.</u>	SC4: <u>0.432 in.</u>	
	SC5: <u>xxx in.</u>	SC6: <u>0.374 in.</u>	
	SC7: <u>0.391 in.</u>	SC8: <u>0.441 in.</u>	



COMMENTS
Bulges in deck below screw at all locations; Deck debonded
Concrete rib failure at all locations
Screw rotation $\approx 40^\circ$ - 45°



(a) Test 2-2-1 - Load vs. North Slip



(b) Test 2-2-1 - Load vs. South Slip

Fig. A.24 Test 2-2-1 Load vs. Slip Plots

Table A.24 Test 2-2-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	xxx	0.000	0.000	0.000
-6.34	-0.63	-0.009	-0.007	0.003	0.002	xxx	0.001	0.000	0.000
-11.25	-1.14	-0.009	-0.002	0.006	0.017	xxx	0.006	0.004	0.009
-15.39	-1.54	-0.009	0.010	0.017	0.034	xxx	0.018	0.010	0.024
-19.01	-1.90	-0.007	0.048	0.044	0.080	xxx	0.047	0.042	0.067
-21.86	-2.19	0.032	0.102	0.097	0.144	xxx	0.100	0.094	0.132
-23.28	-2.34	0.087	0.162	0.158	0.208	xxx	0.153	0.154	0.203
-25.09	-2.51	0.127	0.207	0.205	0.253	xxx	0.195	0.199	0.250
-26.38	-2.64	0.171	0.251	0.251	0.296	xxx	0.237	0.247	0.293
-28.58	-2.87	0.212	0.303	0.300	0.344	xxx	0.284	0.300	0.346
-32.07	-3.21	0.289	0.402	0.391	0.432	xxx	0.374	0.391	0.441
-30.39	-3.04	0.386	0.497	0.468	0.458	xxx	0.383	0.504	0.498
-22.89	-2.29	0.475	0.514	0.467	0.472	xxx	0.332	0.524	0.502

PUSHOUT TEST SUMMARY SHEET

Test: 2-2-2
Test Designation: SC-8-1.5-0.155-0.6C-2-2

Test Date: 24 MAR 93

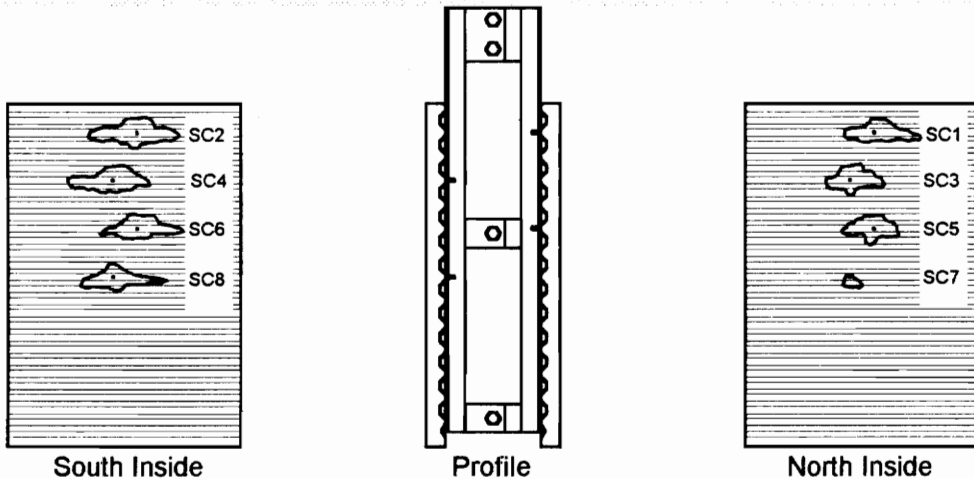
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>0.6C, 28 ga</u>	Width: <u>36 in.</u>	Length: <u>24 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.155</u>		
	F_y : <u>54.5 ksi</u>	F_u : <u>79.8 ksi</u>	
Slab:	Thickness: <u>2 in.</u>	f'_c : <u>6960 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

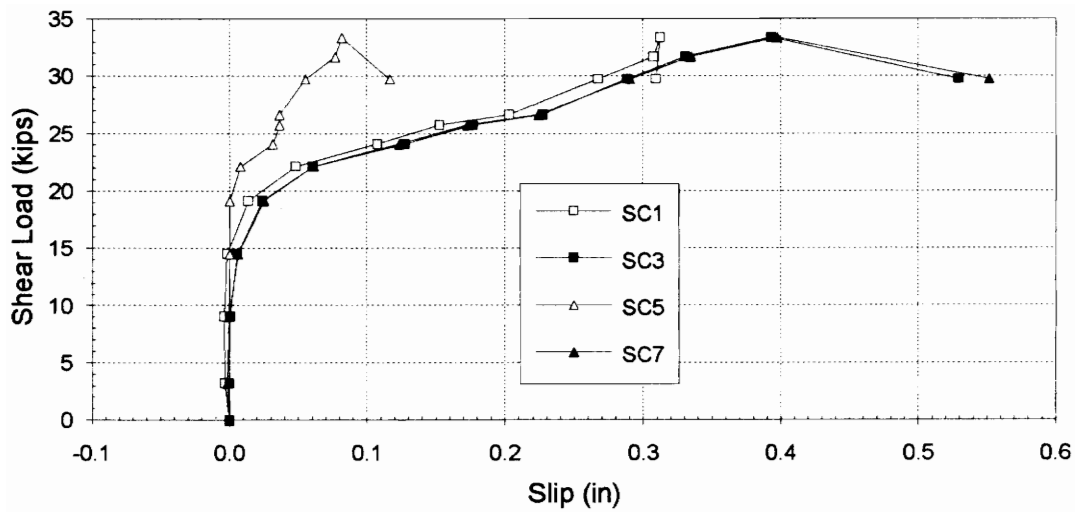
Peak Shear Load:	<u>33.37 kips</u>		
Peak Shear Load Per Fastener:	<u>4.17 kips</u>		
Slip at Peak Shear Load:		SC1: <u>0.313 in.</u>	SC2: <u>0.407 in.</u>
		SC3: <u>0.393 in.</u>	SC4: <u>0.454 in.</u>
		SC5: <u>xxx in.</u>	SC6: <u>0.407 in.</u>
		SC7: <u>0.397 in.</u>	SC8: <u>0.440 in.</u>

DAMAGE

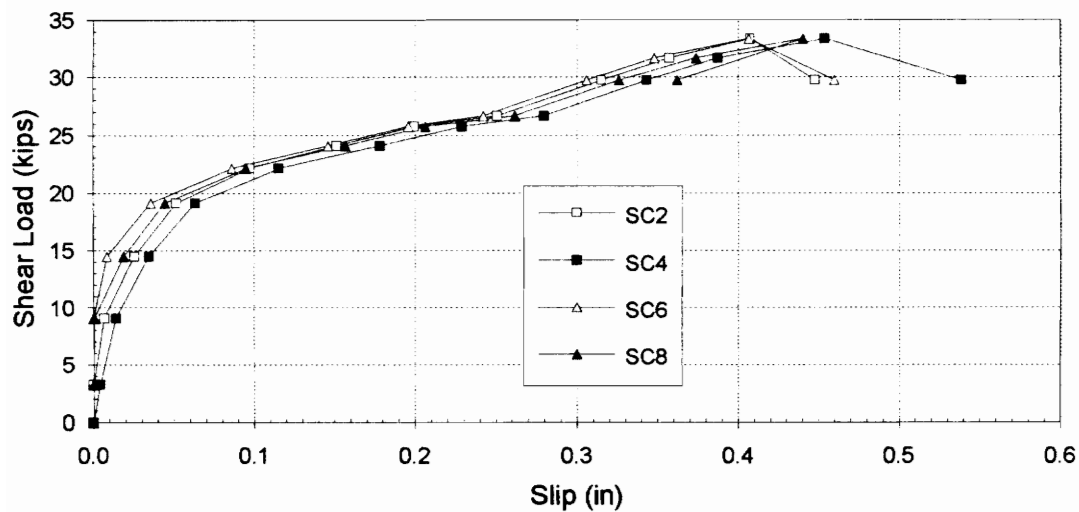


COMMENTS

Bulges in deck below screw at all locations; Deck debonded
Concrete rib failure at SC1, SC2, SC3, SC4, SC5, SC6, SC8
Screw rotation $\approx 35^\circ$ - 40°



(a) Test 2-2-2 - Load vs. North Slip



(b) Test 2-2-2 - Load vs. South Slip

Fig. A.25 Test 2-2-2 Load vs. Slip Plots

Table A.25 Test 2-2-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-3.23	-0.33	-0.003	0.000	0.000	0.004	0.000	0.000	-0.001	0.000
-9.05	-0.91	-0.004	0.007	0.001	0.014	0.000	0.000	0.000	0.001
-14.49	-1.46	-0.002	0.026	0.006	0.035	0.000	0.009	0.006	0.019
-19.14	-1.91	0.013	0.052	0.024	0.064	0.000	0.036	0.025	0.045
-22.12	-2.22	0.048	0.097	0.061	0.115	0.008	0.086	0.061	0.095
-24.06	-2.40	0.108	0.152	0.128	0.178	0.032	0.146	0.124	0.157
-25.74	-2.58	0.153	0.199	0.177	0.229	0.037	0.196	0.173	0.206
-26.64	-2.66	0.204	0.251	0.227	0.280	0.037	0.242	0.225	0.262
-29.75	-2.97	0.267	0.315	0.289	0.343	0.056	0.306	0.291	0.326
-31.69	-3.17	0.308	0.357	0.331	0.387	0.077	0.348	0.335	0.374
-33.37	-3.34	0.313	0.407	0.393	0.454	0.082	0.407	0.397	0.440
-29.75	-2.99	0.310	0.448	0.530	0.539	0.117	0.460	0.552	0.362

PUSHOUT TEST SUMMARY SHEET

Test: 2-2-3
Test Designation: SC-8-1.5-0.155-0.6C-2-3

Test Date: 24 MAR 93

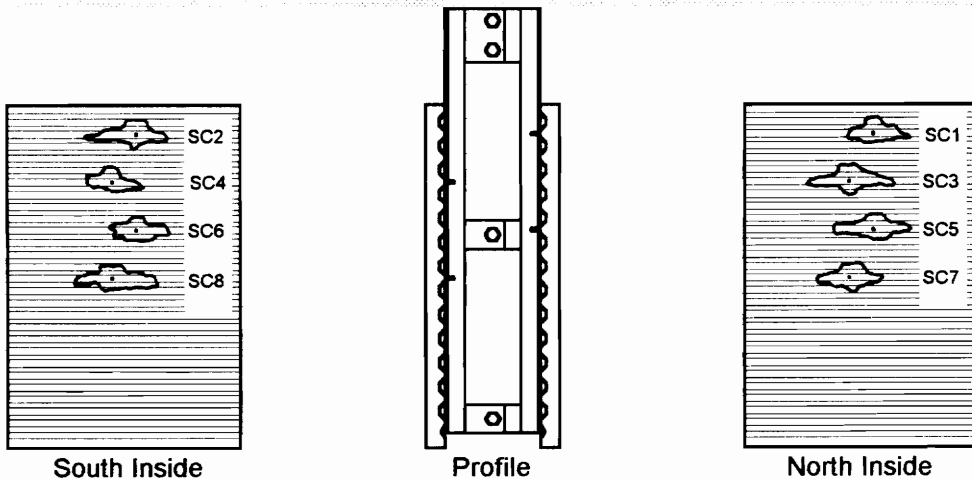
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>0.6C, 28 ga</u> Width: <u>36 in.</u> Length: <u>24 in.</u>
	F_y : <u>N/A</u> F_u : <u>N/A</u>
Base Member:	Section: <u>2L 1.50x1.50x0.155</u>
	F_y : <u>54.5 ksi</u> F_u : <u>79.8 ksi</u>
Slab:	Thickness: <u>2 in.</u> f'_c : <u>6960 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

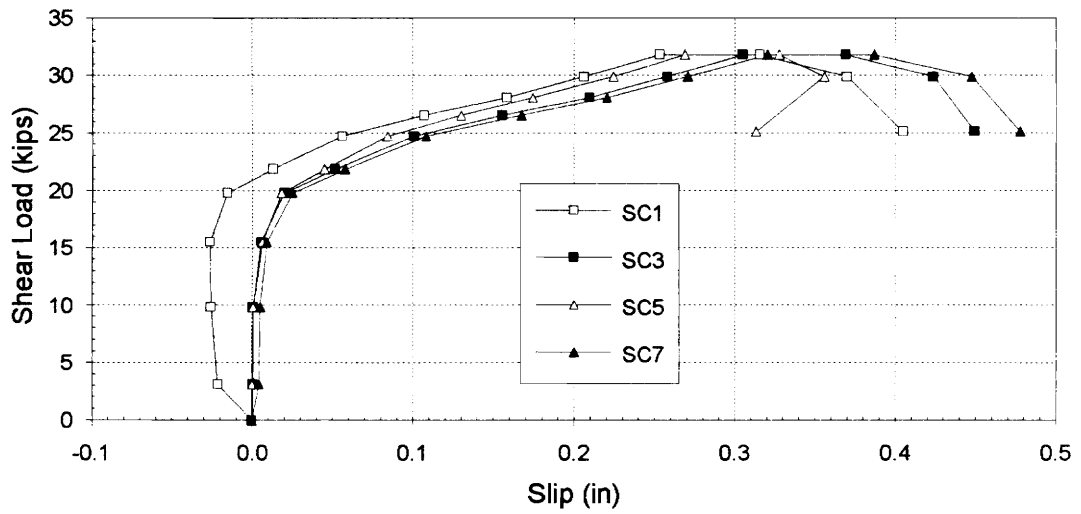
Peak Shear Load:	<u>31.82 kips</u>	
Peak Shear Load Per Fastener:	<u>3.98 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.316 in.</u>	SC2: <u>0.366 in.</u>
	SC3: <u>0.369 in.</u>	SC4: <u>0.471 in.</u>
	SC5: <u>0.328 in.</u>	SC6: <u>0.341 in.</u>
	SC7: <u>0.387 in.</u>	SC8: <u>0.497 in.</u>

DAMAGE

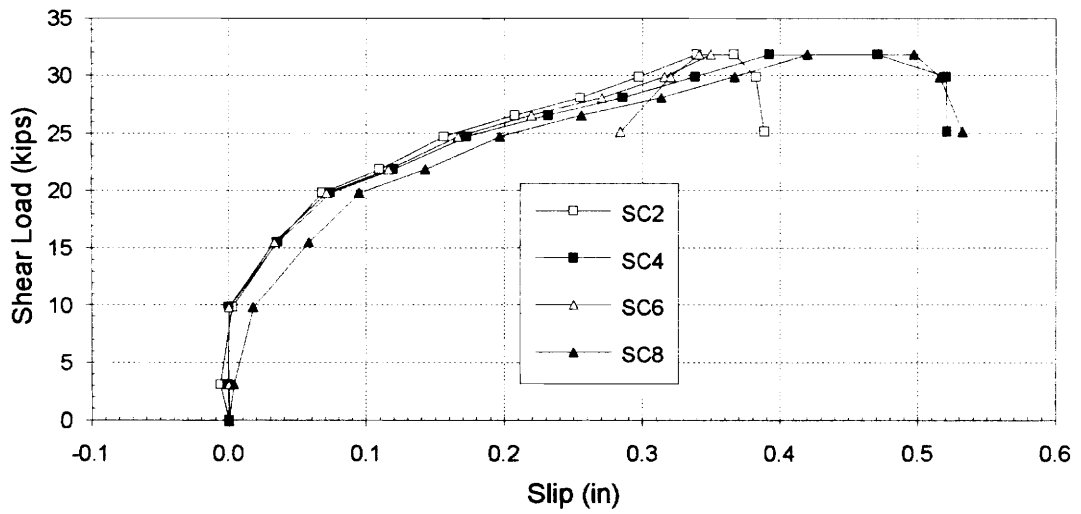


COMMENTS

Bulges in deck below screw at all locations; Deck debonded
Concrete rib failure at all screw locations
Screw rotation $\approx 35^\circ$ - 40°



(a) Test 2-2-3 - Load vs. North Slip



(b) Test 2-2-3 - Load vs. South Slip

Fig. A.26 Test 2-2-3 Load vs. Slip Plots

Table A.26 Test 2-2-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-3.10	-0.32	-0.021	-0.006	0.001	-0.001	0.000	0.000	0.004	0.004
-9.83	-0.99	-0.026	0.002	0.001	0.000	0.001	0.000	0.005	0.018
-15.52	-1.56	-0.026	0.035	0.006	0.035	0.006	0.033	0.009	0.058
-19.79	-1.98	-0.015	0.068	0.020	0.074	0.018	0.071	0.025	0.095
-21.86	-2.19	0.013	0.109	0.052	0.120	0.045	0.116	0.058	0.143
-24.70	-2.48	0.056	0.156	0.101	0.173	0.084	0.166	0.108	0.197
-26.51	-2.65	0.107	0.207	0.156	0.231	0.130	0.219	0.168	0.255
-28.07	-2.82	0.158	0.254	0.210	0.285	0.174	0.270	0.220	0.314
-29.88	-3.00	0.206	0.297	0.258	0.338	0.224	0.316	0.271	0.367
-31.82	-3.18	0.253	0.339	0.305	0.392	0.269	0.350	0.320	0.420
-31.82	-3.18	0.316	0.366	0.369	0.471	0.328	0.341	0.387	0.497
-29.88	-2.99	0.370	0.382	0.424	0.520	0.356	0.320	0.448	0.516
-25.09	-2.51	0.405	0.388	0.449	0.521	0.313	0.284	0.478	0.532

PUSHOUT TEST SUMMARY SHEET

Test: 2-3-1
Test Designation: SC-8-1.5-0.205-0.6C-2-1

Test Date: 25 MAR 93

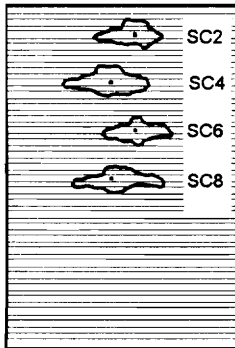
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>0.6C, 28 ga</u>	Width: <u>36 in.</u>	Length: <u>24 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>		
	F_y : <u>54.5 ksi</u>	F_u : <u>80.0 ksi</u>	
Slab:	Thickness: <u>2 in.</u>	f'_c : <u>6960 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

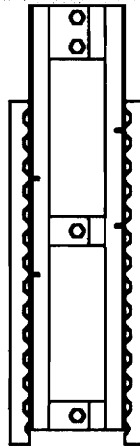
TEST RESULTS

Peak Shear Load:	<u>34.92 kips</u>		
Peak Shear Load Per Fastener:	<u>4.37 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.412 in.</u>	SC2: <u>0.464 in.</u>	
	SC3: <u>0.412 in.</u>	SC4: <u>0.398 in.</u>	
	SC5: <u>0.410 in.</u>	SC6: <u>0.417 in.</u>	
	SC7: <u>0.397 in.</u>	SC8: <u>0.443 in.</u>	

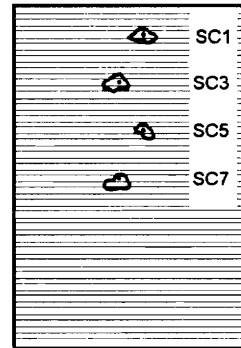
DAMAGE



South Inside



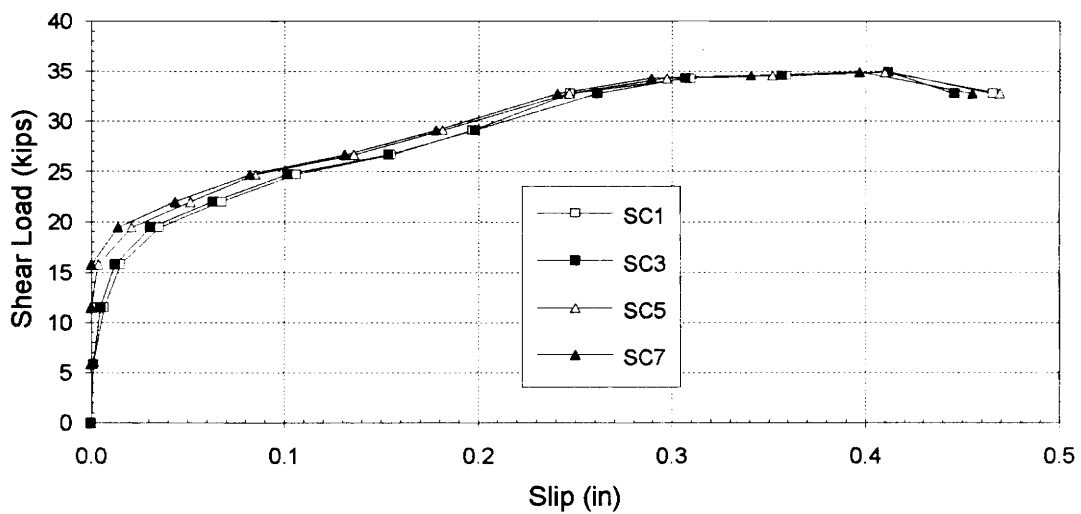
Profile



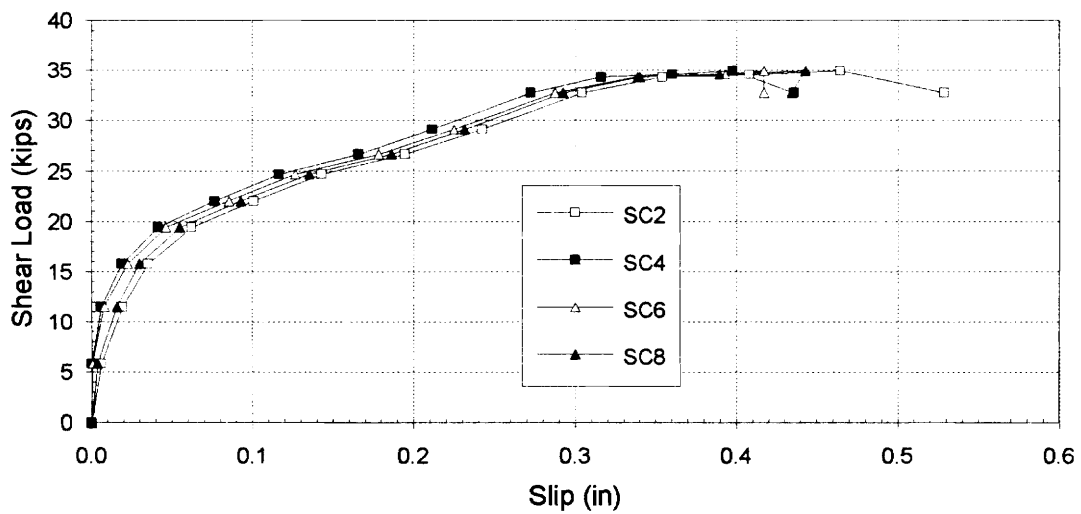
North Inside

COMMENTS

Bulges in deck below screw at all locations; Deck debonded
Concrete rib failure at SC2, SC4, SC6, SC8
Screw rotation $\approx 15^\circ$



(a) Test 2-3-1 - Load vs. North Slip



(b) Test 2-3-1 - Load vs. South Slip

Fig. A.27 Test 2-3-1 Load vs. Slip Plots

Table A.27 Test 2-3-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.82	-0.58	0.001	0.006	0.001	0.000	0.000	0.001	0.000	0.004
-11.51	-1.15	0.007	0.020	0.005	0.006	0.000	0.008	0.000	0.016
-15.78	-1.59	0.015	0.035	0.012	0.019	0.004	0.023	0.000	0.030
-19.40	-1.94	0.035	0.062	0.031	0.042	0.021	0.046	0.014	0.055
-21.99	-2.20	0.067	0.101	0.063	0.077	0.051	0.086	0.043	0.093
-24.70	-2.46	0.106	0.143	0.102	0.117	0.085	0.127	0.082	0.135
-26.64	-2.66	0.155	0.195	0.153	0.166	0.136	0.179	0.131	0.186
-29.10	-2.91	0.197	0.242	0.198	0.211	0.182	0.225	0.178	0.232
-32.72	-3.27	0.247	0.304	0.261	0.272	0.246	0.287	0.241	0.292
-34.27	-3.43	0.310	0.354	0.307	0.316	0.297	0.339	0.289	0.340
-34.53	-3.45	0.359	0.408	0.356	0.360	0.352	0.393	0.341	0.390
-34.92	-3.50	0.412	0.464	0.412	0.398	0.410	0.417	0.397	0.443
-32.72	-3.27	0.466	0.529	0.446	0.435	0.469	0.417	0.455	0.434

PUSHOUT TEST SUMMARY SHEET

Test: 2-3-2
Test Designation: SC-8-1.5-0.205-0.6C-2-2

Test Date: 25 MAR 93

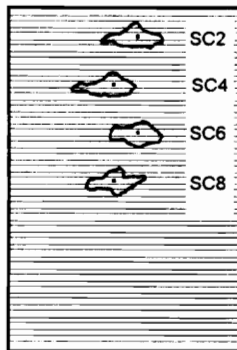
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>0.6C, 28 ga</u>	Width: <u>36 in.</u>	Length: <u>24 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>		
	F_y : <u>54.5 ksi</u>	F_u : <u>80.0 ksi</u>	
Slab:	Thickness: <u>2 in.</u>	f'_c : <u>6960 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

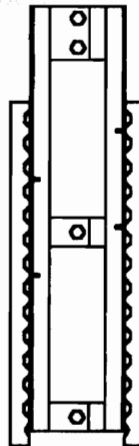
TEST RESULTS

Peak Shear Load:	<u>31.04 kips</u>		
Peak Shear Load Per Fastener:	<u>3.88 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.218 in.</u>	SC2: <u>0.306 in.</u>	
	SC3: <u>0.254 in.</u>	SC4: <u>0.311 in.</u>	
	SC5: <u>0.209 in.</u>	SC6: <u>0.179 in.</u>	
	SC7: <u>0.257 in.</u>	SC8: <u>0.346 in.</u>	

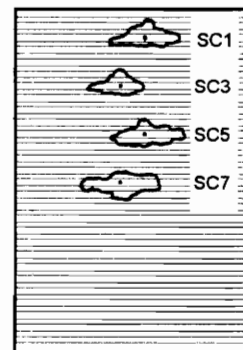
DAMAGE



South Inside



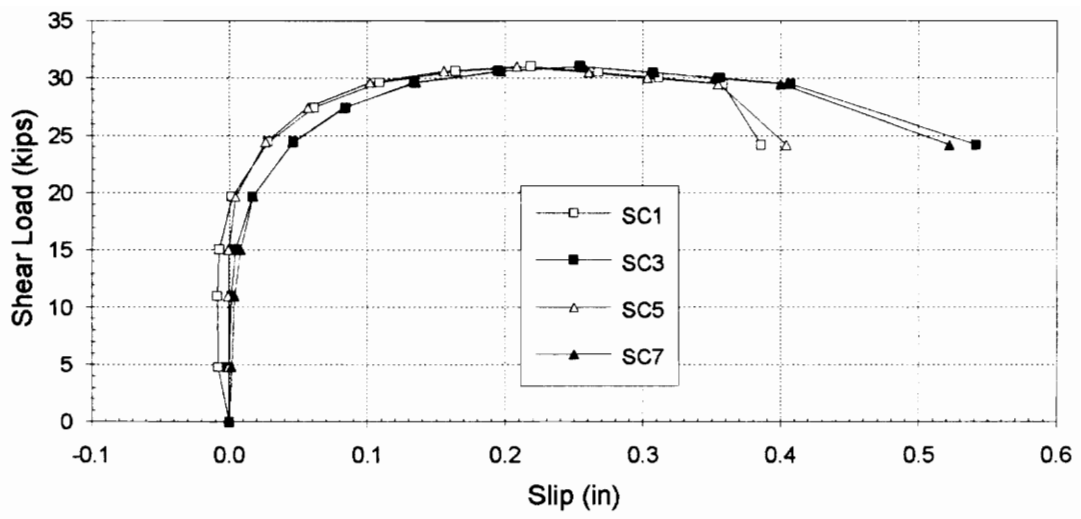
Profile



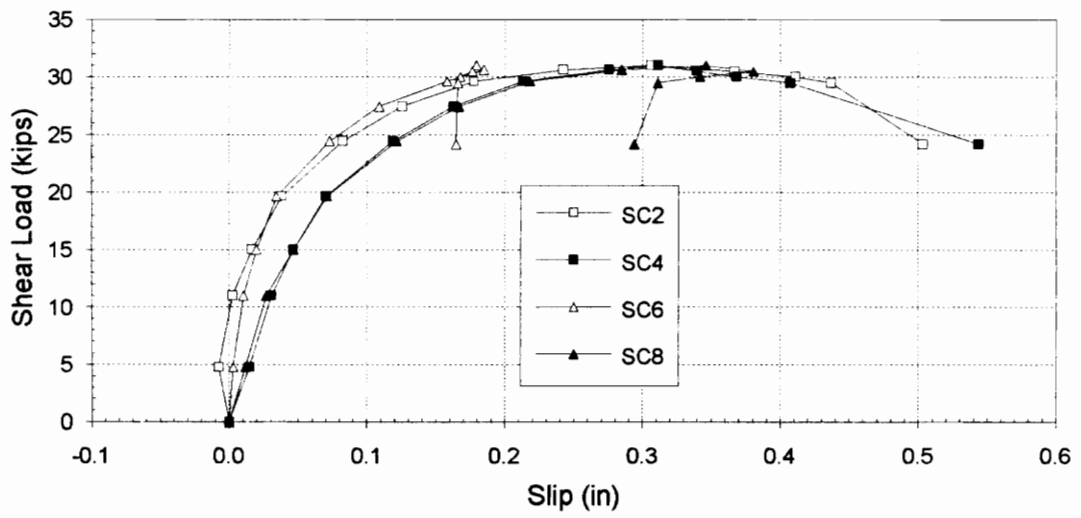
North Inside

COMMENTS

Slight bulges in deck below screw at all locations; Deck debonded
Concrete rib failure at all screw locations
Screw rotation $\approx 20^\circ$



(a) Test 2-3-2 - Load vs. North Slip



(b) Test 2-3-2 - Load vs. South Slip

Fig. A.28 Test 2-3-2 Load vs. Slip Plots

Table A.28 Test 2-3-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.79	-0.49	-0.008	-0.007	-0.001	0.015	-0.001	0.003	0.002	0.012
-10.99	-1.10	-0.009	0.002	0.001	0.031	-0.001	0.010	0.004	0.027
-15.00	-1.51	-0.007	0.017	0.004	0.046	-0.001	0.020	0.008	0.047
-19.66	-1.97	0.002	0.038	0.017	0.070	0.004	0.034	0.017	0.071
-24.44	-2.44	0.028	0.083	0.046	0.118	0.026	0.073	0.046	0.121
-27.42	-2.74	0.062	0.125	0.084	0.162	0.057	0.109	0.083	0.167
-29.62	-2.96	0.109	0.177	0.134	0.213	0.102	0.158	0.135	0.218
-30.65	-3.08	0.164	0.242	0.195	0.275	0.155	0.185	0.197	0.285
-31.04	-3.11	0.218	0.306	0.254	0.311	0.209	0.179	0.257	0.346
-30.52	-3.06	0.267	0.367	0.308	0.340	0.261	0.176	0.309	0.380
-30.01	-3.01	0.311	0.411	0.356	0.368	0.303	0.168	0.352	0.342
-29.49	-2.95	0.358	0.437	0.407	0.407	0.355	0.166	0.400	0.311
-24.19	-2.42	0.386	0.503	0.542	0.544	0.404	0.164	0.522	0.294

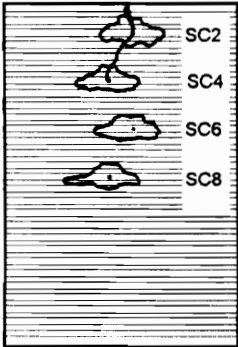
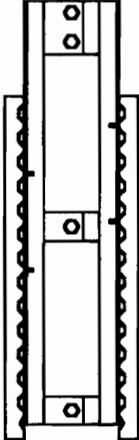
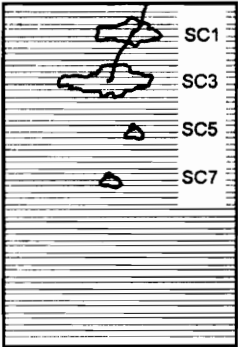
PUSHOUT TEST SUMMARY SHEET

Test: 2-3-3
Test Designation: SC-8-1.5-0.205-0.6C-2-3

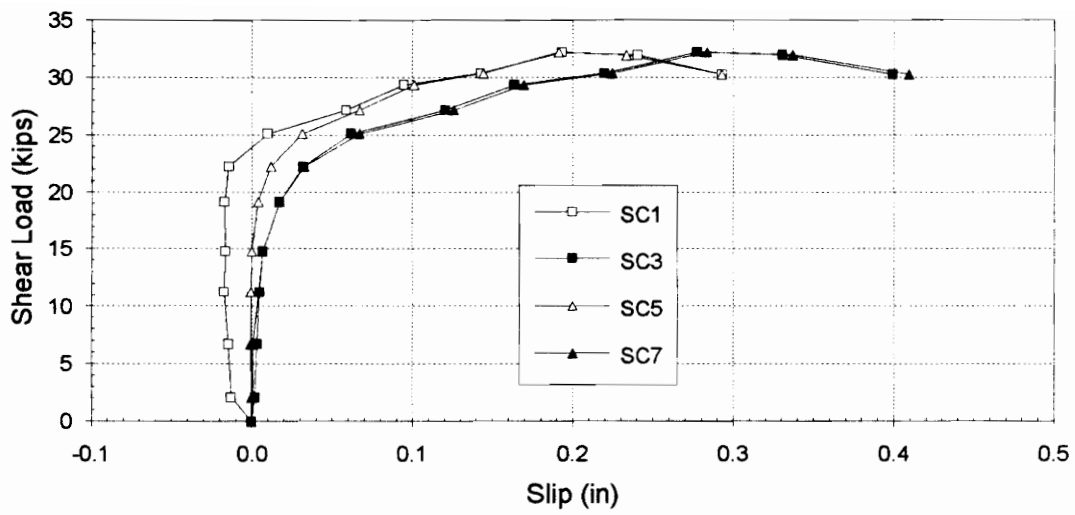
Test Date: 25 MAR 93

SPECIMEN DESCRIPTION			
Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>0.6C, 28 ga</u>	Width: <u>36 in.</u>	Length: <u>24 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>		
	F_y : <u>54.5 ksi</u>	F_u : <u>80.0 ksi</u>	
Slab:	Thickness: <u>2 in.</u>	f'_c : <u>6960 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

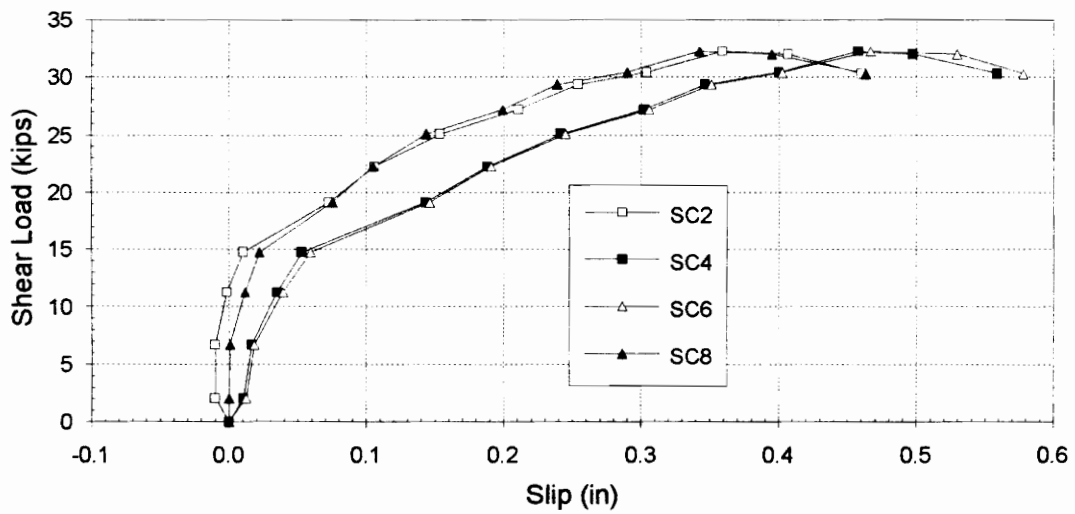
TEST RESULTS			
Peak Shear Load: <u>32.20 kips</u>			
Peak Shear Load Per Fastener: <u>4.03 kips</u>			
Slip at Peak Shear Load:			
	SC1: <u>0.193 in.</u>	SC2: <u>0.359 in.</u>	
	SC3: <u>0.278 in.</u>	SC4: <u>0.457 in.</u>	
	SC5: <u>0.191 in.</u>	SC6: <u>0.466 in.</u>	
	SC7: <u>0.284 in.</u>	SC8: <u>0.342 in.</u>	

DAMAGE		
		
South Inside	Profile	North Inside

COMMENTS
Slight bulges in deck below screw at all locations; Deck debonded
Concrete rib failure at SC1, SC2, SC3, SC4, SC6, SC8
Slight cracking on north and south slabs; Screw rotation $\approx 15^\circ$ - 20°



(a) Test 2-3-3 - Load vs. North Slip



(b) Test 2-3-3 - Load vs. South Slip

Fig. A.29 Test 2-3-3 Load vs. Slip Plots

Table A.29 Test 2-3-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-2.07	-0.21	-0.013	-0.010	0.002	0.010	0.000	0.012	0.001	0.000
-6.73	-0.68	-0.015	-0.010	0.003	0.016	-0.001	0.018	0.001	0.001
-11.25	-1.12	-0.017	-0.001	0.005	0.035	-0.001	0.039	0.004	0.012
-14.74	-1.47	-0.017	0.010	0.007	0.053	0.000	0.059	0.007	0.022
-19.14	-1.91	-0.017	0.073	0.017	0.143	0.004	0.146	0.017	0.075
-22.25	-2.23	-0.015	0.106	0.032	0.188	0.012	0.191	0.032	0.105
-25.09	-2.50	0.010	0.154	0.062	0.241	0.031	0.245	0.067	0.143
-27.16	-2.70	0.059	0.210	0.120	0.302	0.067	0.306	0.126	0.199
-29.36	-2.94	0.095	0.254	0.164	0.346	0.101	0.351	0.170	0.239
-30.39	-3.04	0.143	0.304	0.220	0.400	0.144	0.402	0.225	0.290
-32.20	-3.22	0.193	0.359	0.278	0.457	0.191	0.466	0.284	0.342
-31.95	-3.20	0.240	0.407	0.331	0.497	0.234	0.529	0.337	0.395
-30.26	-3.04	0.293	0.460	0.399	0.559	0.293	0.578	0.409	0.463

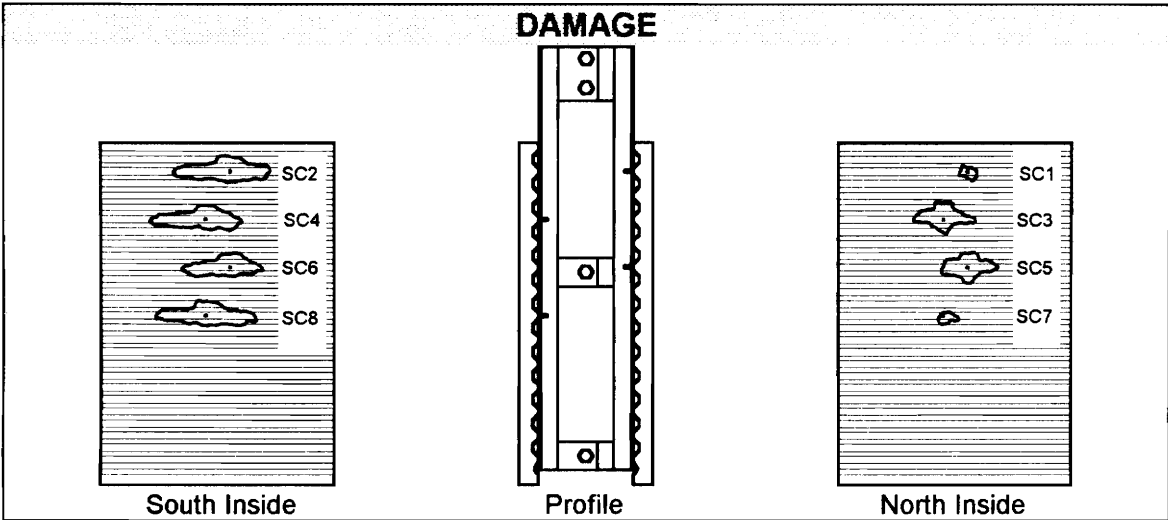
PUSHOUT TEST SUMMARY SHEET

Test: 2-4-1
Test Designation: SC-8-1.5-0.252-0.6C-2-1

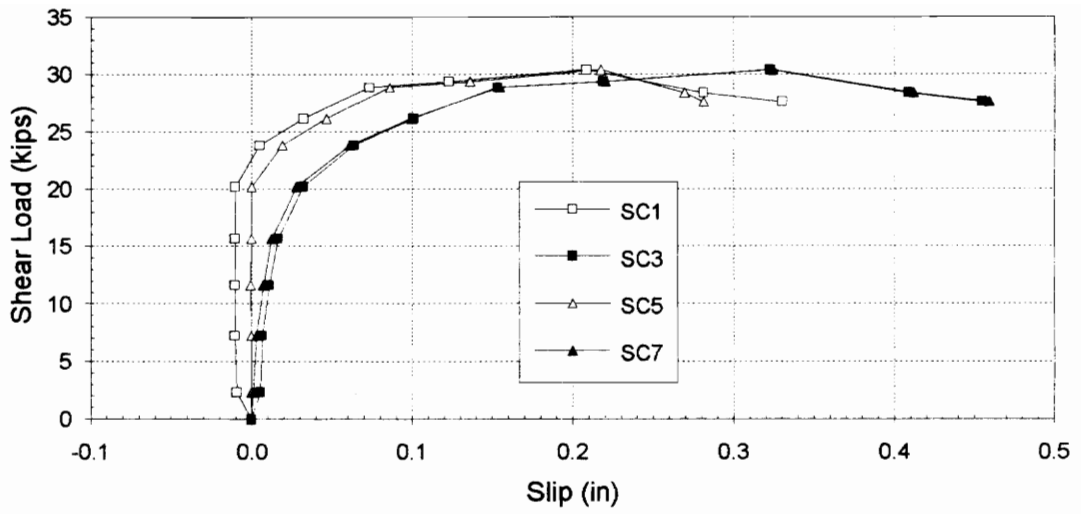
Test Date: 25 MAR 93

SPECIMEN DESCRIPTION			
Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>0.6C, 28 ga</u>	Width: <u>36 in.</u>	Length: <u>24 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.252</u>		
	F_y : <u>51.7 ksi</u>	F_u : <u>77.2 ksi</u>	
Slab:	Thickness: <u>2 in.</u>	f'_c : <u>6960 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

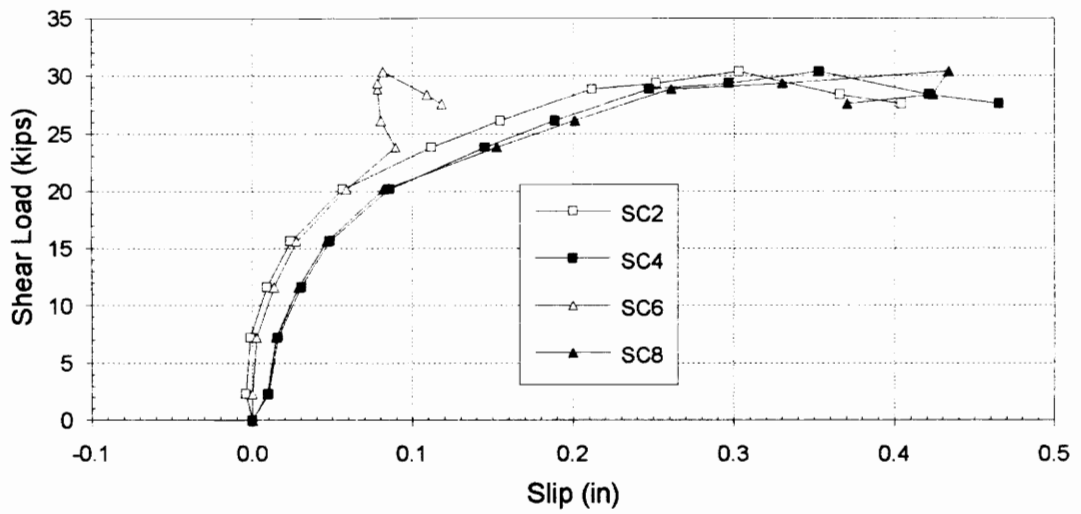
TEST RESULTS			
Peak Shear Load: <u>30.39 kips</u>			
Peak Shear Load Per Fastener: <u>3.80 kips</u>			
Slip at Peak Shear Load:	SC1: <u>0.209 in.</u>	SC2: <u>0.303 in.</u>	
	SC3: <u>0.323 in.</u>	SC4: <u>0.353 in.</u>	
	SC5: <u>0.218 in.</u>	SC6: <u>xxx in.</u>	
	SC7: <u>0.325 in.</u>	SC8: <u>0.434 in.</u>	



COMMENTS
Slight bulges in deck below screw at all locations; Deck debonded
Concrete rib failure at SC2, SC3, SC4, SC5, SC6, SC8
Screw rotation $\approx 10^\circ$ - 15°



(a) Test 2-4-1 - Load vs. North Slip



(b) Test 2-4-1 - Load vs. South Slip

Fig. A.30 Test 2-4-1 Load vs. Slip Plots

Table A.30 Test 2-4-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-2.33	-0.24	-0.009	-0.004	0.006	0.010	0.000	0.000	0.001	0.009
-7.24	-0.72	-0.010	-0.001	0.007	0.016	0.000	0.002	0.003	0.015
-11.64	-1.18	-0.010	0.009	0.011	0.031	-0.001	0.013	0.007	0.029
-15.65	-1.56	-0.010	0.024	0.017	0.048	0.000	0.028	0.012	0.047
-20.18	-2.02	-0.010	0.056	0.032	0.086	0.000	0.059	0.028	0.082
-23.80	-2.39	0.005	0.112	0.064	0.145	0.019	0.089	0.061	0.153
-26.13	-2.61	0.032	0.155	0.101	0.189	0.046	0.080	0.100	0.201
-28.84	-2.90	0.073	0.212	0.153	0.247	0.086	0.078	0.155	0.261
-29.36	-2.94	0.123	0.251	0.219	0.297	0.136	0.078	0.220	0.330
-30.39	-3.05	0.209	0.303	0.323	0.353	0.218	0.081	0.325	0.434
-28.32	-2.82	0.281	0.366	0.409	0.421	0.270	0.109	0.412	0.424
-27.55	-2.75	0.330	0.404	0.455	0.465	0.281	0.118	0.459	0.371

PUSHOUT TEST SUMMARY SHEET

Test: 2-4-2
 Test Designation: SC-8-1.5-0.252-0.6C-2-2

Test Date: 25 MAR 93

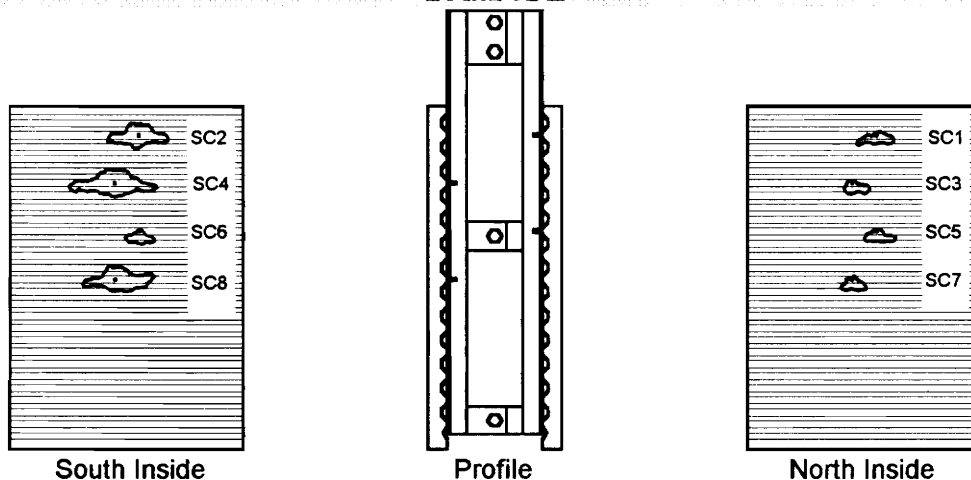
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>0.6C, 28 ga</u>	Width: <u>36 in.</u>	Length: <u>24 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.252</u>		
	F_y : <u>51.7 ksi</u>	F_u : <u>77.2 ksi</u>	
Slab:	Thickness: <u>2 in.</u>	f'_c : <u>6960 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

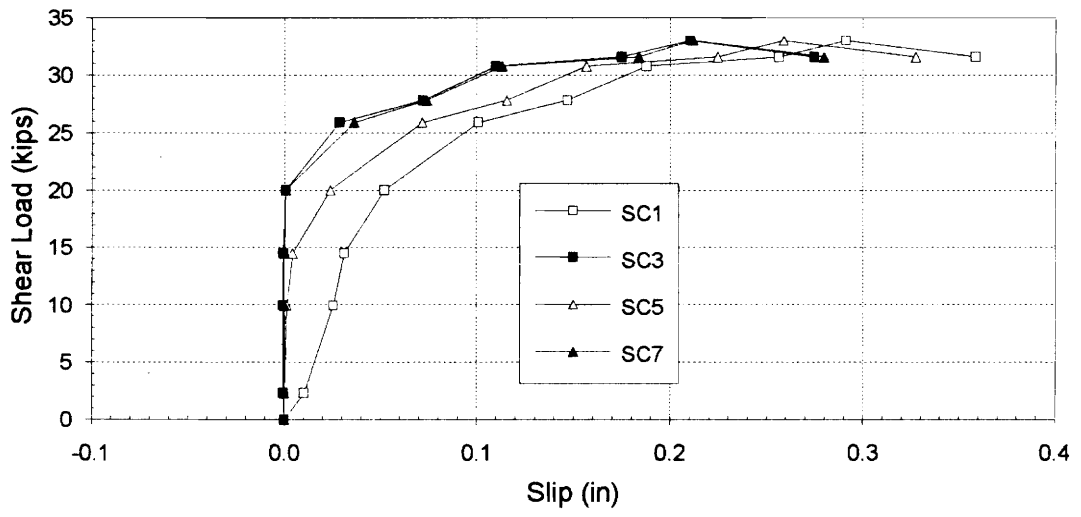
Peak Shear Load: <u>32.98 kips</u>		
Peak Shear Load Per Fastener: <u>4.12 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.291 in.</u>	SC2: <u>0.356 in.</u>
	SC3: <u>0.210 in.</u>	SC4: <u>0.329 in.</u>
	SC5: <u>0.259 in.</u>	SC6: <u>0.307 in.</u>
	SC7: <u>0.212 in.</u>	SC8: <u>0.325 in.</u>

DAMAGE

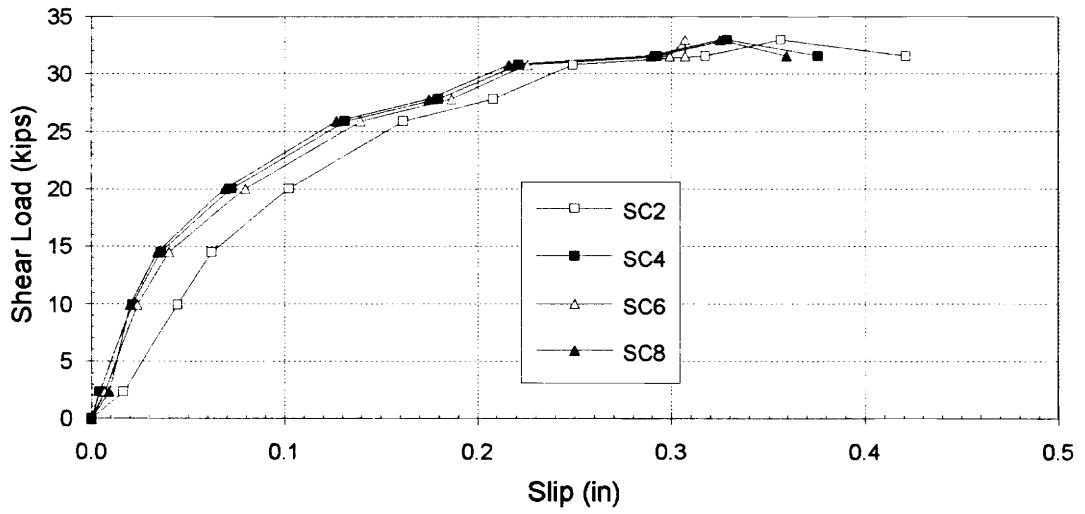


COMMENTS

Slight bulges in deck below screw at all locations; Deck debonded
 Concrete rib failure at SC2, SC4, SC8
 Screw rotation $\approx 10^\circ$ - 15°



(a) Test 2-4-2 - Load vs. North Slip



(b) Test 2-4-2 - Load vs. South Slip

Fig. A.31 Test 2-4-2 Load vs. Slip Plots

Table A.31 Test 2-4-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-2.33	-0.23	0.010	0.017	-0.001	0.004	0.000	0.007	0.000	0.009
-9.96	-1.00	0.026	0.045	-0.001	0.021	0.001	0.024	0.000	0.020
-14.49	-1.45	0.031	0.062	-0.001	0.036	0.004	0.040	0.000	0.034
-20.05	-2.00	0.052	0.102	0.001	0.073	0.024	0.079	0.001	0.069
-25.87	-2.59	0.101	0.161	0.029	0.131	0.072	0.139	0.036	0.127
-27.81	-2.78	0.147	0.208	0.072	0.180	0.116	0.186	0.074	0.175
-30.78	-3.08	0.188	0.249	0.110	0.221	0.157	0.226	0.113	0.216
-31.56	-3.16	0.256	0.317	0.175	0.293	0.224	0.299	0.184	0.289
-32.98	-3.30	0.291	0.356	0.210	0.329	0.259	0.307	0.212	0.325
-31.56	-3.16	0.358	0.421	0.275	0.376	0.327	0.307	0.280	0.359

PUSHOUT TEST SUMMARY SHEET

Test: 2-4-3
 Test Designation: SC-8-1.5-0.252-0.6C-2-3

Test Date: 25 MAR 93

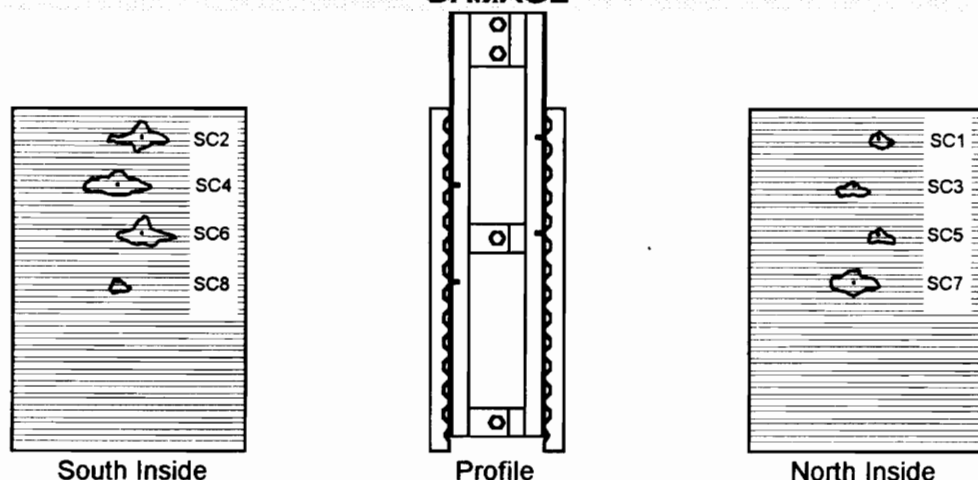
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 1.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>0.6C, 28 ga</u>	Width: <u>36 in.</u>	Length: <u>24 in.</u>
	F_y : <u>N/A</u>	F_u : <u>N/A</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.252</u>		
	F_y : <u>51.7 ksi</u>	F_u : <u>77.2 ksi</u>	
Slab:	Thickness: <u>2 in.</u>	f'_c : <u>6960 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

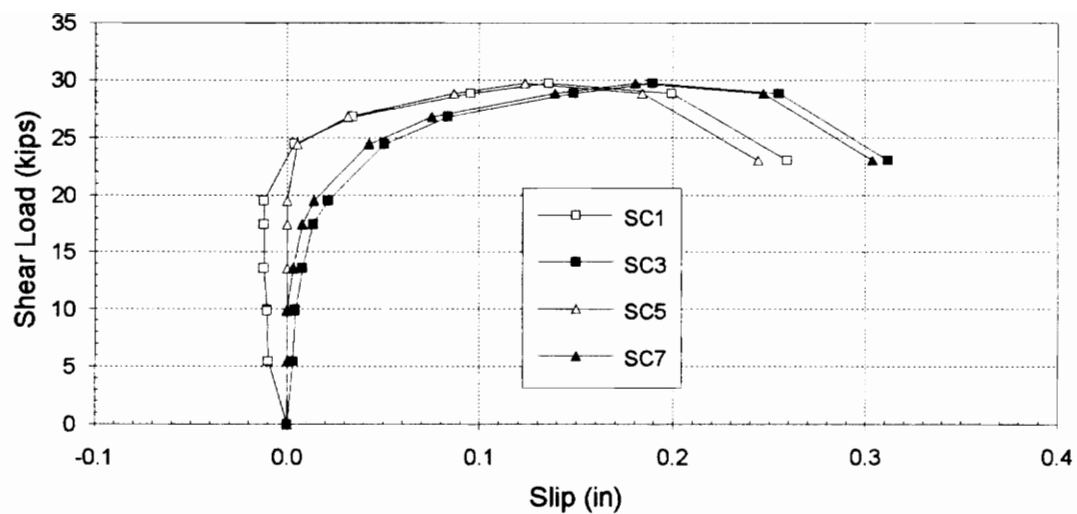
Peak Shear Load: <u>29.75 kips</u>									
Peak Shear Load Per Fastener: <u>3.72 kips</u>									
Slip at Peak Shear Load:	<table border="0" style="width: 100%;"> <tr> <td>SC1: <u>0.136 in.</u></td> <td>SC2: <u>0.294 in.</u></td> </tr> <tr> <td>SC3: <u>0.190 in.</u></td> <td>SC4: <u>0.429 in.</u></td> </tr> <tr> <td>SC5: <u>0.124 in.</u></td> <td>SC6: <u>0.323 in.</u></td> </tr> <tr> <td>SC7: <u>0.181 in.</u></td> <td>SC8: <u>0.437 in.</u></td> </tr> </table>	SC1: <u>0.136 in.</u>	SC2: <u>0.294 in.</u>	SC3: <u>0.190 in.</u>	SC4: <u>0.429 in.</u>	SC5: <u>0.124 in.</u>	SC6: <u>0.323 in.</u>	SC7: <u>0.181 in.</u>	SC8: <u>0.437 in.</u>
SC1: <u>0.136 in.</u>	SC2: <u>0.294 in.</u>								
SC3: <u>0.190 in.</u>	SC4: <u>0.429 in.</u>								
SC5: <u>0.124 in.</u>	SC6: <u>0.323 in.</u>								
SC7: <u>0.181 in.</u>	SC8: <u>0.437 in.</u>								

DAMAGE

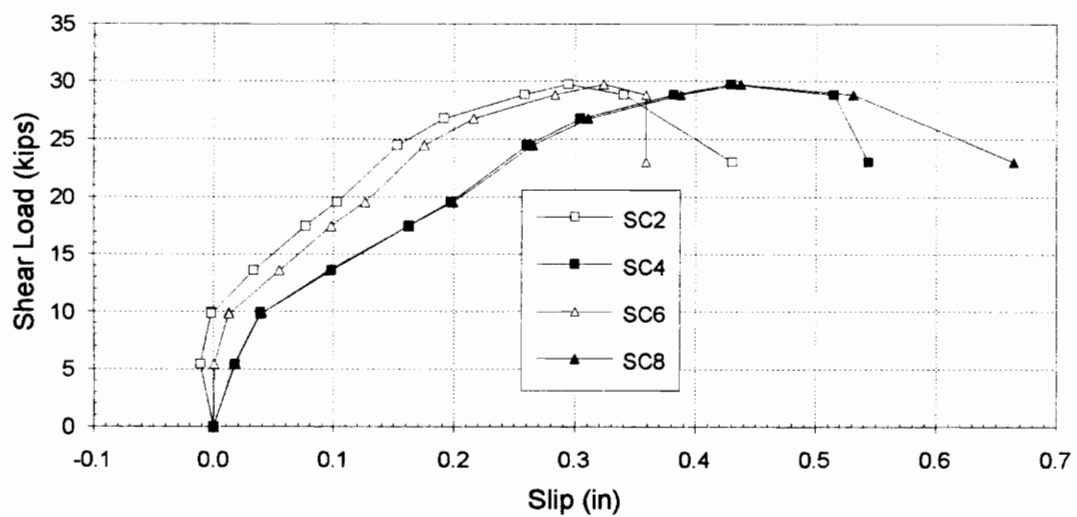


COMMENTS

Slight bulges in deck below screw at all locations; Deck debonded
 Concrete rib failure at SC2, SC4, SC6, SC7
 Screw rotation $\approx 10^\circ$ - 15°



(a) Test 2-4-3 - Load vs. North Slip



(b) Test 2-4-3 - Load vs. South Slip

Fig. A.32 Test 2-4-3 Load vs. Slip Plots

Table A.32 Test 2-4-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.43	-0.53	-0.010	-0.011	0.003	0.018	0.000	0.001	0.000	0.018
-9.96	-0.99	-0.010	-0.002	0.004	0.039	0.000	0.013	0.000	0.040
-9.83	-0.95	-0.010	-0.002	0.004	0.039	0.000	0.013	0.000	0.039
-13.58	-1.37	-0.012	0.033	0.008	0.098	0.000	0.054	0.003	0.096
-17.46	-1.75	-0.012	0.076	0.013	0.162	0.000	0.098	0.008	0.162
-19.53	-1.95	-0.012	0.103	0.021	0.197	0.000	0.126	0.014	0.199
-24.44	-2.44	0.004	0.153	0.051	0.260	0.006	0.175	0.043	0.265
-26.77	-2.68	0.034	0.191	0.084	0.304	0.032	0.216	0.075	0.311
-28.84	-2.89	0.095	0.258	0.149	0.382	0.087	0.283	0.139	0.388
-29.75	-2.97	0.136	0.294	0.190	0.429	0.124	0.323	0.181	0.437
-28.84	-2.87	0.199	0.340	0.255	0.515	0.184	0.358	0.247	0.531
-23.02	-2.30	0.259	0.430	0.312	0.544	0.244	0.358	0.304	0.665

PUSHOUT TEST SUMMARY SHEET

Test: 3-1-1
 Test Designation: SC-8-2-0.109-1.0C-2.5-1

Test Date: 19 FEB 93

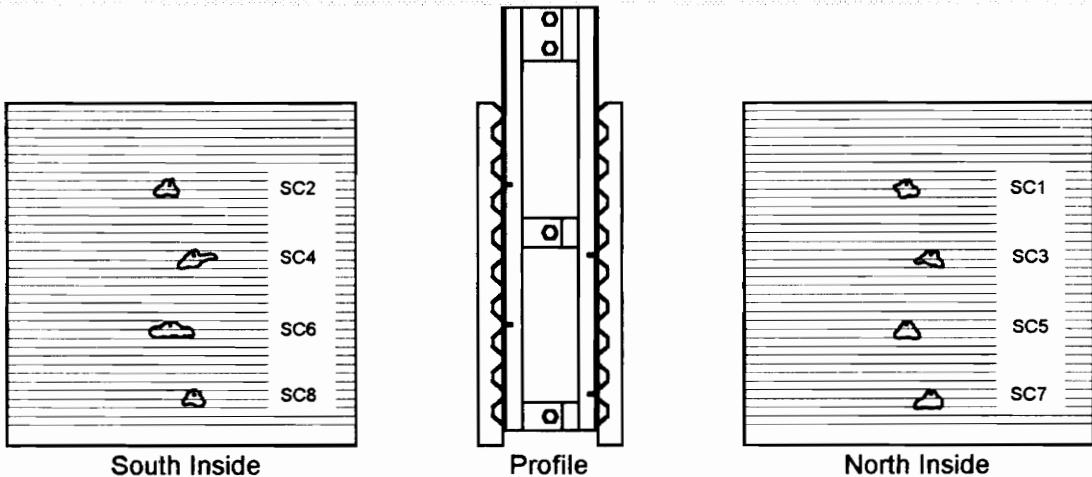
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>		
	F_y : <u>53.8 ksi</u>	F_u : <u>78.2 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>		
	f'_c : <u>4870 psi</u>		
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

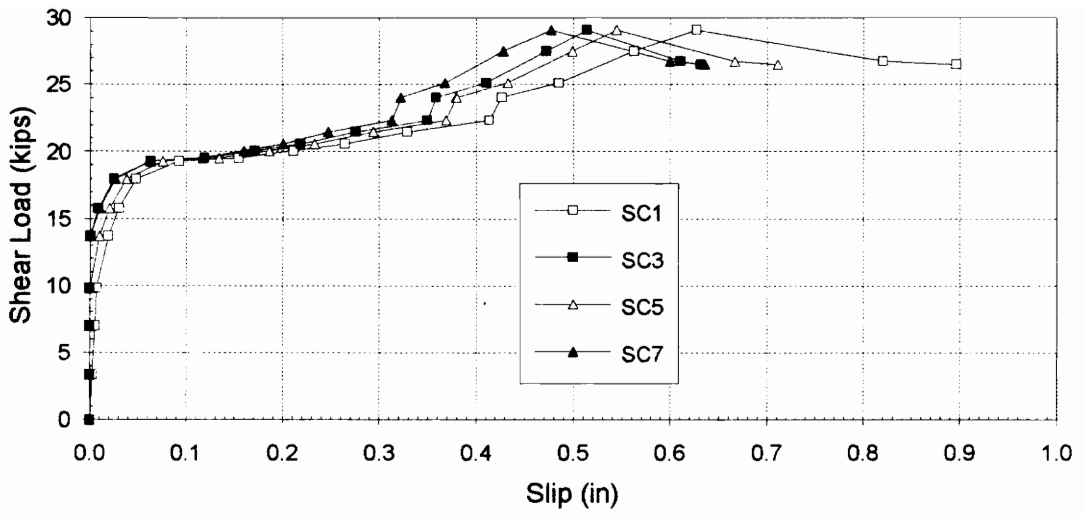
Peak Shear Load: <u>29.10 kips</u>		
Peak Shear Load Per Fastener: <u>3.64 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.627 in.</u>	SC2: <u>0.552 in.</u>
	SC3: <u>0.514 in.</u>	SC4: <u>0.557 in.</u>
	SC5: <u>0.545 in.</u>	SC6: <u>0.592 in.</u>
	SC7: <u>0.477 in.</u>	SC8: <u>0.478 in.</u>

DAMAGE

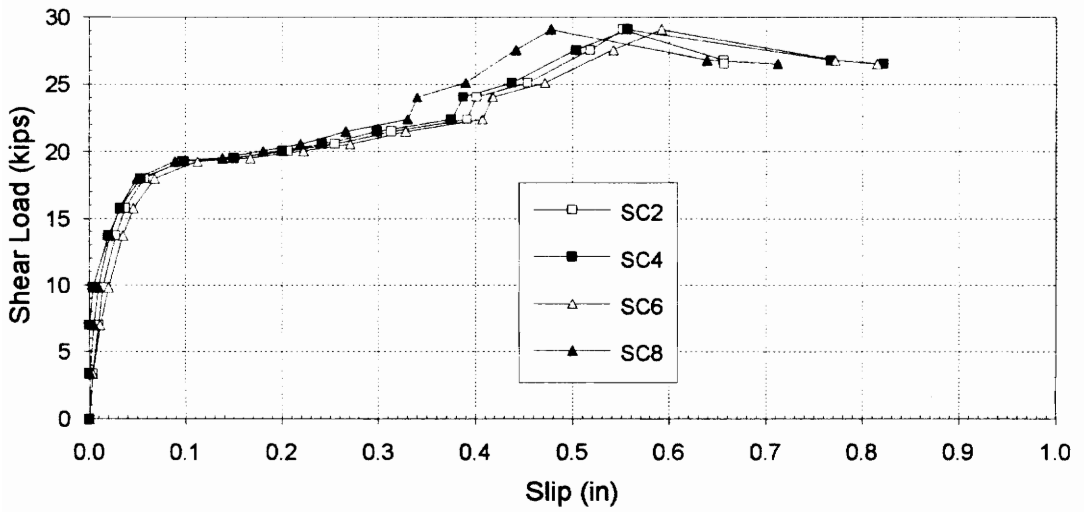


COMMENTS

Bulges in deck below screw at all locations; Deck debonded; Angle deformed at all locations
 Slight buckling above SC1
 Screw rotation $\geq 45^\circ$



(a) Test 3-1-1 - Load vs. North Slip



(b) Test 3-1-1 - Load vs. South Slip

Fig. A.33 Test 3-1-1 Load vs. Slip Plots

Table A.33 Test 3-1-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-3.36	-0.35	0.002	0.004	0.000	0.000	0.000	0.004	0.000	0.001
-6.98	-0.70	0.006	0.010	0.000	0.000	0.000	0.012	0.000	0.005
-9.83	-0.98	0.007	0.015	0.000	0.004	0.001	0.020	0.000	0.010
-13.71	-1.37	0.019	0.028	0.001	0.020	0.010	0.035	0.000	0.022
-15.78	-1.59	0.030	0.038	0.009	0.032	0.020	0.046	0.010	0.032
-17.98	-1.80	0.048	0.057	0.025	0.054	0.038	0.068	0.026	0.050
-19.27	-1.93	0.092	0.097	0.063	0.099	0.076	0.113	0.063	0.089
-19.53	-1.94	0.154	0.150	0.119	0.151	0.133	0.168	0.117	0.139
-20.05	-2.01	0.211	0.206	0.171	0.200	0.186	0.222	0.159	0.181
-20.56	-2.07	0.264	0.255	0.218	0.242	0.233	0.271	0.201	0.219
-21.47	-2.15	0.329	0.314	0.276	0.299	0.294	0.328	0.248	0.267
-22.37	-1.00	0.414	0.391	0.350	0.375	0.369	0.407	0.313	0.330
-24.06	-2.45	0.427	0.401	0.358	0.387	0.379	0.418	0.322	0.340
-24.06	-2.40	0.427	0.401	0.358	0.387	0.380	0.418	0.322	0.340
-25.09	-2.52	0.485	0.454	0.410	0.438	0.433	0.472	0.368	0.390
-27.55	-2.74	0.562	0.518	0.472	0.504	0.499	0.542	0.428	0.442
-29.10	-2.95	0.627	0.552	0.514	0.557	0.545	0.592	0.477	0.478
-26.77	-2.74	0.820	0.656	0.611	0.768	0.666	0.772	0.600	0.639
-26.51	-2.65	0.896	0.657	0.631	0.822	0.711	0.815	0.636	0.712

PUSHOUT TEST SUMMARY SHEET

Test: 3-1-2
Test Designation: SC-8-2-0.109-1.0C-2.5-2

Test Date: 19 FEB 93

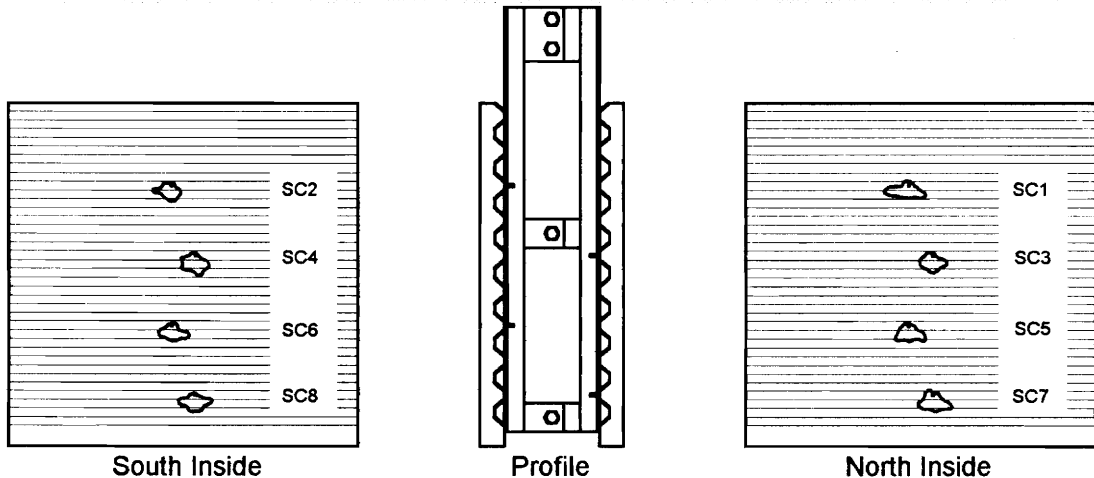
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>		
	F_y : <u>53.8 ksi</u>	F_u : <u>78.2 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>	f'_c : <u>4870 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

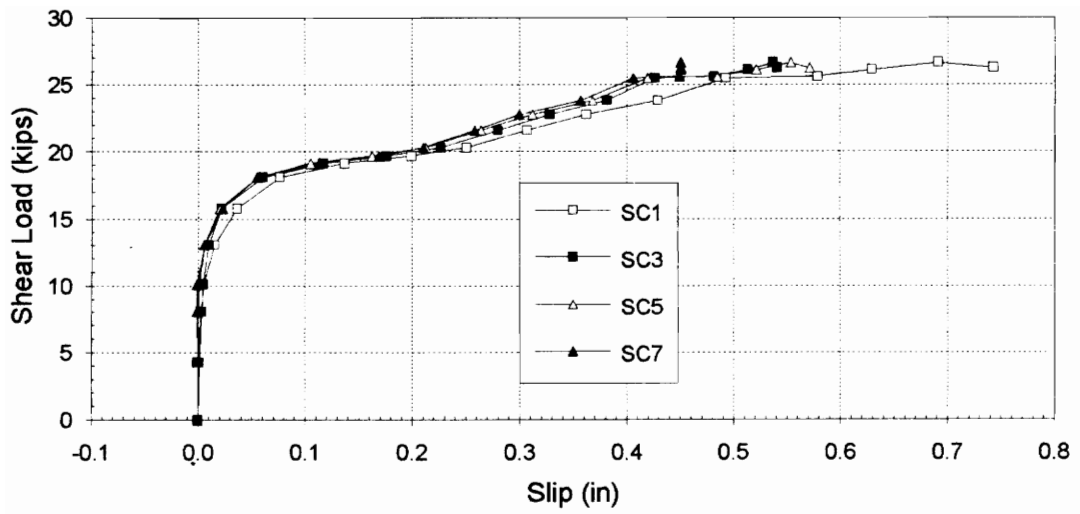
Peak Shear Load:	<u>26.64 kips</u>	
Peak Shear Load Per Fastener:	<u>3.33 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.691 in.</u>	SC2: <u>0.756 in.</u>
	SC3: <u>0.537 in.</u>	SC4: <u>0.782 in.</u>
	SC5: <u>0.553 in.</u>	SC6: <u>0.664 in.</u>
	SC7: <u>0.451 in.</u>	SC8: <u>0.682 in.</u>

DAMAGE

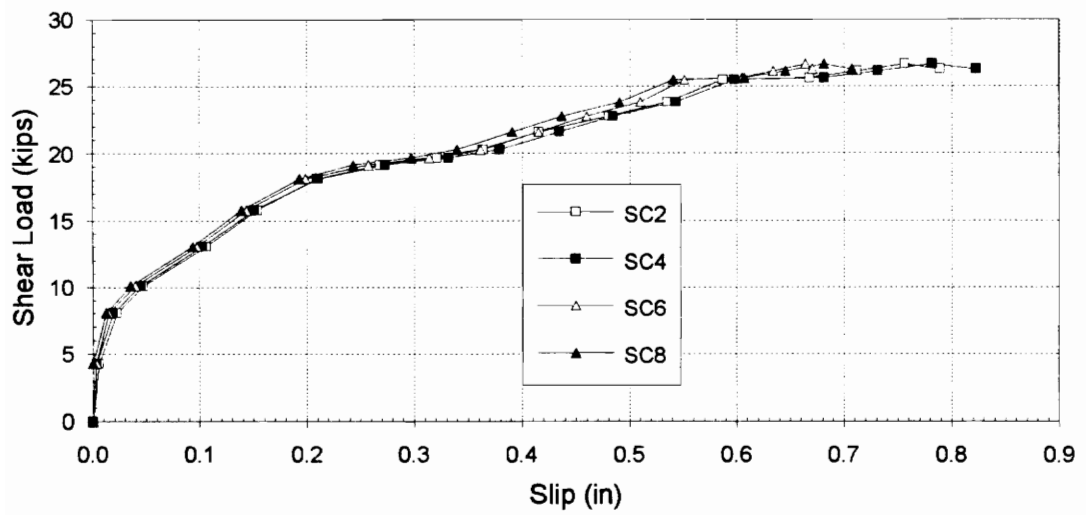


COMMENTS

Bulges in deck below screw at all locations; Deck debonded; Angle deformed at all locations
Slight buckling above SC1
Screw rotation $\approx 40^\circ$ - 45°



(a) Test 3-1-2 - Load vs. North Slip



(b) Test 3-1-2 - Load vs. South Slip

Fig. A.34 Test 3-1-2 Load vs. Slip Plots

Table A.34 Test 3-1-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.27	-0.60	0.000	0.006	0.001	0.003	0.001	0.004	0.000	0.000
-8.02	-0.77	0.003	0.023	0.004	0.019	0.000	0.015	-0.001	0.012
-10.09	-1.04	0.006	0.047	0.005	0.045	0.001	0.040	-0.001	0.036
-13.06	-1.36	0.015	0.106	0.010	0.103	0.006	0.098	0.006	0.094
-15.78	-1.59	0.037	0.154	0.022	0.151	0.020	0.144	0.023	0.139
-18.11	-1.81	0.076	0.210	0.061	0.211	0.056	0.199	0.055	0.193
-19.14	-1.91	0.137	0.268	0.117	0.273	0.105	0.257	0.113	0.243
-19.66	-1.99	0.199	0.321	0.176	0.332	0.163	0.314	0.170	0.297
-20.31	-2.01	0.251	0.363	0.227	0.379	0.213	0.361	0.211	0.339
-21.60	-2.18	0.307	0.415	0.280	0.434	0.264	0.415	0.258	0.391
-22.76	-2.29	0.362	0.480	0.328	0.484	0.312	0.460	0.300	0.437
-23.80	-2.40	0.429	0.535	0.382	0.543	0.368	0.510	0.357	0.491
-25.48	-2.57	0.492	0.587	0.426	0.598	0.420	0.551	0.407	0.541
-25.61	-2.54	0.579	0.668	0.482	0.682	0.485	0.605	0.450	0.607
-26.13	-2.66	0.629	0.712	0.513	0.732	0.521	0.634	0.451	0.646
-26.64	-2.71	0.691	0.756	0.537	0.782	0.553	0.664	0.451	0.682
-26.25	-2.61	0.743	0.789	0.541	0.823	0.571	0.671	0.451	0.707

PUSHOUT TEST SUMMARY SHEET

Test: 3-1-3
Test Designation: SC-8-2-0.109-1.0C-2.5-3

Test Date: 19 FEB 93

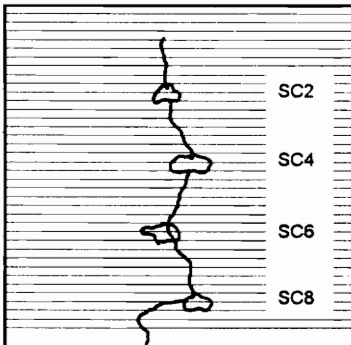
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.0C, 26 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u> F_u : <u>90.2 ksi</u>
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>
	F_y : <u>53.8 ksi</u> F_u : <u>78.2 ksi</u>
Slab:	Thickness: <u>2.5 in.</u> f'_c : <u>4870 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

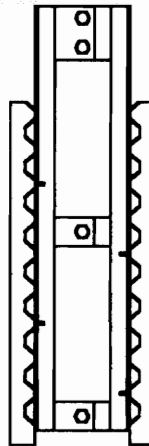
TEST RESULTS

Peak Shear Load:	<u>27.42 kips</u>	
Peak Shear Load Per Fastener:	<u>3.43 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.684 in.</u>	SC2: <u>0.587 in.</u>
	SC3: <u>0.569 in.</u>	SC4: <u>0.700 in.</u>
	SC5: <u>0.553 in.</u>	SC6: <u>0.679 in.</u>
	SC7: <u>0.565 in.</u>	SC8: <u>0.614 in.</u>

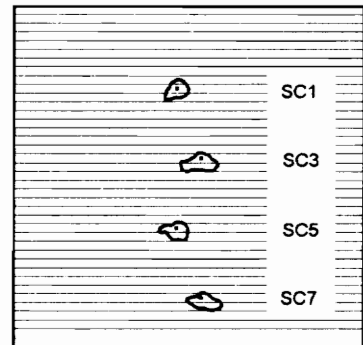
DAMAGE



South Inside



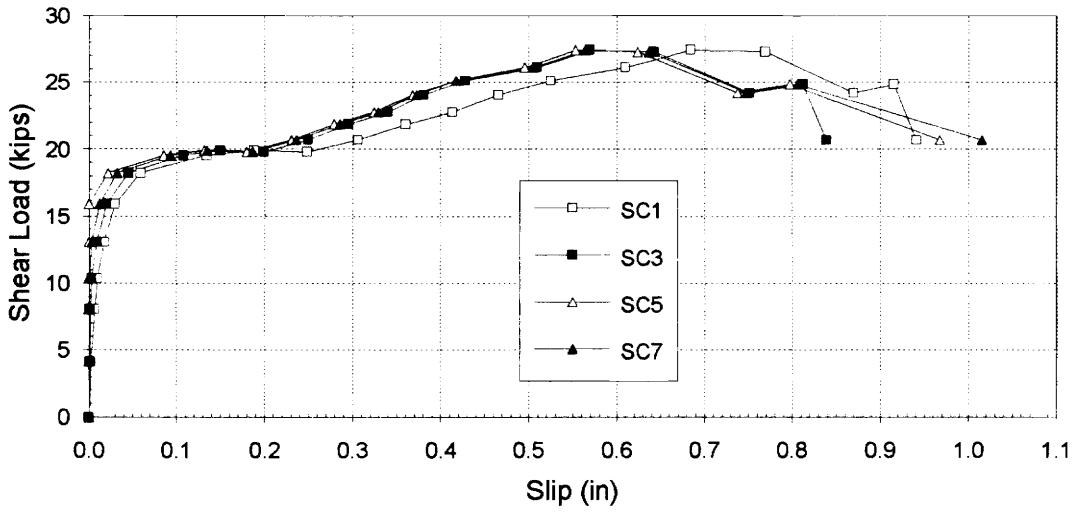
Profile



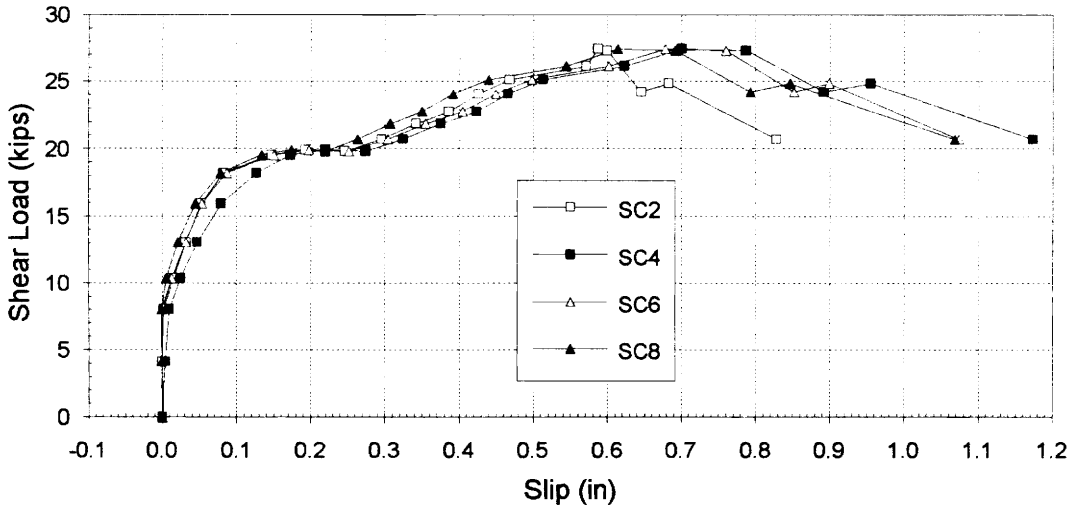
North Inside

COMMENTS

Bulges in deck below screw at all locations; Deck debonded; Angle deformed at all locations
Slight buckling above SC1; Faint crack on south slab
Screws pulling out of base material; Screw rotation $\geq 45^\circ$



(a) Test 3-1-3 - Load vs. North Slip



(b) Test 3-1-3 - Load vs. South Slip

Fig. A.35 Test 3-1-3 Load vs. Slip Plots

Table A.35 Test 3-1-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.14	-0.45	0.002	-0.001	0.001	0.004	0.000	-0.001	0.000	-0.001
-8.02	-0.81	0.007	0.002	0.002	0.010	0.000	-0.001	0.000	-0.001
-10.35	-1.01	0.010	0.016	0.004	0.025	0.000	0.013	0.000	0.006
-13.06	-1.31	0.018	0.032	0.009	0.048	0.000	0.032	0.004	0.021
-15.91	-1.58	0.030	0.053	0.020	0.079	0.000	0.054	0.012	0.045
-18.24	-1.83	0.059	0.083	0.045	0.126	0.022	0.087	0.032	0.078
-19.53	-1.95	0.134	0.147	0.108	0.173	0.086	0.150	0.093	0.134
-19.92	-2.00	0.188	0.193	0.150	0.220	0.131	0.197	0.135	0.174
-19.79	-2.09	0.248	0.247	0.199	0.274	0.179	0.251	0.186	0.219
-20.69	-2.10	0.306	0.295	0.249	0.324	0.231	0.304	0.236	0.263
-21.86	-2.19	0.360	0.342	0.295	0.375	0.279	0.355	0.285	0.307
-22.76	-2.28	0.414	0.386	0.340	0.423	0.324	0.404	0.329	0.350
-24.06	-2.41	0.466	0.426	0.381	0.466	0.368	0.449	0.372	0.391
-25.09	-2.51	0.525	0.469	0.428	0.513	0.418	0.498	0.418	0.440
-26.13	-2.64	0.610	0.571	0.509	0.623	0.495	0.602	0.505	0.544
-27.42	-2.75	0.684	0.587	0.569	0.700	0.553	0.679	0.565	0.614
-27.29	-2.73	0.770	0.599	0.643	0.787	0.624	0.760	0.637	0.692
-24.19	-2.44	0.870	0.645	0.751	0.892	0.738	0.852	0.748	0.793
-24.83	-2.50	0.915	0.683	0.813	0.955	0.797	0.899	0.807	0.846
-20.69	-2.04	0.941	0.828	0.839	1.174	0.967	1.074	1.015	1.068

PUSHOUT TEST SUMMARY SHEET

Test: 3-2-1
 Test Designation: SC-8-2-0.155-1.0C-2.5-1

Test Date: 24 FEB 93

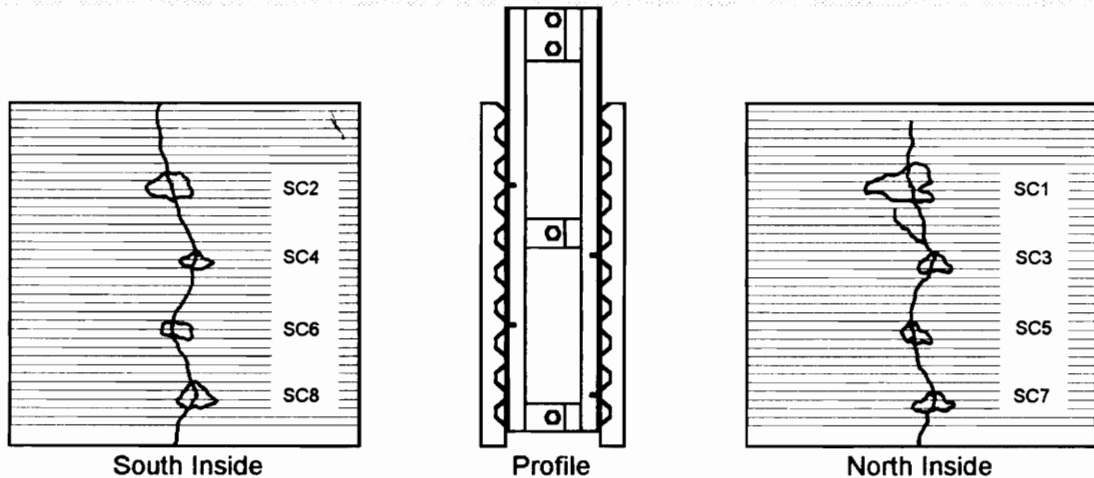
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.155</u>		
	F_y : <u>52.7 ksi</u>	F_u : <u>77.3 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>		
	f'_c : <u>4880 psi</u>		
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

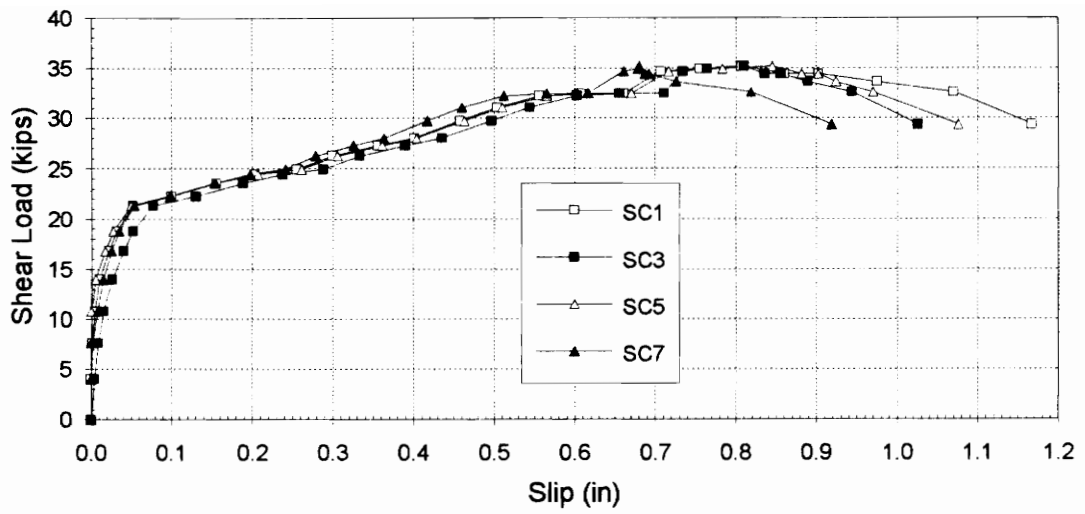
Peak Shear Load: <u>35.18 kips</u>		
Peak Shear Load Per Fastener: <u>4.40 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.807 in.</u>	SC2: <u>0.894 in.</u>
	SC3: <u>0.810 in.</u>	SC4: <u>0.850 in.</u>
	SC5: <u>0.845 in.</u>	SC6: <u>0.672 in.</u>
	SC7: <u>0.681 in.</u>	SC8: <u>0.832 in.</u>

DAMAGE

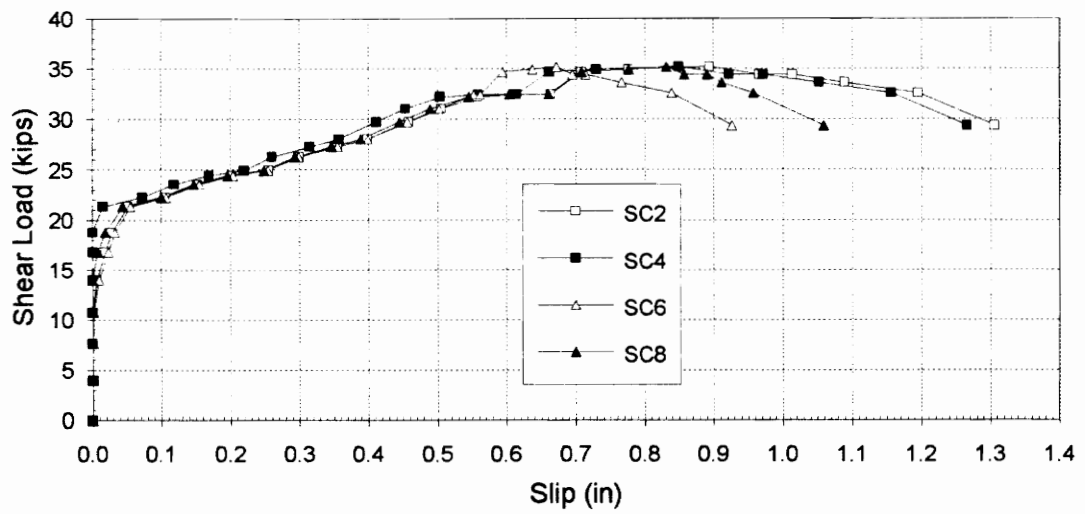


COMMENTS

Bulges in deck below screw at all locations; Deck debonded
 Longitudinal splitting of both north and south slab; Concrete rib failure at SC1, SC2, SC8
 SC4 pulling out of base material; Screw rotation $\approx 35^\circ$ - 40°



(a) Test 3-2-1 - Load vs. North Slip



(b) Test 3-2-1 - Load vs. South Slip

Fig. A.36 Test 3-2-1 Load vs. Slip Plots

Table A.36 Test 3-2-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.01	-0.40	0.000	0.001	0.004	0.000	0.000	0.001	0.000	0.000
-7.63	-0.76	0.001	0.000	0.009	0.000	0.000	0.001	0.002	0.000
-10.73	-1.06	0.005	0.001	0.015	0.000	0.000	0.002	0.008	0.000
-13.97	-1.41	0.010	0.007	0.026	0.001	0.006	0.010	0.015	0.000
-16.81	-1.68	0.022	0.020	0.040	0.001	0.017	0.024	0.026	0.008
-18.75	-1.88	0.032	0.029	0.052	0.001	0.028	0.033	0.035	0.019
-21.34	-2.13	0.052	0.052	0.077	0.016	0.050	0.056	0.054	0.044
-22.25	-2.23	0.100	0.106	0.130	0.073	0.098	0.108	0.100	0.101
-23.54	-2.37	0.155	0.153	0.189	0.119	0.154	0.155	0.154	0.148
-24.44	-2.44	0.203	0.202	0.238	0.169	0.207	0.204	0.198	0.197
-24.96	-2.50	0.256	0.255	0.289	0.221	0.261	0.254	0.241	0.249
-26.25	-2.63	0.300	0.299	0.334	0.260	0.306	0.299	0.279	0.294
-27.29	-2.73	0.356	0.355	0.390	0.315	0.362	0.355	0.326	0.346
-28.07	-2.81	0.401	0.399	0.436	0.357	0.404	0.399	0.364	0.389
-29.75	-2.97	0.458	0.458	0.497	0.411	0.463	0.456	0.417	0.445
-31.04	-3.11	0.504	0.505	0.544	0.454	0.510	0.502	0.460	0.489
-32.20	-3.23	0.556	0.558	0.603	0.504	0.565	0.545	0.513	0.545
-32.46	-3.25	0.608	0.611	0.656	0.559	0.617	0.552	0.565	0.604
-32.46	-3.25	0.661	0.664	0.711	0.614	0.671	0.562	0.616	0.661
-34.66	-3.46	0.708	0.708	0.735	0.662	0.717	0.594	0.661	0.708
-34.92	-3.50	0.756	0.776	0.765	0.729	0.783	0.637	0.679	0.777
-35.18	-3.51	0.807	0.894	0.810	0.850	0.845	0.672	0.681	0.832
-34.40	-3.44	0.861	0.966	0.836	0.922	0.882	0.695	0.687	0.857
-34.40	-3.45	0.902	1.013	0.856	0.972	0.903	0.714	0.692	0.890
-33.63	-3.34	0.975	1.089	0.890	1.052	0.924	0.766	0.726	0.912
-32.59	-3.27	1.070	1.195	0.944	1.156	0.970	0.839	0.819	0.957
-29.36	-2.95	1.167	1.306	1.026	1.266	1.076	0.927	0.919	1.059

PUSHOUT TEST SUMMARY SHEET

Test: 3-2-2
Test Designation: SC-8-2-0.155-1.0C-2.5-2

Test Date: 02 MAR 93

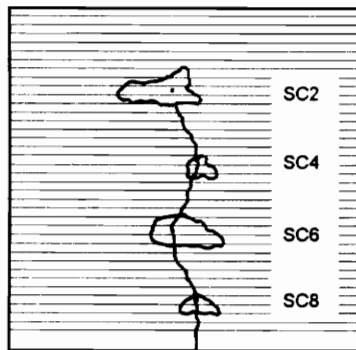
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.155</u>		
	F_y : <u>52.7 ksi</u>	F_u : <u>77.3 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>	f'_c : <u>4890 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

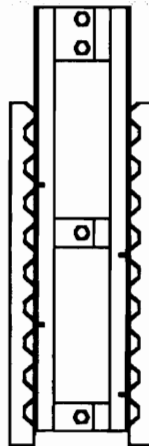
TEST RESULTS

Peak Shear Load:	<u>35.05 kips</u>		
Peak Shear Load Per Fastener:	<u>4.38 kips</u>		
Slip at Peak Shear Load:		SC1: <u>0.608 in.</u>	SC2: <u>0.362 in.</u>
		SC3: <u>0.639 in.</u>	SC4: <u>0.597 in.</u>
		SC5: <u>0.594 in.</u>	SC6: <u>0.634 in.</u>
		SC7: <u>0.586 in.</u>	SC8: <u>0.615 in.</u>

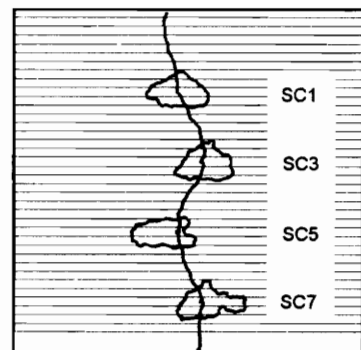
DAMAGE



South Inside



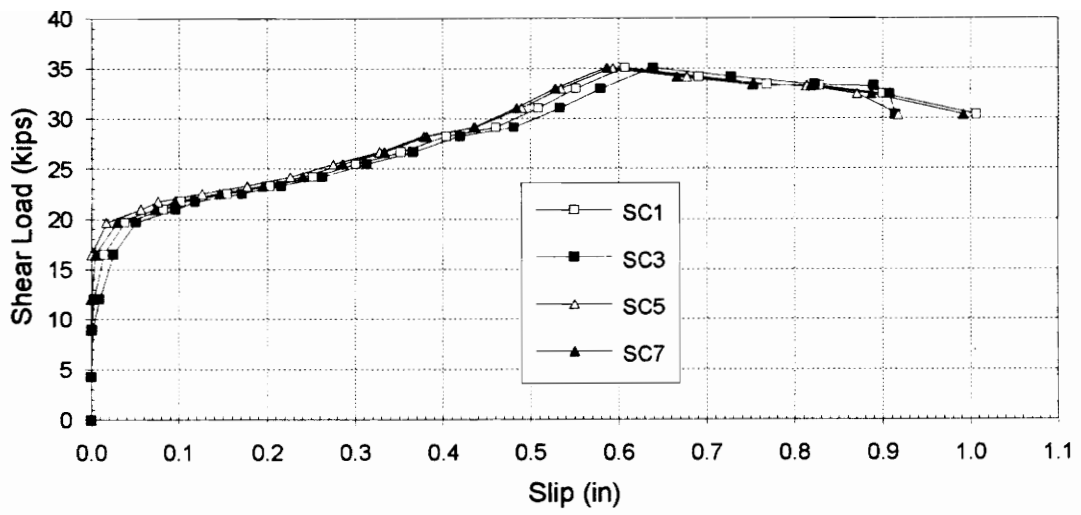
Profile



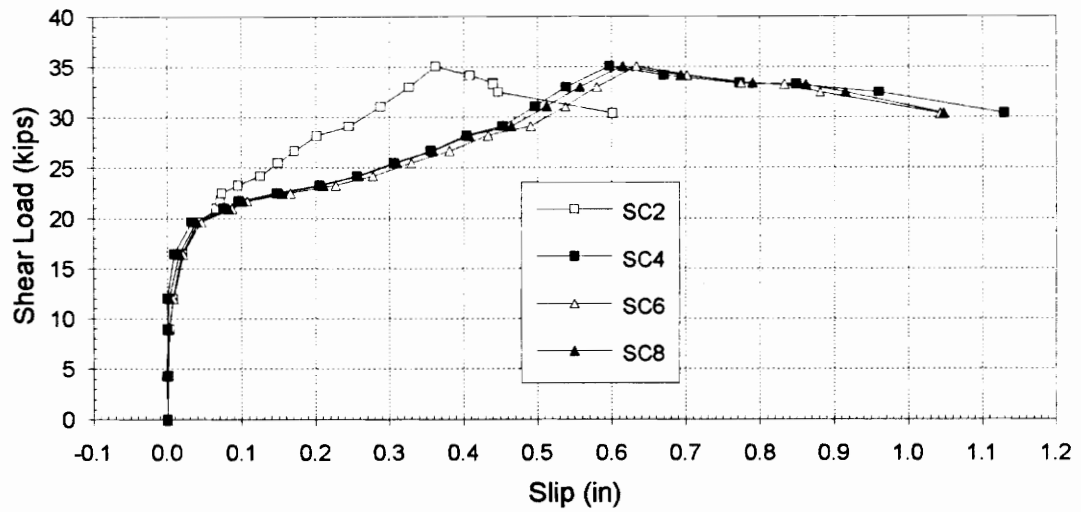
North Inside

COMMENTS

Bulges in deck below screw at all locations; Deck debonded
Longitudinal splitting of both north and south slab
Concrete rib failure at SC1, SC2, SC3, SC5, SC6, SC7; Screw rotation $\approx 45^\circ$



(a) Test 3-2-2 - Load vs. North Slip



(b) Test 3-2-2 - Load vs. South Slip

Fig. A.37 Test 3-2-2 Load vs. Slip Plots

Table A.37 Test 3-2-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.27	-0.44	0.000	0.001	0.001	-0.001	0.000	-0.001	0.000	0.000
-8.92	-0.90	0.001	0.003	0.002	0.000	0.000	0.002	0.000	0.000
-12.03	-1.21	0.004	0.008	0.010	0.000	0.001	0.009	0.000	0.002
-16.43	-1.63	0.015	0.020	0.025	0.010	0.001	0.022	0.005	0.017
-19.66	-1.97	0.038	0.042	0.051	0.034	0.017	0.046	0.029	0.040
-20.95	-2.10	0.081	0.067	0.095	0.077	0.056	0.087	0.073	0.083
-21.73	-2.17	0.102	0.072	0.118	0.097	0.076	0.108	0.095	0.102
-22.50	-2.26	0.154	0.073	0.171	0.149	0.126	0.166	0.146	0.154
-23.28	-2.33	0.203	0.095	0.216	0.205	0.177	0.228	0.195	0.210
-24.19	-2.41	0.252	0.125	0.263	0.257	0.226	0.278	0.240	0.259
-25.48	-2.55	0.301	0.149	0.314	0.306	0.275	0.330	0.286	0.309
-26.64	-2.66	0.353	0.171	0.366	0.356	0.328	0.381	0.333	0.359
-28.19	-2.83	0.404	0.202	0.420	0.404	0.378	0.433	0.382	0.408
-29.10	-2.92	0.461	0.245	0.481	0.453	0.437	0.491	0.436	0.465
-31.04	-3.10	0.509	0.288	0.533	0.497	0.490	0.538	0.484	0.512
-32.98	-3.30	0.551	0.327	0.580	0.539	0.534	0.580	0.528	0.557
-35.05	-3.51	0.608	0.362	0.639	0.597	0.594	0.634	0.586	0.615
-34.14	-3.42	0.691	0.409	0.728	0.671	0.678	0.702	0.667	0.694
-33.37	-3.33	0.768	0.440	0.823	0.773	0.754	0.774	0.752	0.790
-33.24	-3.32	0.828	0.440	0.890	0.849	0.814	0.832	0.819	0.862
-33.24	-3.32	0.828	0.440	0.890	0.849	0.814	0.832	0.819	0.862
-32.46	-3.25	0.900	0.448	0.907	0.960	0.871	0.881	0.888	0.915
-30.39	-3.04	1.007	0.602	0.915	1.130	0.918	1.042	0.992	1.047

PUSHOUT TEST SUMMARY SHEET

Test: 3-2-3
Test Designation: SC-8-2-0.155-1.0C-2.5-3

Test Date: 11 MAR 93

SPECIMEN DESCRIPTION

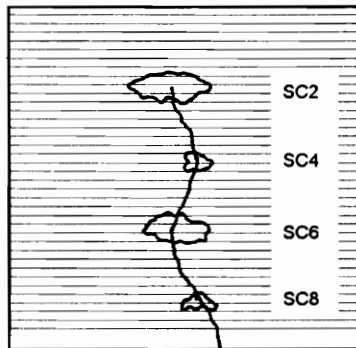
Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.0C, 26 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u> F_u : <u>90.2 ksi</u>
Base Member:	Section: <u>2L 1.50x1.50x0.155</u>
	F_y : <u>52.7 ksi</u> F_u : <u>77.3 ksi</u>
Slab:	Thickness: <u>2.5 in.</u> f_c : <u>4770 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

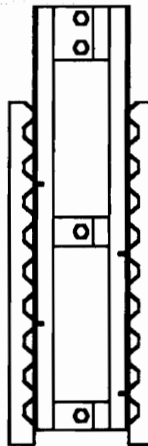
Peak Shear Load: 33.37 kips
Peak Shear Load Per Fastener: 4.17 kips
Slip at Peak Shear Load:

SC1: <u>0.516 in.</u>	SC2: <u>0.710 in.</u>
SC3: <u>0.769 in.</u>	SC4: <u>0.509 in.</u>
SC5: <u>0.243 in.</u>	SC6: <u>0.533 in.</u>
SC7: <u>0.666 in.</u>	SC8: <u>0.585 in.</u>

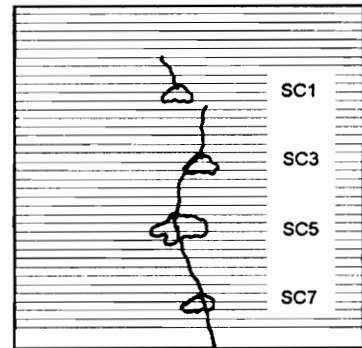
DAMAGE



South Inside



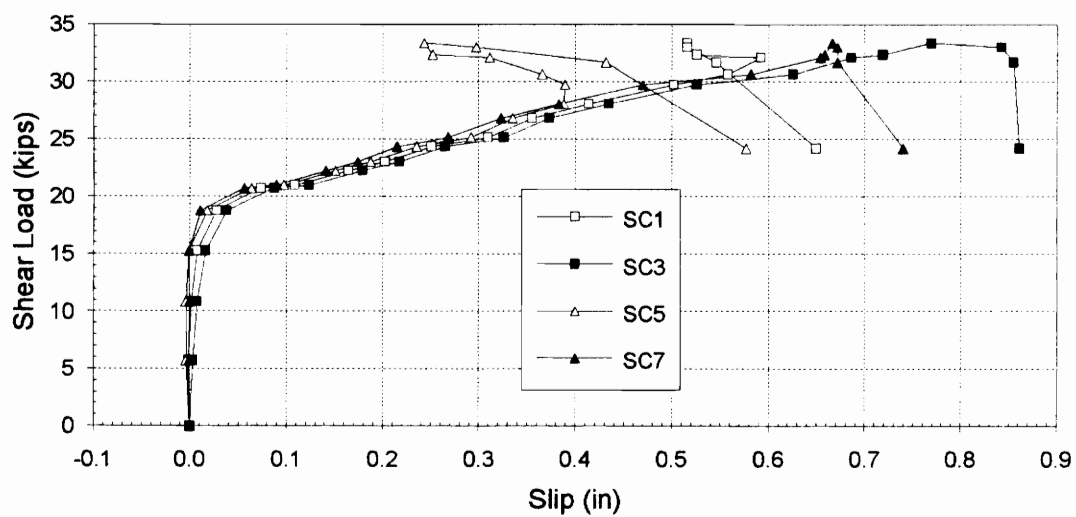
Profile



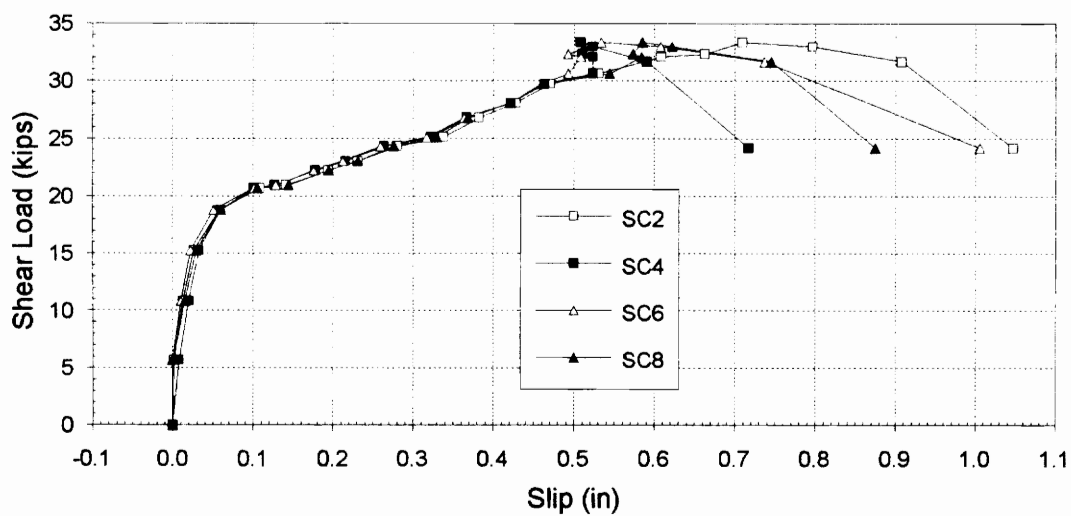
North Inside

COMMENTS

Bulges in deck below screw at all locations; Deck debonded
Longitudinal splitting of both north and south slab
SC6 sheared off; SC1, SC5, SC7, pulling out of base material; Screw rotation $\approx 30^\circ$ - 45°



(a) Test 3-2-3 - Load vs. North Slip



(b) Test 3-2-3 - Load vs. South Slip

Fig. A.38 Test 3-2-3 Load vs. Slip Plots

Table A.38 Test 3-2-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.69	-0.57	-0.001	0.001	0.003	0.007	-0.004	-0.001	-0.001	0.001
-10.86	-1.10	0.002	0.013	0.008	0.020	-0.004	0.010	0.000	0.015
-15.26	-1.53	0.008	0.026	0.017	0.032	-0.001	0.023	-0.001	0.029
-18.75	-1.89	0.028	0.058	0.038	0.059	0.018	0.051	0.011	0.059
-20.69	-2.06	0.073	0.109	0.087	0.100	0.064	0.101	0.056	0.105
-20.95	-2.10	0.109	0.141	0.124	0.127	0.097	0.128	0.089	0.144
-22.25	-2.22	0.165	0.194	0.179	0.178	0.151	0.175	0.141	0.194
-23.02	-2.30	0.203	0.231	0.218	0.215	0.188	0.212	0.175	0.231
-24.31	-2.43	0.251	0.280	0.265	0.263	0.235	0.259	0.215	0.276
-25.09	-2.52	0.310	0.337	0.327	0.322	0.292	0.317	0.268	0.329
-26.77	-2.69	0.355	0.382	0.373	0.366	0.335	0.363	0.323	0.368
-28.07	-2.81	0.414	0.428	0.435	0.421	0.388	0.422	0.383	0.421
-29.75	-2.97	0.502	0.470	0.526	0.464	0.390	0.460	0.470	0.462
-30.65	-3.07	0.558	0.530	0.626	0.523	0.366	0.493	0.582	0.544
-32.07	-3.21	0.592	0.609	0.686	0.523	0.312	0.509	0.654	0.584
-32.33	-3.23	0.526	0.663	0.718	0.510	0.252	0.493	0.658	0.573
-33.37	-3.34	0.516	0.710	0.769	0.509	0.243	0.533	0.666	0.585
-32.98	-3.30	0.516	0.797	0.842	0.523	0.297	0.608	0.672	0.622
-31.69	-3.18	0.546	0.908	0.855	0.591	0.432	0.737	0.672	0.745
-24.19	-2.45	0.650	1.047	0.861	0.717	0.577	1.005	0.740	0.875

PUSHOUT TEST SUMMARY SHEET

Test: 3-3-1
 Test Designation: SC-8-2-0.205-1.0C-2.5-1

Test Date: 12 MAR 93

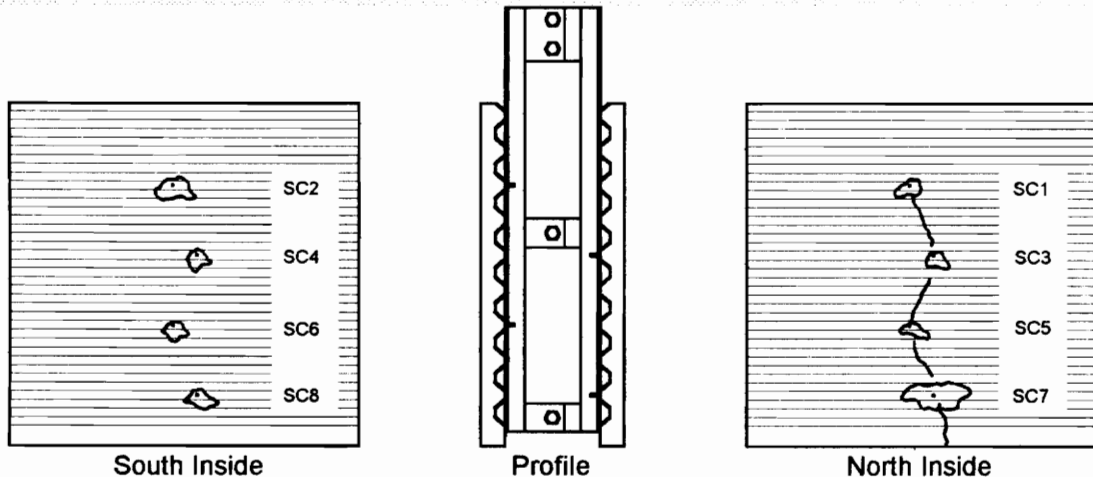
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>		
	F_y : <u>58.2 ksi</u>	F_u : <u>85.2 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>		
	f'_c : <u>4580 psi</u>		
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

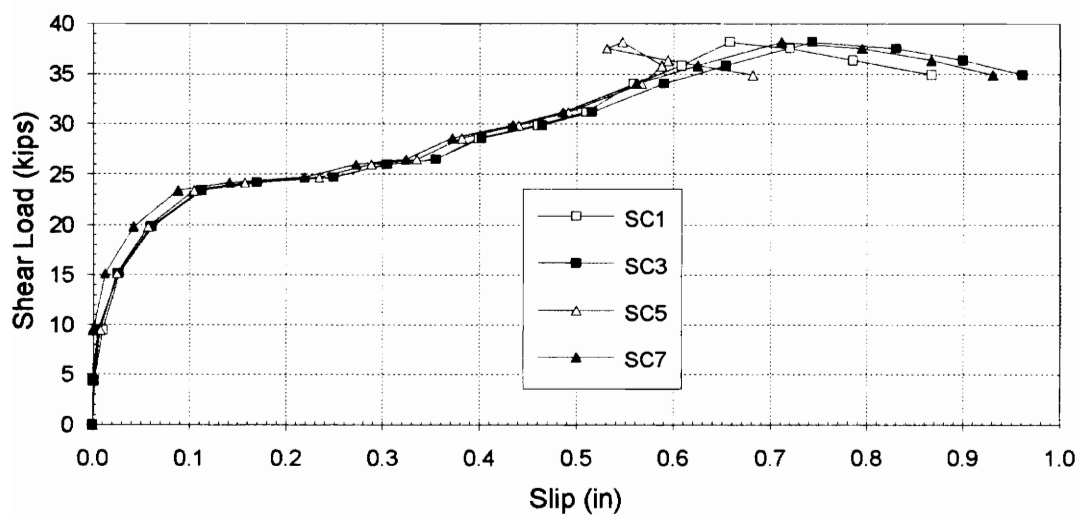
Peak Shear Load: <u>38.15 kips</u>		
Peak Shear Load Per Fastener: <u>4.77 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.658 in.</u>	SC2: <u>0.243 in.</u>
	SC3: <u>0.743 in.</u>	SC4: <u>0.677 in.</u>
	SC5: <u>0.547 in.</u>	SC6: <u>0.580 in.</u>
	SC7: <u>0.711 in.</u>	SC8: <u>0.679 in.</u>

DAMAGE

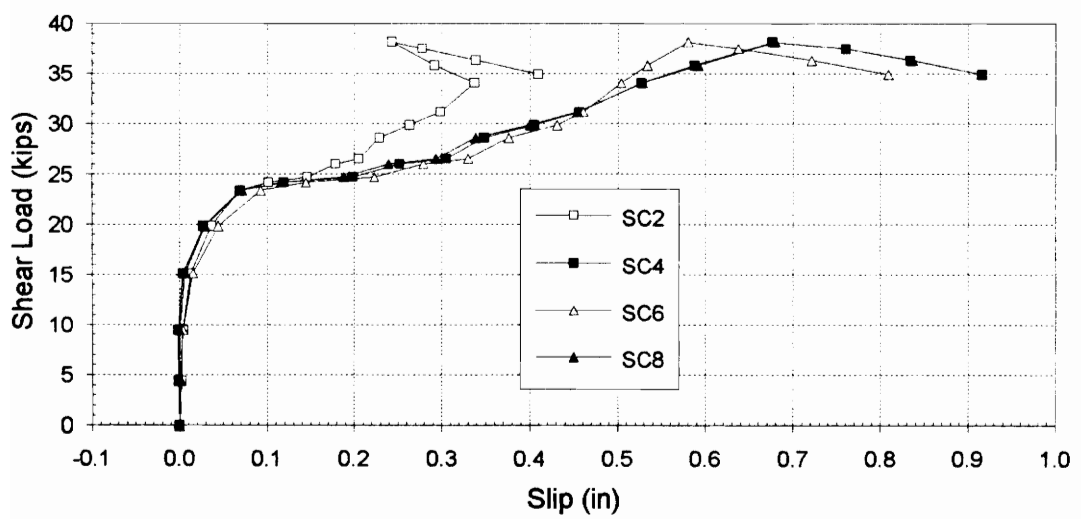


COMMENTS

Bulges in deck below screw at all locations; Deck debonded
 Longitudinal splitting of north slab; Concrete rib failure at SC7
 SC3 and SC8 pulling out of base material; Screw rotation $\approx 20^\circ$



(a) Test 3-3-1 - Load vs. North Slip



(b) Test 3-3-1 - Load vs. South Slip

Fig. A.39 Test 3-3-1 Load vs. Slip Plots

Table A.39 Test 3-3-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.40	-0.44	0.002	0.002	0.000	-0.001	0.001	0.001	0.000	-0.001
-9.44	-0.94	0.010	0.004	0.005	-0.001	0.007	0.004	0.000	0.000
-15.13	-1.52	0.027	0.013	0.026	0.004	0.024	0.015	0.012	0.006
-19.79	-1.98	0.061	0.036	0.059	0.027	0.057	0.044	0.042	0.029
-23.41	-2.33	0.113	0.069	0.111	0.070	0.105	0.092	0.088	0.071
-24.19	-2.42	0.170	0.102	0.169	0.119	0.157	0.144	0.141	0.116
-24.70	-2.46	0.249	0.146	0.249	0.198	0.234	0.223	0.219	0.187
-26.00	-2.60	0.304	0.179	0.305	0.252	0.288	0.279	0.273	0.239
-26.51	-2.64	0.355	0.205	0.355	0.305	0.335	0.330	0.324	0.293
-28.58	-2.86	0.399	0.229	0.402	0.348	0.382	0.376	0.372	0.338
-29.88	-2.99	0.460	0.263	0.465	0.406	0.440	0.431	0.435	0.401
-31.17	-3.13	0.510	0.298	0.515	0.456	0.491	0.460	0.486	0.454
-34.01	-3.40	0.559	0.337	0.590	0.527	0.567	0.504	0.561	0.528
-35.83	-3.58	0.608	0.292	0.654	0.588	0.588	0.534	0.625	0.592
-38.15	-3.82	0.658	0.243	0.743	0.677	0.547	0.580	0.711	0.679
-37.51	-3.75	0.719	0.278	0.830	0.760	0.531	0.637	0.794	0.761
-36.34	-3.63	0.785	0.339	0.899	0.834	0.594	0.721	0.867	0.836
-34.92	-3.49	0.867	0.410	0.961	0.916	0.681	0.809	0.930	0.916

PUSHOUT TEST SUMMARY SHEET

Test: 3-3-2
 Test Designation: SC-8-2-0.205-1.0C-2.5-2

Test Date: 12 MAR 93

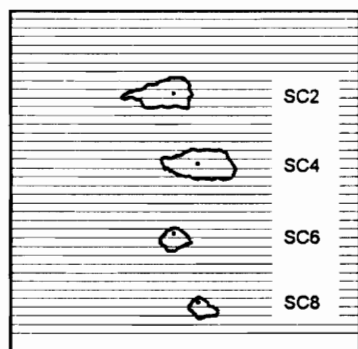
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>		
	F_y : <u>58.2 ksi</u>	F_u : <u>85.2 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>	f'_c : <u>4580 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

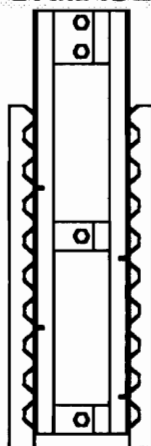
TEST RESULTS

Peak Shear Load: <u>35.31 kips</u>									
Peak Shear Load Per Fastener: <u>4.41 kips</u>									
Slip at Peak Shear Load:	<table border="0" style="width: 100%;"> <tr> <td>SC1: <u>0.665 in.</u></td> <td>SC2: <u>xxx in.</u></td> </tr> <tr> <td>SC3: <u>0.607 in.</u></td> <td>SC4: <u>0.559 in.</u></td> </tr> <tr> <td>SC5: <u>0.557 in.</u></td> <td>SC6: <u>0.578 in.</u></td> </tr> <tr> <td>SC7: <u>0.388 in.</u></td> <td>SC8: <u>0.735 in.</u></td> </tr> </table>	SC1: <u>0.665 in.</u>	SC2: <u>xxx in.</u>	SC3: <u>0.607 in.</u>	SC4: <u>0.559 in.</u>	SC5: <u>0.557 in.</u>	SC6: <u>0.578 in.</u>	SC7: <u>0.388 in.</u>	SC8: <u>0.735 in.</u>
SC1: <u>0.665 in.</u>	SC2: <u>xxx in.</u>								
SC3: <u>0.607 in.</u>	SC4: <u>0.559 in.</u>								
SC5: <u>0.557 in.</u>	SC6: <u>0.578 in.</u>								
SC7: <u>0.388 in.</u>	SC8: <u>0.735 in.</u>								

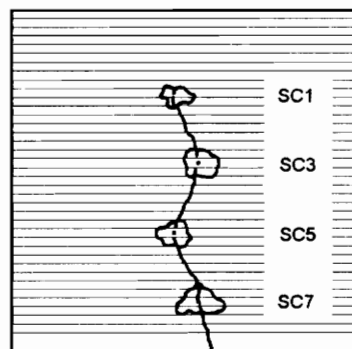
DAMAGE



South Inside



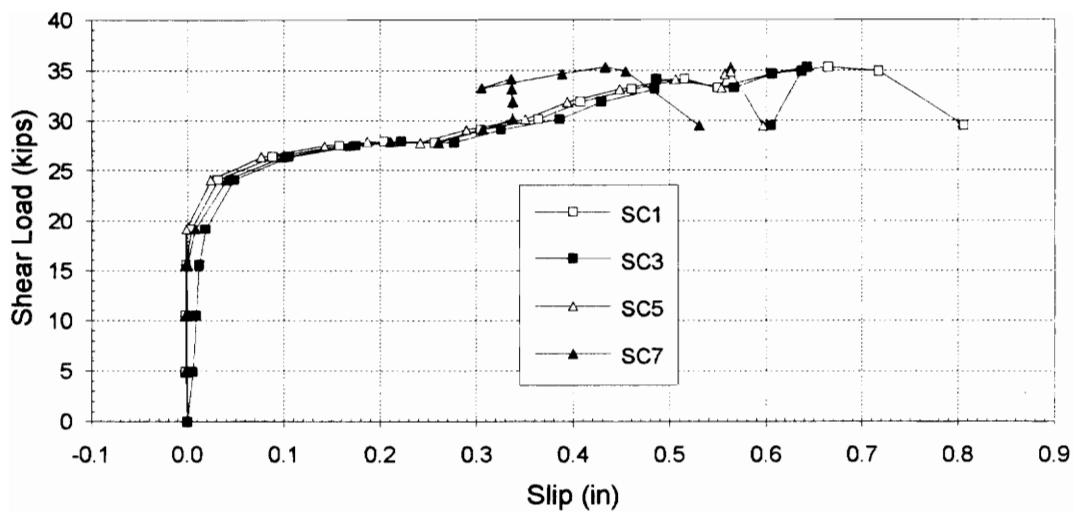
Profile



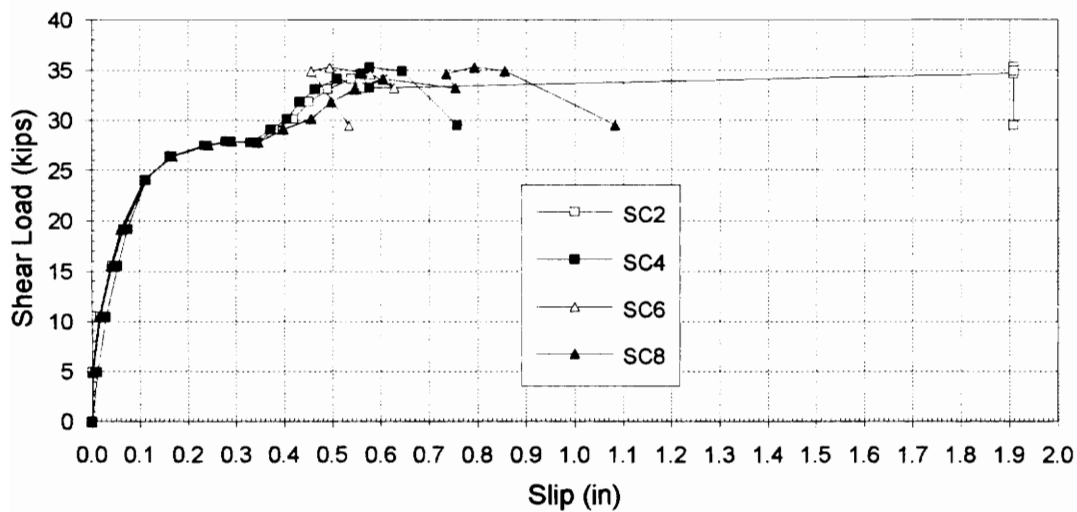
North Inside

COMMENTS

Bulges in deck below screw at all locations; Deck debonded
 Longitudinal splitting of south slab; Concrete rib failure at SC2 and SC4
 SC8 sheared off; Screw rotation $\approx 20^\circ$



(a) Test 3-3-2 - Load vs. North Slip



(b) Test 3-3-2 - Load vs. South Slip

Fig. A.40 Test 3-3-2 Load vs. Slip Plots

Table A.40 Test 3-3-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.91	-0.49	-0.002	0.002	0.006	0.011	-0.002	0.000	0.000	0.000
-10.48	-1.04	-0.002	0.018	0.009	0.030	-0.002	0.015	0.000	0.016
-15.52	-1.55	-0.001	0.043	0.012	0.054	-0.002	0.040	0.000	0.041
-19.14	-1.91	0.004	0.066	0.018	0.075	-0.001	0.061	0.008	0.062
-24.06	-2.40	0.031	0.112	0.048	0.113	0.024	0.109	0.040	0.111
-26.38	-2.64	0.088	0.166	0.105	0.163	0.076	0.166	0.099	0.168
-27.55	-2.74	0.158	0.241	0.176	0.235	0.143	0.242	0.168	0.243
-27.94	-2.79	0.204	0.289	0.222	0.279	0.187	0.290	0.211	0.292
-27.81	-2.78	0.257	0.344	0.277	0.330	0.242	0.345	0.261	0.347
-29.10	-2.91	0.305	0.377	0.326	0.371	0.289	0.395	0.307	0.398
-30.13	-3.01	0.364	0.418	0.386	0.406	0.350	0.454	0.338	0.456
-31.82	-3.18	0.407	0.450	0.429	0.431	0.394	0.497	0.338	0.496
-33.11	-3.31	0.461	0.490	0.484	0.463	0.448	0.550	0.337	0.545
-34.14	-3.41	0.515	0.539	0.486	0.509	0.506	0.611	0.336	0.604
-33.24	-3.35	0.550	0.558	0.567	0.577	0.554	0.627	0.306	0.753
-34.66	-3.48	0.606	1.908	0.607	0.559	0.557	0.578	0.388	0.735
-35.31	-3.53	0.665	1.908	0.643	0.577	0.563	0.493	0.433	0.793
-34.92	-3.50	0.717	1.908	0.637	0.644	0.563	0.456	0.455	0.856
-29.49	-2.95	0.806	1.908	0.605	0.758	0.597	0.534	0.530	1.082

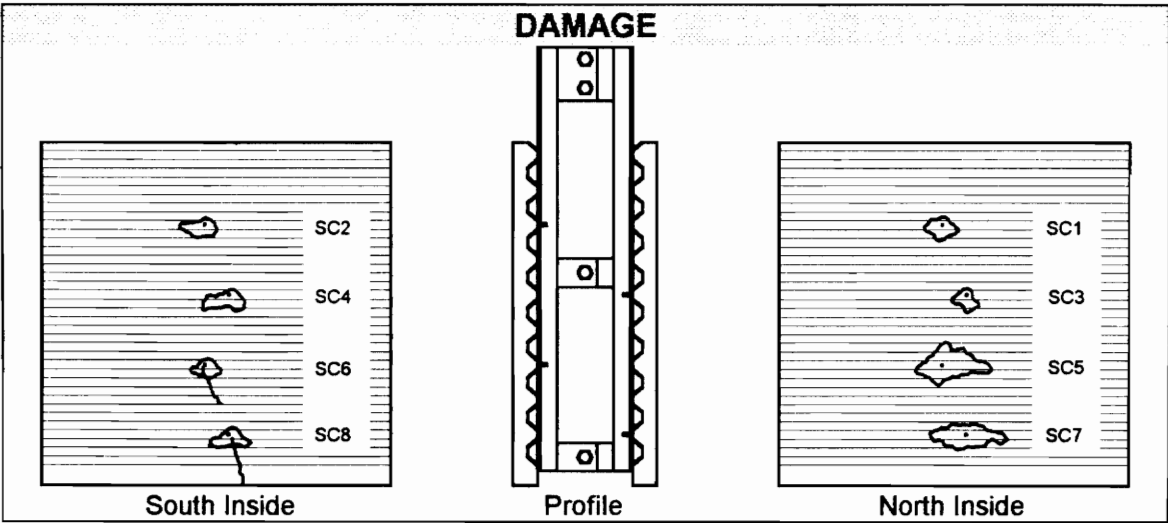
PUSHOUT TEST SUMMARY SHEET

Test: 3-3-3
Test Designation: SC-8-2-0.205-1.0C-2.5-3

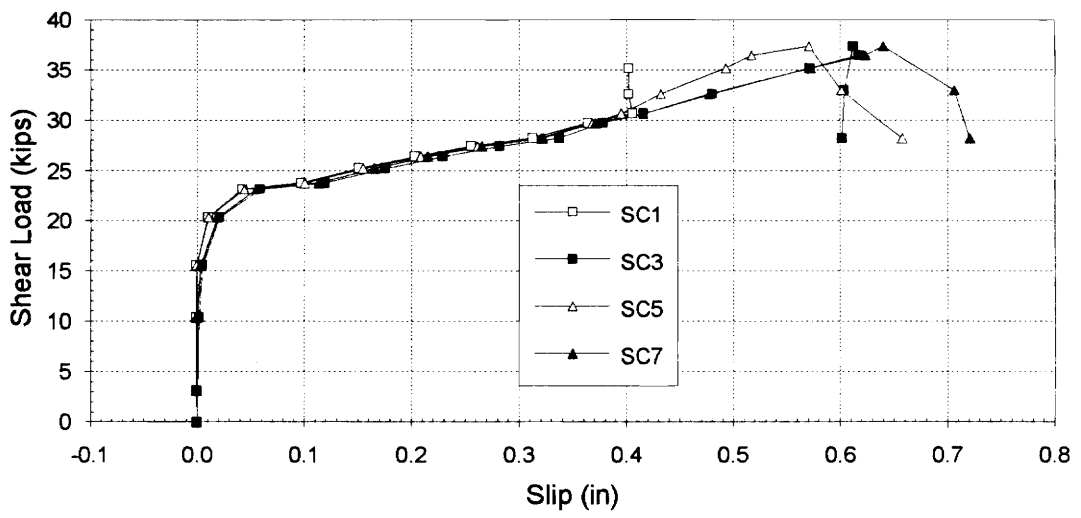
Test Date: 12 MAR 93

SPECIMEN DESCRIPTION			
Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>		
	F_y : <u>58.2 ksi</u>	F_u : <u>85.2 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>	f'_c : <u>4580 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

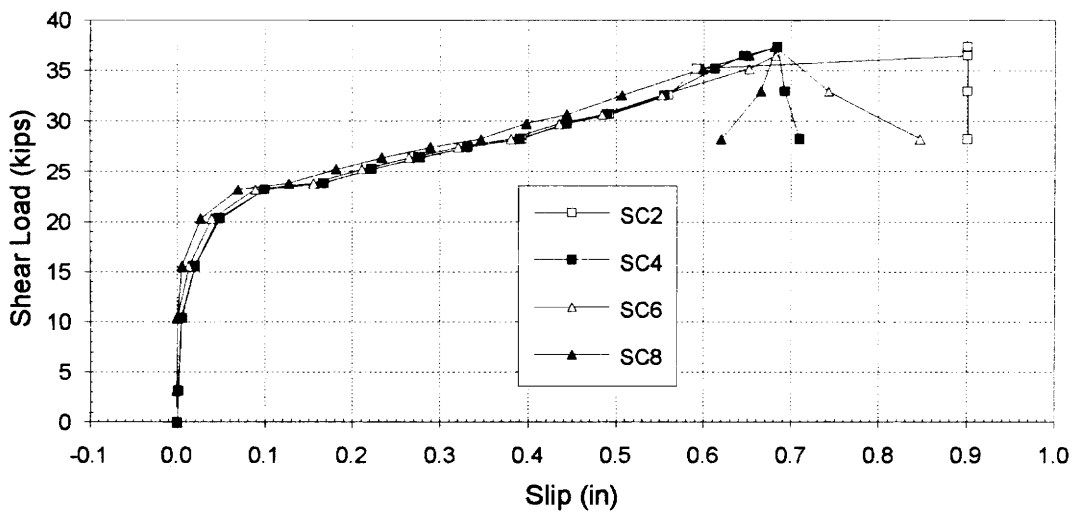
TEST RESULTS			
Peak Shear Load:	<u>37.38 kips</u>		
Peak Shear Load Per Fastener:	<u>4.67 kips</u>		
Slip at Peak Shear Load:	SC1: <u>xxx in.</u>	SC2: <u>xxx in.</u>	
	SC3: <u>0.612 in.</u>	SC4: <u>0.684 in.</u>	
	SC5: <u>0.571 in.</u>	SC6: <u>0.681 in.</u>	
	SC7: <u>0.640 in.</u>	SC8: <u>0.683 in.</u>	



COMMENTS
Bulges in deck below screw at all locations; Deck debonded
Slight cracking of south slab; Concrete rib failure at SC5 and SC7
SC3 and SC6 sheared off; Screw rotation $\approx 20^\circ$



(a) Test 3-3-3 - Load vs. North Slip



(b) Test 3-3-3 - Load vs. South Slip

Fig. A.41 Test 3-3-3 Load vs. Slip Plots

Table A.41 Test 3-3-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-3.10	-0.32	-0.001	0.001	0.000	0.001	-0.001	-0.001	0.000	-0.001
-10.35	-1.03	-0.001	0.006	0.002	0.005	-0.001	0.000	0.000	0.000
-15.52	-1.55	-0.001	0.020	0.005	0.020	-0.001	0.013	0.003	0.006
-20.31	-2.03	0.010	0.047	0.021	0.049	0.010	0.039	0.019	0.027
-23.15	-2.31	0.042	0.100	0.059	0.100	0.043	0.089	0.055	0.070
-23.80	-2.40	0.097	0.166	0.119	0.167	0.100	0.156	0.113	0.127
-25.22	-2.52	0.151	0.222	0.175	0.222	0.155	0.211	0.165	0.182
-26.38	-2.66	0.203	0.277	0.229	0.276	0.209	0.265	0.215	0.234
-27.42	-2.73	0.256	0.331	0.282	0.331	0.262	0.320	0.266	0.289
-28.19	-2.82	0.313	0.392	0.338	0.391	0.320	0.380	0.322	0.346
-29.75	-2.96	0.364	0.444	0.378	0.443	0.368	0.435	0.371	0.398
-30.65	-3.09	0.406	0.492	0.416	0.490	0.395	0.484	0.416	0.443
-32.59	-3.25	0.402	0.560	0.480	0.555	0.432	0.552	0.478	0.507
-35.18	-3.53	0.402	0.592	0.572	0.613	0.493	0.652	0.573	0.599
-36.47	-3.66	xxx	0.901	0.618	0.646	0.517	0.682	0.624	0.652
-37.38	-3.72	xxx	0.901	0.612	0.684	0.571	0.681	0.640	0.683
-32.98	-3.30	xxx	0.901	0.604	0.693	0.601	0.743	0.706	0.665
-28.19	-2.85	xxx	0.901	0.602	0.710	0.657	0.847	0.721	0.621

PUSHOUT TEST SUMMARY SHEET

Test: 3-4-1
Test Designation: SC-8-2-0.252-1.0C-2.5-1

Test Date: 11 MAR 93

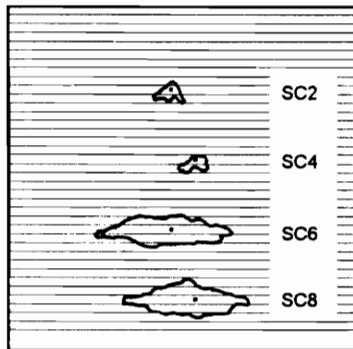
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.0C, 26 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u> F_u : <u>90.2 ksi</u>
Base Member:	Section: <u>2L 2.00x2.00x0.252</u>
	F_y : <u>51.9 ksi</u> F_u : <u>78.8 ksi</u>
Slab:	Thickness: <u>2.5 in.</u> f'_c : <u>4770 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

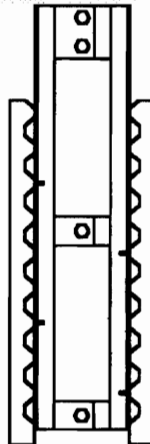
TEST RESULTS

Peak Shear Load:	<u>33.50 kips</u>	
Peak Shear Load Per Fastener:	<u>4.19 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.498 in.</u>	SC2: <u>0.464 in.</u>
	SC3: <u>0.281 in.</u>	SC4: <u>0.423 in.</u>
	SC5: <u>0.466 in.</u>	SC6: <u>0.429 in.</u>
	SC7: <u>0.433 in.</u>	SC8: <u>0.445 in.</u>

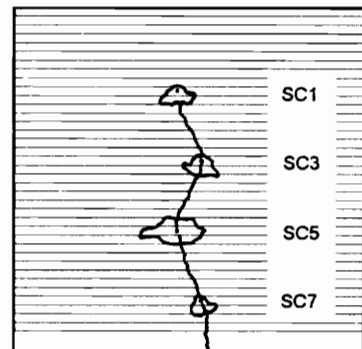
DAMAGE



South Inside



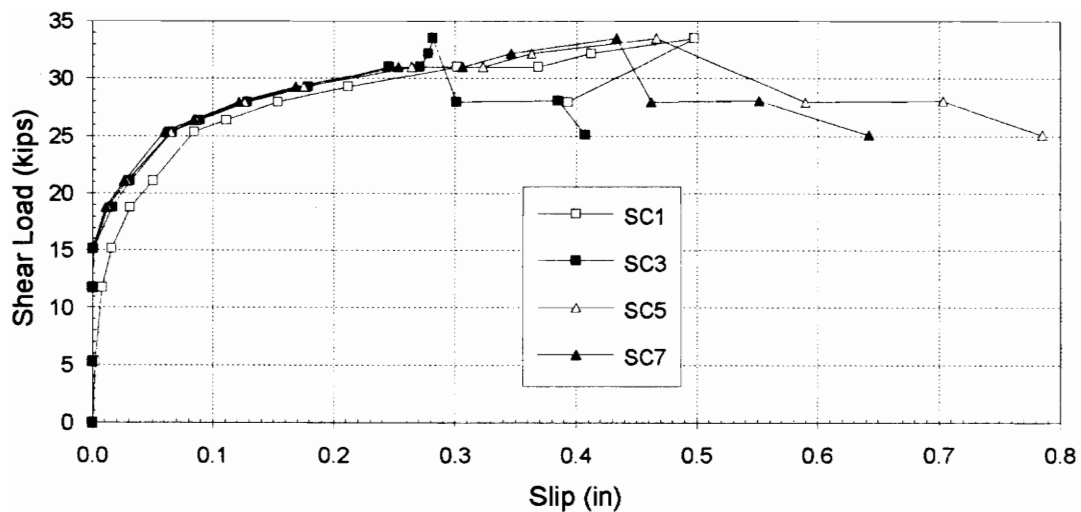
Profile



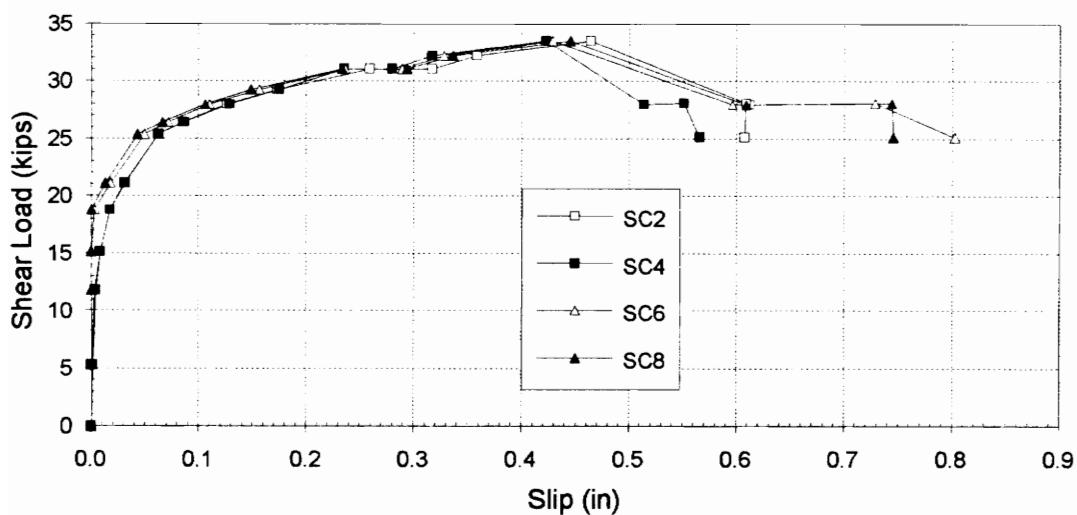
North Inside

COMMENTS

Bulges in deck below screw at all locations; Deck debonded
Slight cracking of north slab; Concrete rib failure at SC6 and SC8
SC2 and SC4 sheared off; Screw rotation $\approx 15^\circ$



(a) Test 3-4-1 - Load vs. North Slip



(b) Test 3-4-1 - Load vs. South Slip

Fig. A.42 Test 3-4-1 Load vs. Slip Plots

Table A.42 Test 3-4-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.30	-0.52	0.002	0.000	0.000	0.001	0.000	0.000	0.000	0.000
-11.77	-1.18	0.008	0.004	0.000	0.004	0.000	0.000	0.000	0.000
-15.13	-1.51	0.016	0.009	0.001	0.009	0.001	0.000	0.000	0.001
-18.75	-1.89	0.031	0.018	0.017	0.018	0.013	0.004	0.011	0.001
-21.08	-2.10	0.050	0.032	0.031	0.031	0.029	0.018	0.026	0.013
-25.35	-2.53	0.084	0.063	0.066	0.063	0.065	0.050	0.060	0.044
-26.38	-2.64	0.111	0.086	0.089	0.087	0.086	0.072	0.084	0.067
-27.94	-2.80	0.154	0.127	0.128	0.129	0.126	0.111	0.121	0.107
-29.23	-2.91	0.212	0.173	0.179	0.175	0.175	0.157	0.168	0.149
-31.04	-3.10	0.302	0.259	0.245	0.235	0.264	0.236	0.253	0.233
-31.04	-3.12	0.368	0.317	0.271	0.280	0.323	0.289	0.306	0.294
-32.20	-3.22	0.412	0.358	0.278	0.317	0.363	0.328	0.346	0.336
-33.50	-3.36	0.498	0.464	0.281	0.423	0.466	0.429	0.433	0.445
-27.94	-2.82	0.393	0.613	0.301	0.514	0.590	0.596	0.462	0.609
-28.07	-2.81	xxx	0.609	0.385	0.551	0.703	0.729	0.551	0.744
-25.09	-2.54	xxx	0.607	0.407	0.566	0.785	0.802	0.642	0.746

PUSHOUT TEST SUMMARY SHEET

Test: 3-4-2
Test Designation: SC-8-2-0.252-1.0C-2.5-2

Test Date: 12 MAR 93

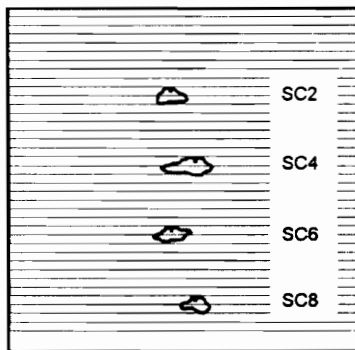
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.0C, 26 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u> F_u : <u>90.2 ksi</u>
Base Member:	Section: <u>2L 2.00x2.00x0.252</u>
	F_y : <u>51.9 ksi</u> F_u : <u>78.8 ksi</u>
Slab:	Thickness: <u>2.5 in.</u> f'_c : <u>4580 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

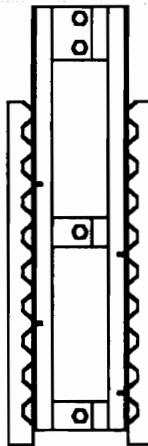
TEST RESULTS

Peak Shear Load:	<u>29.62 kips</u>	
Peak Shear Load Per Fastener:	<u>3.70 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.403 in.</u>	SC2: <u>0.487 in.</u>
	SC3: <u>0.412 in.</u>	SC4: <u>0.485 in.</u>
	SC5: <u>0.272 in.</u>	SC6: <u>0.466 in.</u>
	SC7: <u>0.403 in.</u>	SC8: <u>0.463 in.</u>

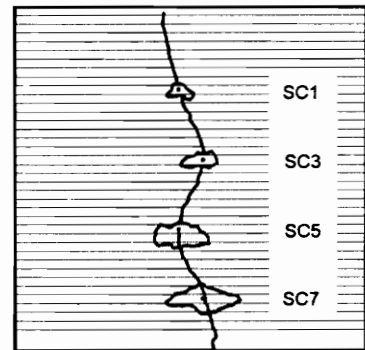
DAMAGE



South Inside



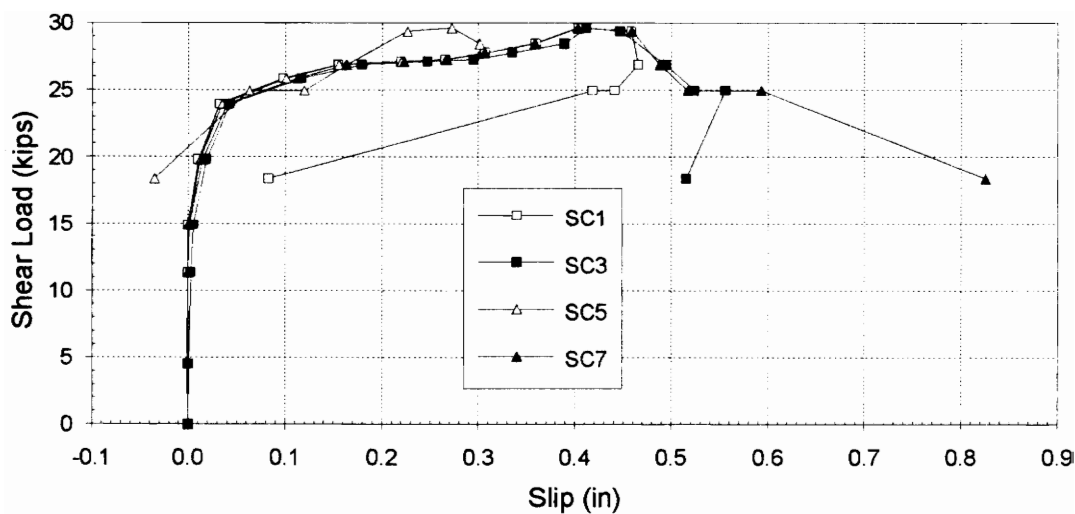
Profile



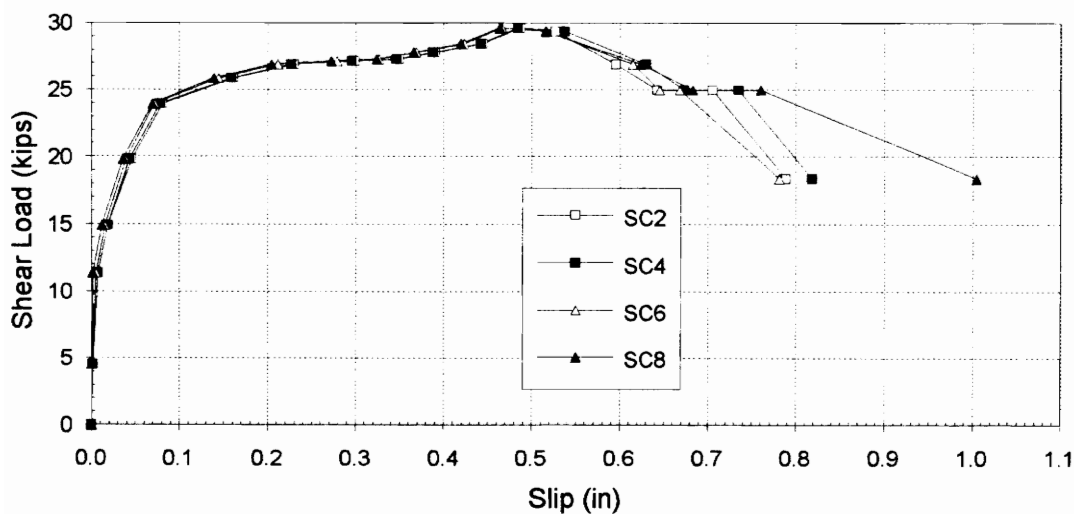
North Inside

COMMENTS

Minor bulges in deck below screw at all locations; Deck debonded
Longitudinal splitting of north slab; Concrete rib failure at SC6 and SC8
SC1 and SC3 sheared off; Screw rotation $\approx 15^\circ$ - 20°



(a) Test 3-4-2 - Load vs. North Slip



(b) Test 3-4-2 - Load vs. South Slip

Fig. A.43 Test 3-4-2 Load vs. Slip Plots

Table A.43 Test 3-4-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.53	-0.47	0.000	0.001	0.001	0.001	0.000	0.000	-0.001	0.000
-11.38	-1.13	0.000	0.008	0.003	0.008	0.000	0.006	0.000	0.002
-14.87	-1.49	0.000	0.019	0.006	0.019	0.000	0.016	0.001	0.012
-19.79	-1.98	0.010	0.046	0.019	0.043	0.012	0.039	0.015	0.036
-23.93	-2.40	0.032	0.081	0.043	0.079	0.035	0.072	0.040	0.070
-25.87	-2.59	0.098	0.161	0.117	0.160	0.101	0.145	0.113	0.139
-26.90	-2.70	0.155	0.230	0.180	0.227	0.155	0.212	0.164	0.205
-27.16	-2.73	0.220	0.299	0.247	0.296	0.220	0.279	0.223	0.273
-27.29	-2.73	0.266	0.349	0.295	0.347	0.266	0.327	0.267	0.324
-27.81	-2.76	0.307	0.390	0.335	0.387	0.307	0.369	0.307	0.366
-28.45	-2.84	0.359	0.444	0.389	0.442	0.301	0.423	0.358	0.419
-29.62	-2.96	0.403	0.487	0.412	0.485	0.272	0.466	0.403	0.463
-29.36	-2.95	0.458	0.527	0.447	0.537	0.226	0.516	0.459	0.515
-26.90	-2.69	0.466	0.595	0.494	0.630	0.164	0.615	0.488	0.624
-24.96	-2.51	0.441	0.643	0.524	0.674	0.120	0.645	0.517	0.683
-24.96	-2.50	0.419	0.706	0.556	0.735	0.063	0.668	0.593	0.760
-18.37	-1.87	0.083	0.789	0.516	0.818	-0.035	0.781	0.825	1.004

PUSHOUT TEST SUMMARY SHEET

Test: 3-4-3
 Test Designation: SC-8-2-0.252-1.0C-2.5-3

Test Date: 12 MAR 93

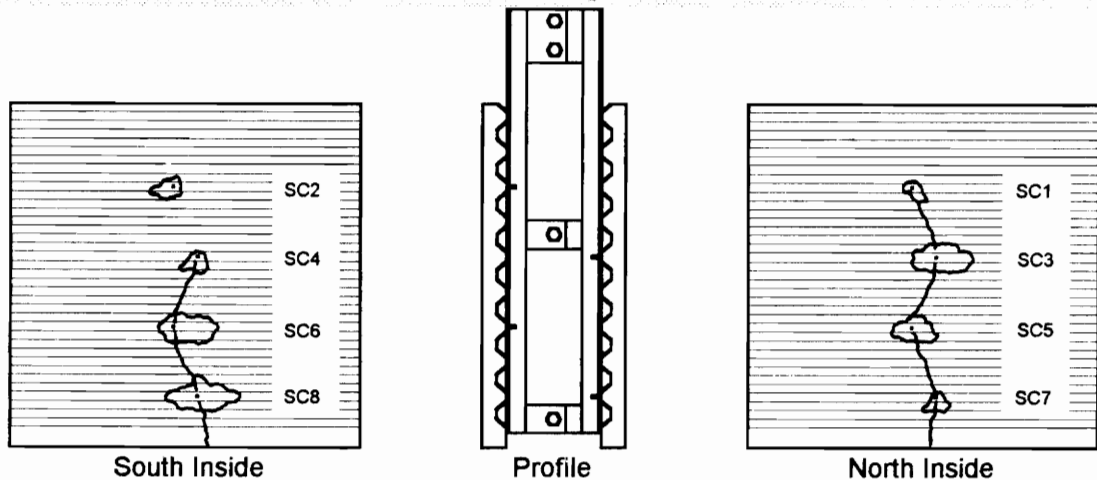
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.252</u>		
	F_y : <u>51.9 ksi</u>	F_u : <u>78.8 ksi</u>	
Slab:	Thickness: <u>2.5 in.</u>		
	f'_c : <u>4580 psi</u>		
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

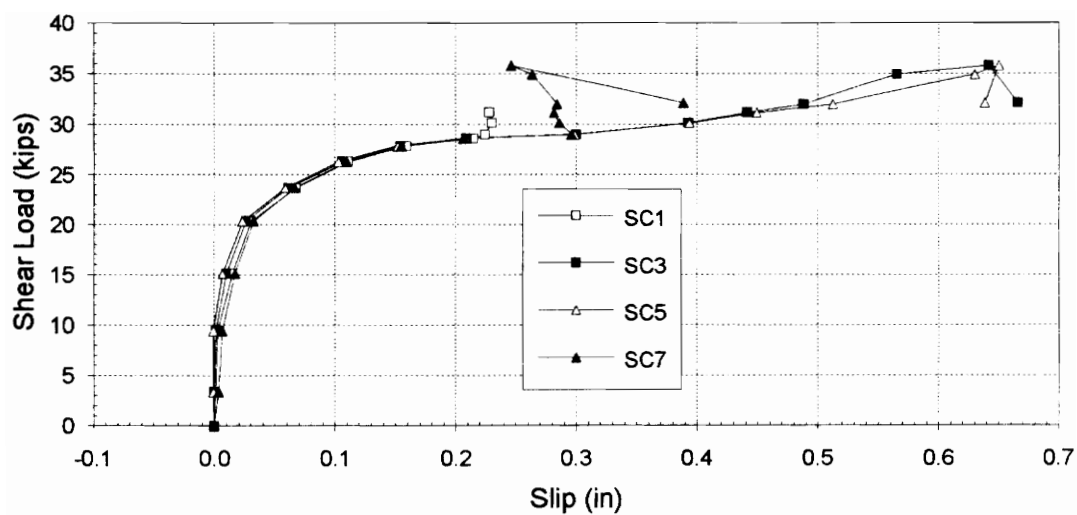
Peak Shear Load: <u>35.83 kips</u>									
Peak Shear Load Per Fastener: <u>4.48 kips</u>									
Slip at Peak Shear Load:	<table border="0" style="width: 100%;"> <tr> <td>SC1: <u>xxx in.</u></td> <td>SC2: <u>0.603 in.</u></td> </tr> <tr> <td>SC3: <u>0.642 in.</u></td> <td>SC4: <u>0.693 in.</u></td> </tr> <tr> <td>SC5: <u>0.650 in.</u></td> <td>SC6: <u>0.496 in.</u></td> </tr> <tr> <td>SC7: <u>0.246 in.</u></td> <td>SC8: <u>0.687 in.</u></td> </tr> </table>	SC1: <u>xxx in.</u>	SC2: <u>0.603 in.</u>	SC3: <u>0.642 in.</u>	SC4: <u>0.693 in.</u>	SC5: <u>0.650 in.</u>	SC6: <u>0.496 in.</u>	SC7: <u>0.246 in.</u>	SC8: <u>0.687 in.</u>
SC1: <u>xxx in.</u>	SC2: <u>0.603 in.</u>								
SC3: <u>0.642 in.</u>	SC4: <u>0.693 in.</u>								
SC5: <u>0.650 in.</u>	SC6: <u>0.496 in.</u>								
SC7: <u>0.246 in.</u>	SC8: <u>0.687 in.</u>								

DAMAGE

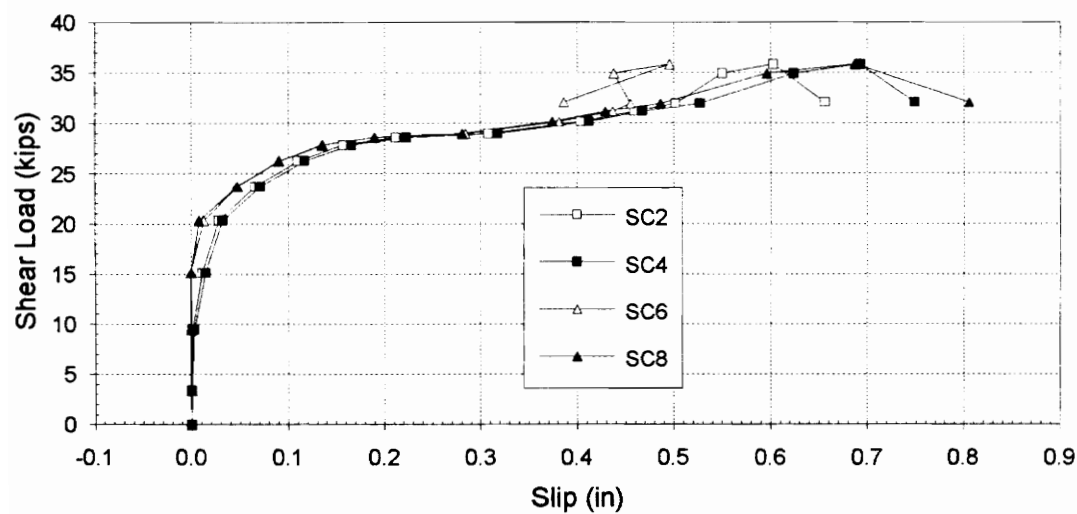


COMMENTS

Minor bulges in deck below screw at all locations; Deck debonded
 Slight cracking of north and south slab; Concrete rib failure at SC3, SC5, SC6, SC8
 Screw rotation $\approx 10^\circ$ - 15°



(a) Test 3-4-3 - Load vs. North Slip



(b) Test 3-4-3 - Load vs. South Slip

Fig. A.44 Test 3-4-3 Load vs. Slip Plots

Table A.44 Test 3-4-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-3.36	-0.34	0.001	0.001	0.000	0.000	-0.001	-0.001	0.004	0.000
-9.44	-0.96	0.003	0.001	0.001	0.003	-0.001	-0.001	0.007	0.000
-15.13	-1.50	0.015	0.012	0.010	0.015	0.007	-0.001	0.017	0.000
-20.31	-2.04	0.031	0.028	0.026	0.032	0.023	0.013	0.032	0.008
-23.67	-2.36	0.067	0.066	0.061	0.071	0.059	0.048	0.067	0.047
-26.25	-2.62	0.111	0.110	0.106	0.117	0.103	0.090	0.110	0.090
-27.81	-2.78	0.159	0.157	0.154	0.166	0.152	0.135	0.155	0.136
-28.58	-2.87	0.215	0.212	0.209	0.222	0.209	0.190	0.206	0.190
-28.97	-2.90	0.225	0.308	0.300	0.318	0.298	0.284	0.296	0.281
-30.13	-3.02	0.230	0.404	0.393	0.412	0.394	0.381	0.286	0.374
-31.17	-3.09	0.228	0.459	0.441	0.468	0.450	0.437	0.282	0.429
-31.95	-3.20	xxx	0.502	0.489	0.527	0.513	0.455	0.284	0.486
-34.92	-3.49	xxx	0.550	0.566	0.624	0.630	0.438	0.263	0.596
-35.83	-3.58	xxx	0.603	0.642	0.693	0.650	0.496	0.246	0.687
-32.07	-3.23	xxx	0.656	0.666	0.749	0.639	0.386	0.389	0.805

PUSHOUT TEST SUMMARY SHEET

Test: 4-1-1
Test Designation: SC-8-2-0.109-1.5VL-4-1

Test Date: 02 FEB 93

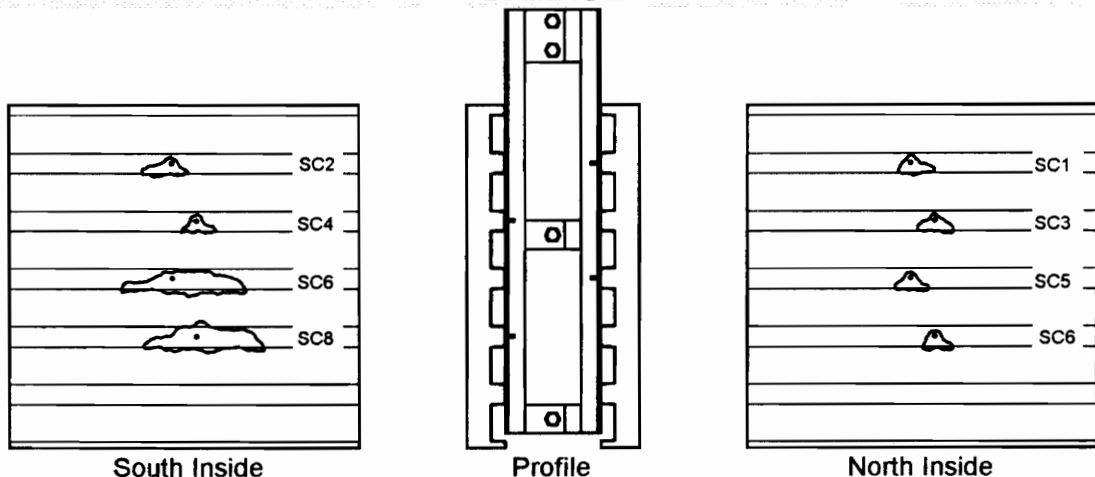
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>
	F_y : <u>53.8 ksi</u> F_u : <u>80.9 ksi</u>
Slab:	Thickness: <u>4 in.</u> f'_c : <u>5400 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

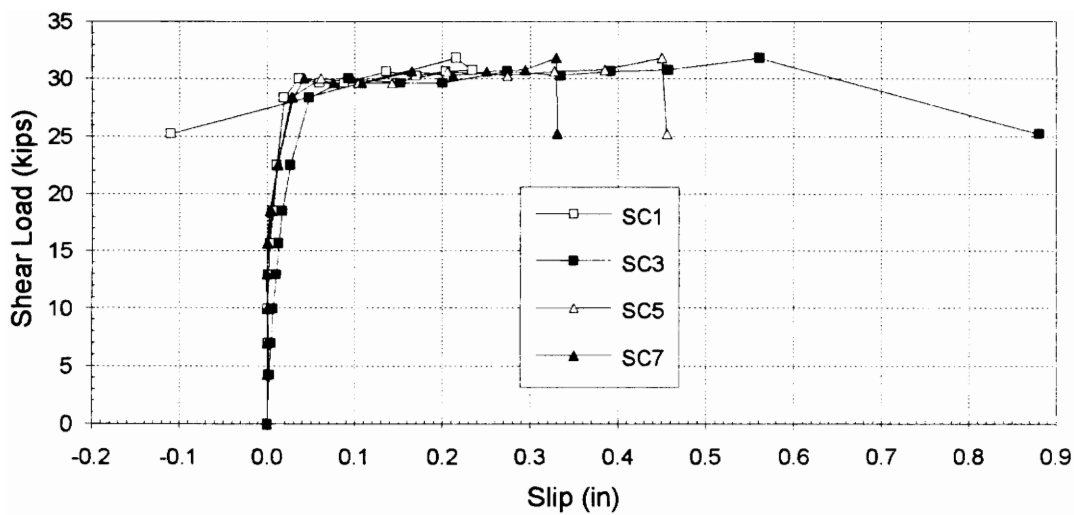
Peak Shear Load:	<u>31.82 kips</u>
Peak Shear Load Per Fastener:	<u>3.98 kips</u>
Slip at Peak Shear Load:	
	SC1: <u>0.215 in.</u> SC2: <u>0.563 in.</u>
	SC3: <u>0.561 in.</u> SC4: <u>0.450 in.</u>
	SC5: <u>0.450 in.</u> SC6: <u>0.422 in.</u>
	SC7: <u>0.330 in.</u> SC8: <u>0.268 in.</u>

DAMAGE

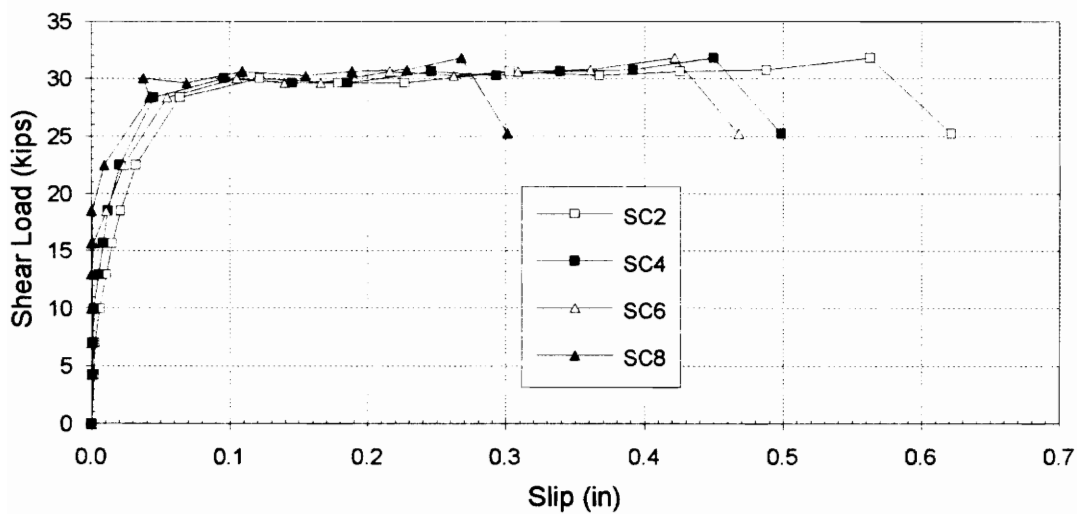


COMMENTS

Bulges in deck below screw at all locations
Angles buckled above SC3; Concrete rib failure at SC6 and SC8
Screw rotation $\approx 30^\circ$ - 35°



(a) Test 4-1-1 - Load vs. North Slip



(b) Test 4-1-1 - Load vs. South Slip

Fig. A.45 Test 4-1-1 Load vs. Slip Plots

Table A.45 Test 4-1-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.27	-0.46	0.002	0.002	0.002	0.001	0.000	0.000	0.000	0.000
-6.98	-0.70	0.001	0.002	0.004	0.001	0.000	0.000	0.000	0.000
-9.96	-1.01	0.001	0.006	0.007	0.002	0.000	0.000	0.000	0.001
-12.93	-1.31	0.001	0.011	0.010	0.005	0.000	0.000	-0.001	0.001
-15.65	-1.64	0.003	0.015	0.013	0.009	0.000	0.002	0.001	0.001
-18.49	-1.87	0.007	0.021	0.017	0.012	0.003	0.011	0.005	0.001
-22.50	-2.28	0.011	0.032	0.026	0.021	0.012	0.024	0.012	0.010
-28.32	-2.87	0.019	0.064	0.048	0.045	0.028	0.055	0.029	0.042
-30.01	-3.18	0.035	0.122	0.093	0.096	0.061	0.105	0.042	0.038
-29.62	-3.19	0.059	0.179	0.152	0.145	0.104	0.139	0.076	0.069
-29.62	-3.16	0.088	0.227	0.200	0.186	0.143	0.166	0.108	0.069
-30.65	-3.22	0.136	0.303	0.274	0.246	0.206	0.216	0.165	0.109
-30.26	-3.03	0.170	0.368	0.335	0.293	0.275	0.262	0.212	0.155
-30.65	-3.03	0.204	0.426	0.391	0.339	0.327	0.309	0.251	0.189
-30.78	-3.03	0.234	0.488	0.458	0.392	0.385	0.361	0.295	0.229
-31.82	-2.99	0.215	0.563	0.561	0.450	0.450	0.422	0.330	0.268
-25.22	-2.57	-0.110	0.621	0.880	0.499	0.456	0.468	0.331	0.301

PUSHOUT TEST SUMMARY SHEET

Test: 4-1-2
Test Designation: SC-8-2-0.109-1.5VL-4-2

Test Date: 02 FEB 93

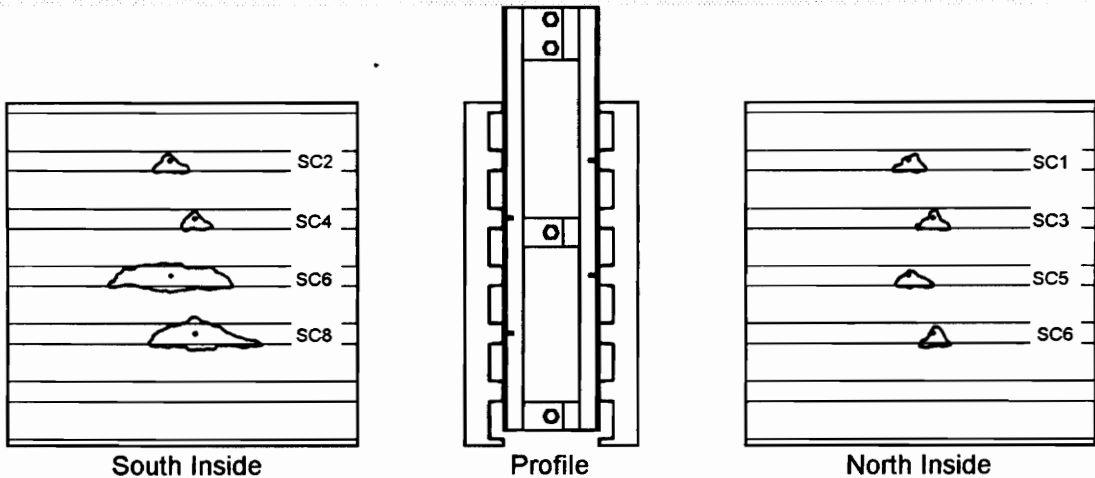
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>
	F_y : <u>53.8 ksi</u> F_u : <u>80.9 ksi</u>
Slab:	Thickness: <u>4 in.</u> f'_c : <u>5400 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

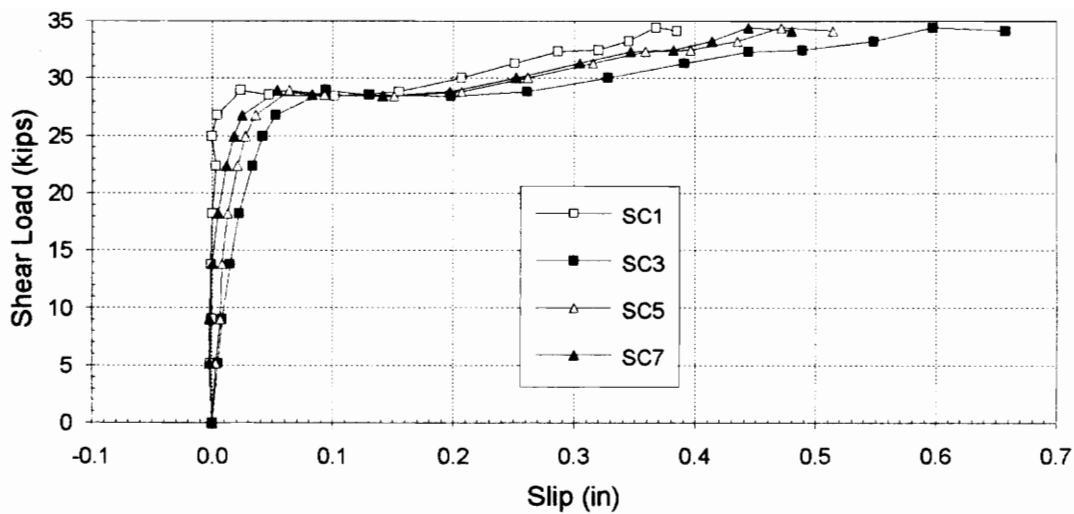
Peak Shear Load:	<u>34.40 kips</u>	
Peak Shear Load Per Fastener:	<u>4.30 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.368 in.</u>	SC2: <u>0.686 in.</u>
	SC3: <u>0.597 in.</u>	SC4: <u>0.468 in.</u>
	SC5: <u>0.472 in.</u>	SC6: <u>0.412 in.</u>
	SC7: <u>0.444 in.</u>	SC8: <u>0.418 in.</u>

DAMAGE

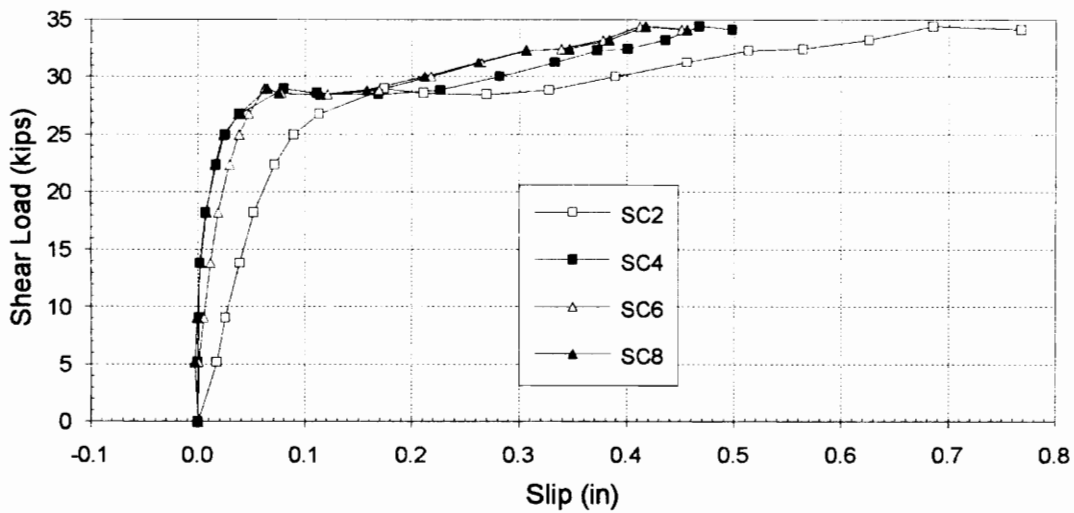


COMMENTS

Bulges in deck below screw at all locations
Angles buckled above SC2 and SC3; Concrete rib failure at SC6 and SC8
Screw rotation $\approx 30^\circ$



(a) Test 4-1-2 - Load vs. North Slip



(b) Test 4-1-2 - Load vs. South Slip

Fig. A.46 Test 4-1-2 Load vs. Slip Plots

Table A.46 Test 4-1-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.17	-0.63	-0.002	0.018	0.005	0.000	0.003	0.001	-0.002	-0.003
-9.05	-0.96	-0.001	0.026	0.009	0.001	0.007	0.006	-0.002	-0.001
-13.84	-1.36	-0.001	0.039	0.015	0.002	0.008	0.012	0.000	0.002
-18.24	-1.88	0.000	0.052	0.022	0.007	0.013	0.019	0.005	0.008
-22.37	-2.23	0.003	0.072	0.033	0.017	0.021	0.029	0.012	0.016
-24.96	-2.48	-0.001	0.089	0.042	0.025	0.027	0.039	0.018	0.024
-26.77	-2.71	0.004	0.113	0.053	0.038	0.035	0.047	0.024	0.038
-28.97	-3.05	0.023	0.174	0.094	0.080	0.064	0.062	0.054	0.064
-28.58	-2.98	0.047	0.211	0.130	0.111	0.093	0.078	0.083	0.075
-28.45	-2.99	0.102	0.270	0.198	0.169	0.151	0.121	0.141	0.114
-28.84	-2.95	0.155	0.328	0.261	0.227	0.207	0.169	0.197	0.158
-30.01	-2.97	0.207	0.389	0.328	0.282	0.262	0.218	0.252	0.212
-31.30	-3.13	0.251	0.456	0.391	0.333	0.316	0.265	0.304	0.262
-32.33	-3.14	0.286	0.513	0.444	0.373	0.359	0.307	0.347	0.306
-32.46	-3.30	0.320	0.564	0.489	0.401	0.396	0.339	0.382	0.347
-33.24	-3.20	0.345	0.626	0.548	0.436	0.435	0.378	0.414	0.383
-34.40	-3.45	0.368	0.686	0.597	0.468	0.472	0.412	0.444	0.418
-34.14	-3.42	0.385	0.768	0.658	0.498	0.514	0.451	0.480	0.456

PUSHOUT TEST SUMMARY SHEET

Test: 4-1-3
Test Designation: SC-8-2-0.109-1.5VL-4-3

Test Date: 02 FEB 93

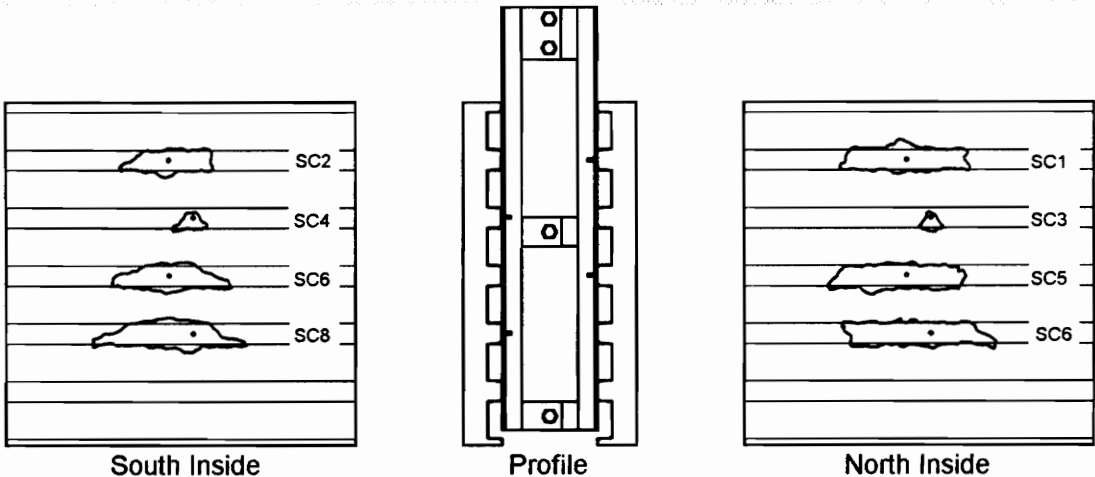
SPECIMEN DESCRIPTION

Fastener: Type: Elco, grade 8, 5/16 in. ϕ , 2 in. standoff screw
Per Specimen: 8
Deck: Type: 1.5VL, 22 ga Width: 36 in. Length: 36 in.
 F_y : 45.7 ksi F_u : 53.4 ksi
Base Member: Section: 2L 1.25x1.25x0.109
 F_y : 53.8 ksi F_u : 80.9 ksi
Slab: Thickness: 4 in. f'_c : 5400 psi
Mesh: Type: WWF 6x6-W1.4xW1.4

TEST RESULTS

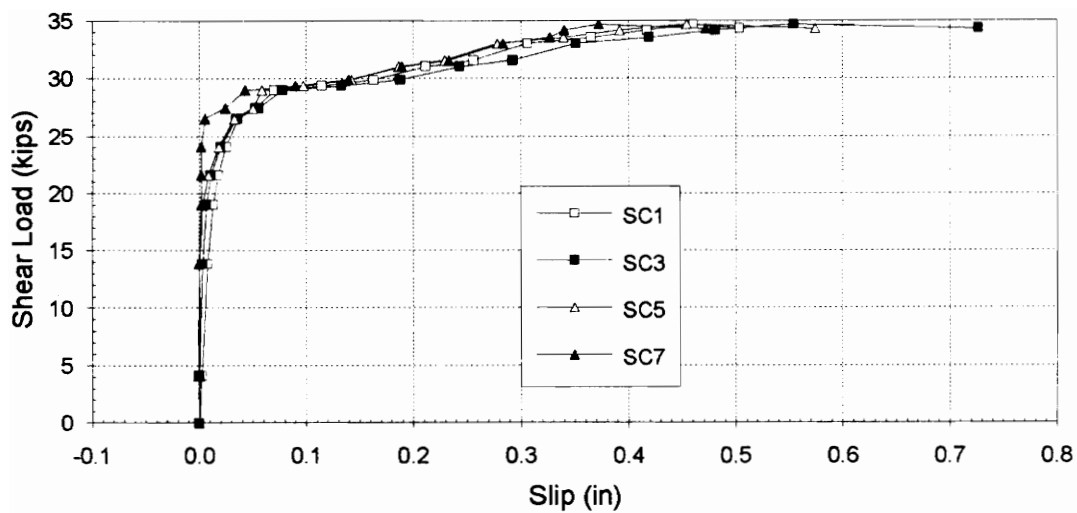
Peak Shear Load: 34.66 kips
Peak Shear Load Per Fastener: 4.33 kips
Slip at Peak Shear Load: SC1: 0.461 in. SC2: 0.589 in.
SC3: 0.554 in. SC4: 0.614 in.
SC5: 0.455 in. SC6: 0.548 in.
SC7: 0.372 in. SC8: 0.451 in.

DAMAGE

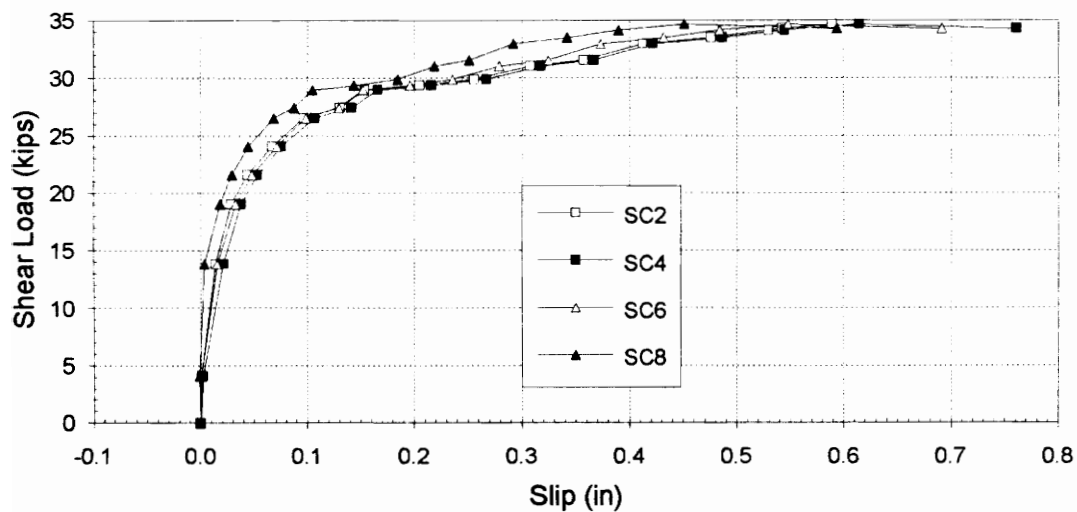


COMMENTS

Bulges in deck below screw at all locations; SC2, SC6 pulling out of base material
Local buckle above SC3; Concrete rib failure at SC1, SC2, SC5, SC6, SC7, SC8
Screw rotation $\approx 45^\circ$



(a) Test 4-1-3 - Load vs. North Slip



(b) Test 4-1-3 - Load vs. South Slip

Fig. A.47 Test 4-1-3 Load vs. Slip Plots

Table A.47 Test 4-1-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.14	-0.43	0.002	0.001	0.000	0.002	0.000	0.001	-0.001	-0.001
-13.84	-1.35	0.008	0.014	0.003	0.021	0.000	0.016	0.000	0.004
-19.01	-1.91	0.013	0.029	0.007	0.038	0.003	0.033	0.002	0.018
-21.60	-2.13	0.018	0.043	0.011	0.053	0.009	0.048	0.002	0.029
-24.06	-2.36	0.025	0.067	0.020	0.076	0.018	0.072	0.002	0.045
-26.51	-2.62	0.037	0.097	0.035	0.107	0.033	0.098	0.006	0.069
-27.42	-2.55	0.053	0.130	0.056	0.142	0.050	0.130	0.024	0.088
-28.97	-3.05	0.070	0.154	0.078	0.166	0.059	0.152	0.043	0.105
-29.36	-3.14	0.115	0.205	0.133	0.216	0.097	0.196	0.090	0.144
-29.88	-3.03	0.163	0.256	0.188	0.267	0.142	0.235	0.140	0.184
-31.04	-3.15	0.212	0.308	0.243	0.318	0.187	0.279	0.189	0.219
-31.56	-3.20	0.256	0.357	0.293	0.366	0.229	0.325	0.233	0.251
-32.98	-3.37	0.306	0.412	0.351	0.422	0.278	0.373	0.284	0.292
-33.50	-3.15	0.365	0.476	0.419	0.486	0.339	0.432	0.327	0.342
-34.14	-3.30	0.417	0.530	0.481	0.545	0.392	0.484	0.341	0.390
-34.66	-3.44	0.461	0.589	0.554	0.614	0.454	0.548	0.372	0.451
-34.27	-3.39	0.503	0.543	0.727	0.761	0.574	0.691	0.472	0.594

PUSHOUT TEST SUMMARY SHEET

Test: 4-2-1
Test Designation: SC-8-2-0.170-1.5VL-4-1

Test Date: 03 FEB 93

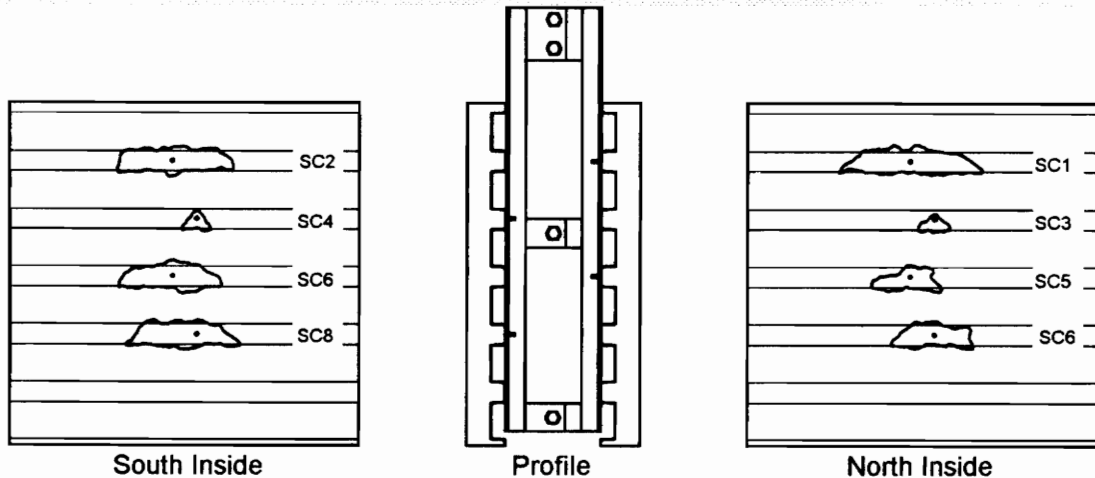
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 1.50x1.50x0.170</u>
	F_y : <u>55.6 ksi</u> F_u : <u>83.8 ksi</u>
Slab:	Thickness: <u>4 in.</u> f'_c : <u>5080 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

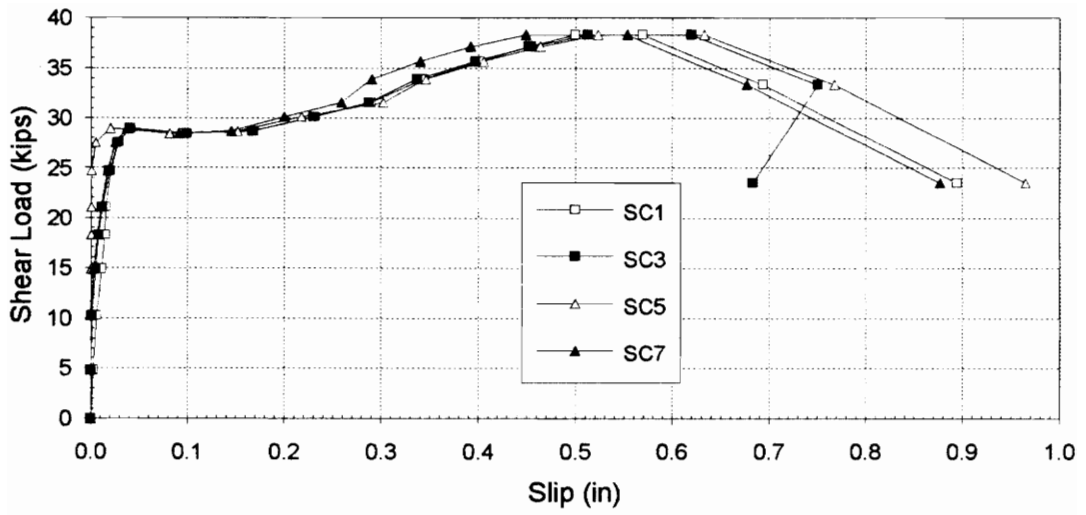
Peak Shear Load:	<u>38.28 kips</u>	
Peak Shear Load Per Fastener:	<u>4.79 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.569 in.</u>	SC2: <u>0.627 in.</u>
	SC3: <u>0.620 in.</u>	SC4: <u>0.682 in.</u>
	SC5: <u>0.633 in.</u>	SC6: <u>0.608 in.</u>
	SC7: <u>0.553 in.</u>	SC8: <u>0.584 in.</u>

DAMAGE

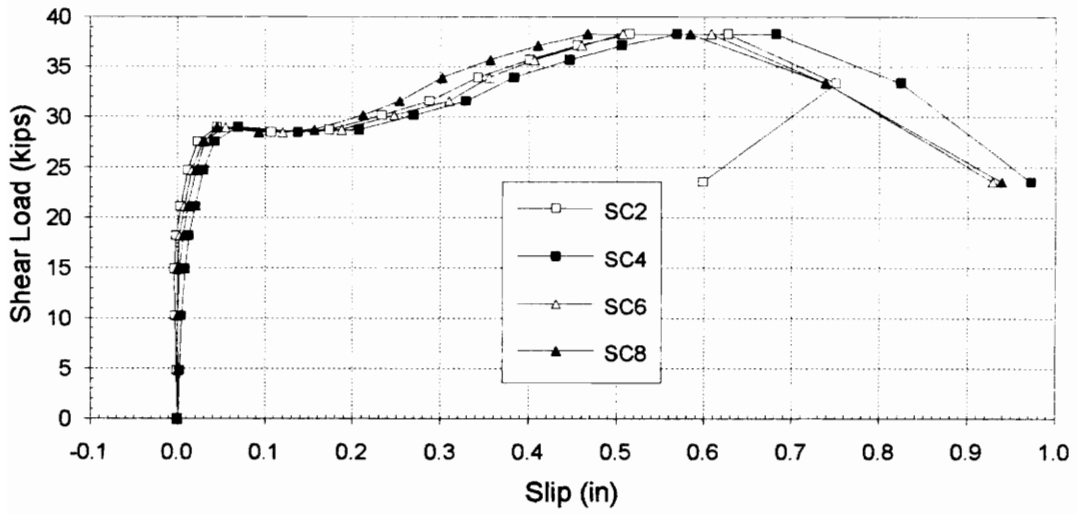


COMMENTS

Bulges in deck below screw at all locations
Concrete rib failure at SC1, SC2, SC5, SC6, SC7, SC8
Screw rotation $\approx 20^\circ$ - 30°



(a) Test 4-2-1 - Load vs. North Slip



(b) Test 4-2-1 - Load vs. South Slip

Fig. A.48 Test 4-2-1 Load vs. Slip Plots

Table A.48 Test 4-2-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.79	-0.53	0.002	-0.001	0.000	0.002	0.001	0.001	0.000	0.001
-10.22	-0.57	0.006	-0.002	0.001	0.005	0.001	0.001	0.000	0.001
-14.87	-1.48	0.011	-0.004	0.005	0.009	0.001	0.001	0.003	0.002
-18.24	-1.83	0.015	-0.001	0.008	0.013	0.001	0.002	0.007	0.007
-21.08	-2.12	0.015	0.004	0.012	0.020	0.001	0.008	0.010	0.012
-24.70	-2.47	0.020	0.012	0.019	0.030	0.001	0.017	0.017	0.021
-27.55	-2.75	0.028	0.023	0.028	0.043	0.005	0.029	0.025	0.031
-28.97	-2.93	0.040	0.045	0.041	0.069	0.020	0.055	0.037	0.045
-28.45	-2.85	0.096	0.107	0.099	0.138	0.081	0.120	0.091	0.093
-28.71	-2.88	0.166	0.174	0.168	0.208	0.152	0.188	0.145	0.156
-30.13	-2.99	0.231	0.234	0.231	0.270	0.218	0.247	0.200	0.212
-31.56	-3.13	0.289	0.287	0.287	0.329	0.302	0.309	0.259	0.254
-33.89	-3.46	0.344	0.342	0.337	0.384	0.346	0.355	0.290	0.302
-35.70	-3.56	0.401	0.401	0.397	0.447	0.406	0.407	0.341	0.357
-37.12	-3.72	0.452	0.455	0.454	0.506	0.464	0.460	0.393	0.411
-38.28	-3.81	0.499	0.515	0.513	0.569	0.523	0.506	0.449	0.466
-38.28	-3.89	0.569	0.627	0.620	0.682	0.633	0.608	0.553	0.584
-33.37	-3.32	0.693	0.751	0.750	0.824	0.768	0.739	0.677	0.738
-23.54	-3.47	0.894	0.599	0.683	0.973	0.965	0.929	0.877	0.939

PUSHOUT TEST SUMMARY SHEET

Test: 4-2-2
Test Designation: SC-8-2-0.170-1.5VL-4-2

Test Date: 04 FEB 93

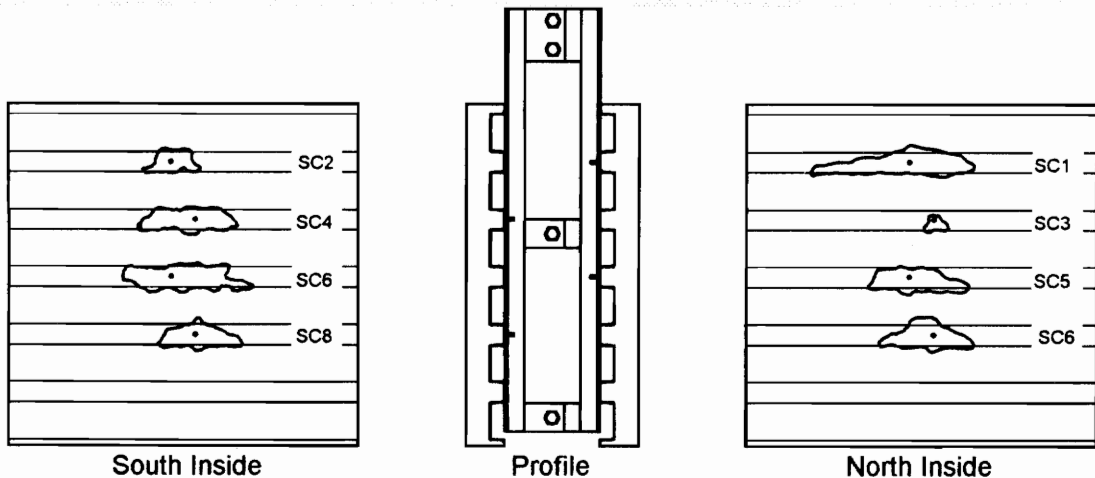
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 1.50x1.50x0.170</u>
	F_y : <u>55.6 ksi</u> F_u : <u>83.8 ksi</u>
Slab:	Thickness: <u>4 in.</u> f'_c : <u>5290 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

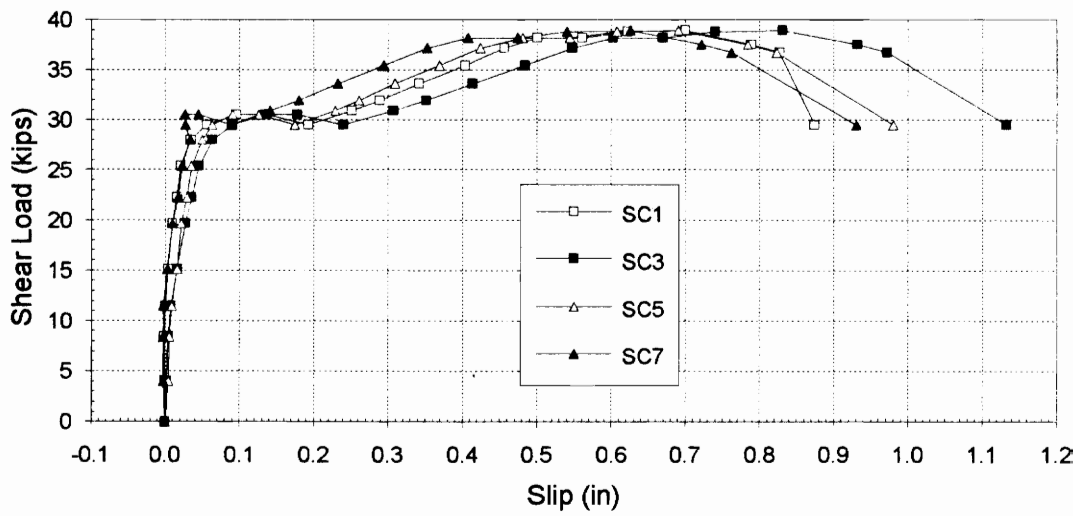
Peak Shear Load:	<u>38.93 kips</u>	
Peak Shear Load Per Fastener:	<u>4.87 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.700 in.</u>	SC2: <u>0.785 in.</u>
	SC3: <u>0.831 in.</u>	SC4: <u>0.677 in.</u>
	SC5: <u>0.691 in.</u>	SC6: <u>0.684 in.</u>
	SC7: <u>0.626 in.</u>	SC8: <u>0.513 in.</u>

DAMAGE

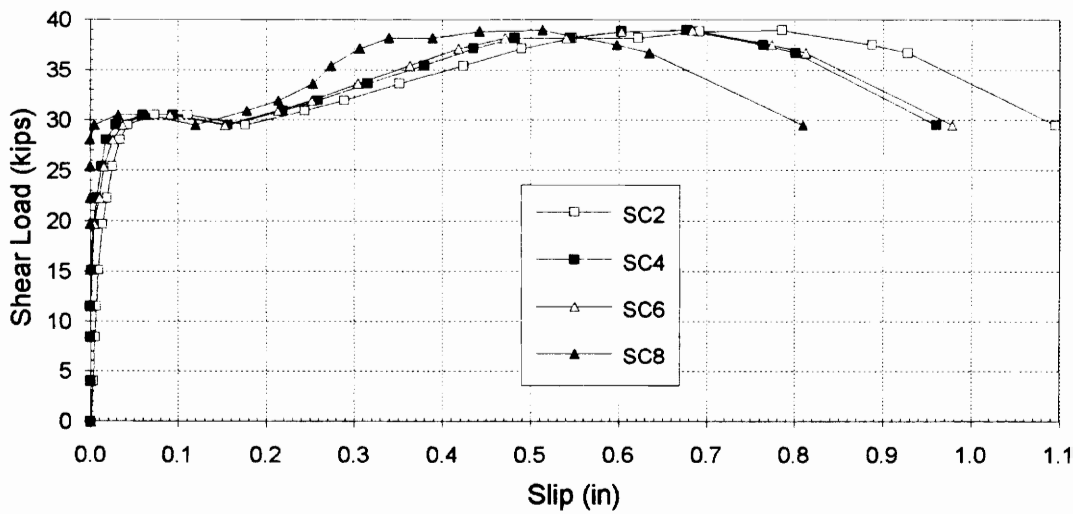


COMMENTS

Bulges in deck below screw at all locations
Concrete rib failure at SC1, SC2, SC4, SC5, SC6, SC7, SC8
Screw rotation $\approx 10^\circ$ - 20°



(a) Test 4-2-2 - Load vs. North Slip



(b) Test 4-2-2 - Load vs. South Slip

Fig. A.49 Test 4-2-2 Load vs. Slip Plots

Table A.49 Test 4-2-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.01	-0.40	-0.001	0.004	0.002	0.000	0.004	0.000	-0.002	0.000
-8.41	-0.84	-0.001	0.005	0.004	0.000	0.006	0.000	-0.002	0.000
-11.51	-1.15	0.000	0.007	0.008	0.000	0.009	0.000	-0.002	0.000
-15.13	-1.51	0.004	0.009	0.016	0.001	0.016	0.002	0.003	0.000
-19.66	-1.97	0.010	0.014	0.027	0.004	0.022	0.005	0.010	0.000
-22.25	-2.24	0.016	0.020	0.036	0.008	0.029	0.011	0.018	0.000
-25.35	-2.53	0.021	0.026	0.045	0.013	0.035	0.016	0.023	0.000
-28.07	-2.80	0.034	0.034	0.064	0.018	0.050	0.026	0.034	0.000
-29.49	-2.95	0.056	0.043	0.091	0.029	0.064	0.037	0.028	0.005
-30.52	-3.06	0.096	0.073	0.135	0.060	0.091	0.063	0.027	0.032
-30.52	-3.05	0.136	0.111	0.178	0.095	0.126	0.091	0.045	0.064
-29.49	-2.95	0.193	0.177	0.240	0.156	0.175	0.153	0.089	0.120
-30.91	-3.09	0.251	0.244	0.308	0.219	0.229	0.213	0.141	0.178
-31.95	-3.19	0.289	0.289	0.352	0.259	0.261	0.252	0.180	0.214
-33.63	-3.36	0.342	0.351	0.414	0.315	0.309	0.305	0.233	0.253
-35.44	-3.54	0.404	0.424	0.484	0.379	0.369	0.363	0.295	0.274
-37.12	-3.71	0.456	0.489	0.548	0.435	0.424	0.418	0.353	0.306
-38.15	-3.82	0.500	0.547	0.602	0.482	0.481	0.471	0.407	0.339
-38.15	-3.80	0.560	0.621	0.670	0.544	0.544	0.540	0.474	0.388
-38.80	-3.88	0.622	0.692	0.740	0.603	0.607	0.603	0.540	0.442
-38.93	-3.89	0.700	0.785	0.831	0.677	0.691	0.684	0.626	0.513
-37.51	-3.77	0.789	0.887	0.932	0.764	0.784	0.773	0.722	0.597
-36.73	-3.67	0.827	0.927	0.972	0.801	0.823	0.813	0.762	0.635
-29.49	-2.98	0.875	1.095	1.133	0.960	0.981	0.978	0.931	0.809

PUSHOUT TEST SUMMARY SHEET

Test: 4-2-3
 Test Designation: SC-8-2-0.170-1.5VL-4-3

Test Date: 04 FEB 93

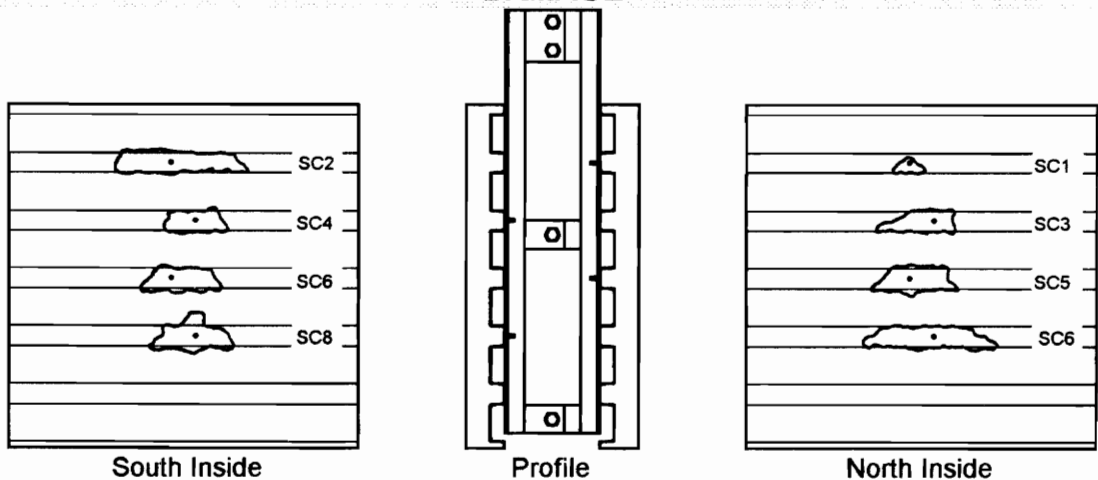
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.5VL, 22 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u>	F_u : <u>53.4 ksi</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.170</u>		
	F_y : <u>55.6 ksi</u>	F_u : <u>83.8 ksi</u>	
Slab:	Thickness: <u>4 in.</u>		
		f'_c : <u>5290 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

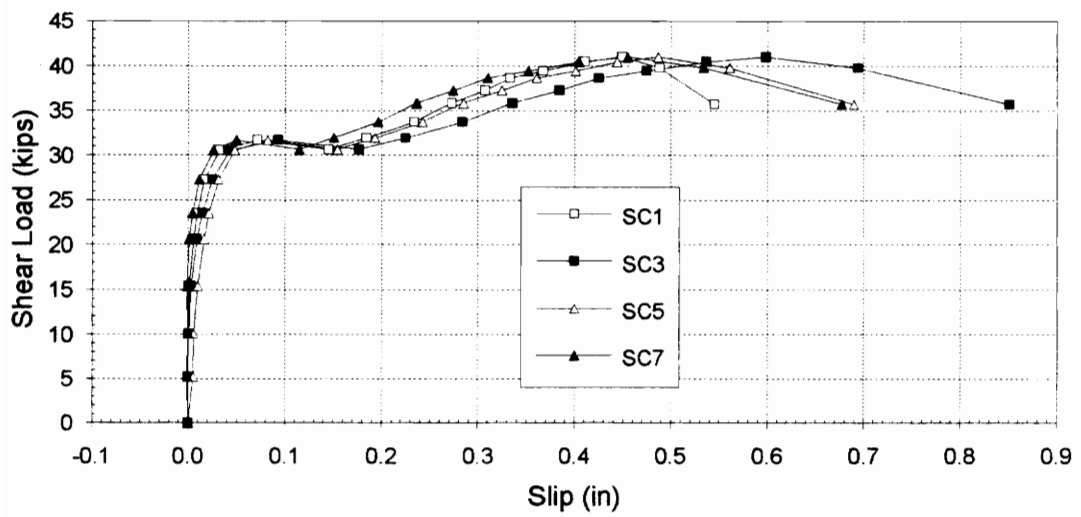
Peak Shear Load:	<u>41.00 kips</u>	
Peak Shear Load Per Fastener:	<u>5.13 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.450 in.</u>	SC2: <u>0.709 in.</u>
	SC3: <u>0.599 in.</u>	SC4: <u>0.471 in.</u>
	SC5: <u>0.487 in.</u>	SC6: <u>0.544 in.</u>
	SC7: <u>0.455 in.</u>	SC8: <u>0.437 in.</u>

DAMAGE

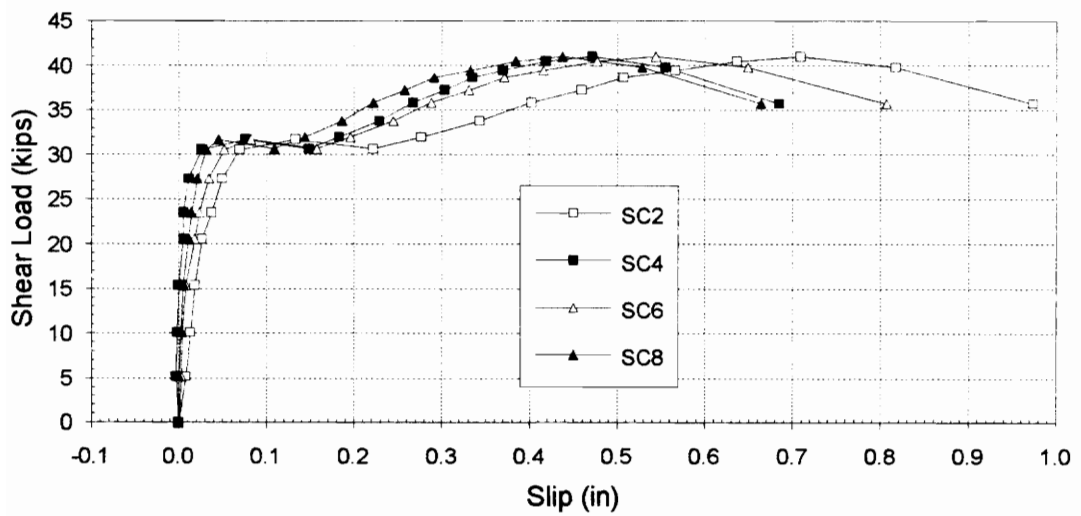


COMMENTS

Bulges in deck below screw at all locations
 Concrete rib failure at SC2, SC3, SC4, SC5, SC6, SC7, SC8
 Screw rotation $\approx 25^\circ$ - 30°



(a) Test 4-2-3 - Load vs. North Slip



(b) Test 4-2-3 - Load vs. South Slip

Fig. A.50 Test 4-2-3 Load vs. Slip Plots

Table A.50 Test 4-2-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.17	-0.53	0.000	0.009	0.000	-0.003	0.006	0.003	-0.001	0.000
-10.09	-1.02	0.001	0.013	0.001	-0.002	0.006	0.004	0.000	0.002
-15.39	-1.54	0.001	0.018	0.003	0.000	0.010	0.009	-0.001	0.006
-20.56	-2.06	0.006	0.027	0.009	0.005	0.017	0.018	0.001	0.012
-23.54	-2.27	0.009	0.038	0.015	0.005	0.021	0.024	0.004	0.015
-27.29	-2.76	0.017	0.050	0.024	0.012	0.031	0.034	0.012	0.021
-30.52	-3.08	0.032	0.069	0.043	0.026	0.048	0.052	0.026	0.031
-31.69	-3.29	0.072	0.133	0.093	0.076	0.082	0.082	0.050	0.045
-30.65	-3.02	0.145	0.222	0.177	0.148	0.154	0.157	0.115	0.108
-31.95	-3.20	0.185	0.276	0.225	0.183	0.193	0.196	0.151	0.144
-33.76	-3.38	0.234	0.343	0.284	0.229	0.242	0.245	0.197	0.186
-35.83	-3.60	0.273	0.402	0.336	0.267	0.284	0.288	0.236	0.222
-37.25	-3.74	0.307	0.459	0.384	0.303	0.325	0.331	0.274	0.257
-38.67	-3.85	0.333	0.507	0.425	0.335	0.360	0.371	0.310	0.291
-39.45	-4.00	0.367	0.566	0.475	0.369	0.401	0.416	0.352	0.332
-40.48	-4.07	0.410	0.637	0.537	0.418	0.444	0.477	0.404	0.384
-41.00	-4.14	0.450	0.709	0.599	0.471	0.487	0.544	0.455	0.437
-39.83	-3.99	0.488	0.817	0.694	0.555	0.561	0.649	0.534	0.528
-35.70	-3.64	0.545	0.973	0.850	0.685	0.690	0.806	0.677	0.664

PUSHOUT TEST SUMMARY SHEET

Test: 4-3-1
Test Designation: SC-8-2-0.243-1.5VL-4-1

Test Date: 04 FEB 93

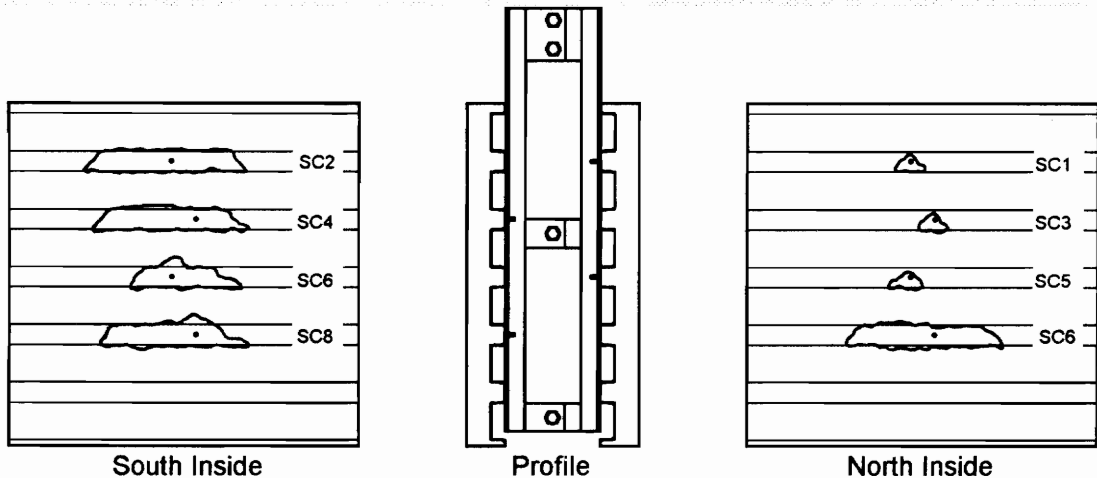
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 2.00x2.00x0.243</u>
	F_y : <u>57.7 ksi</u> F_u : <u>83.6 ksi</u>
Slab:	Thickness: <u>4 in.</u> f'_c : <u>5290 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

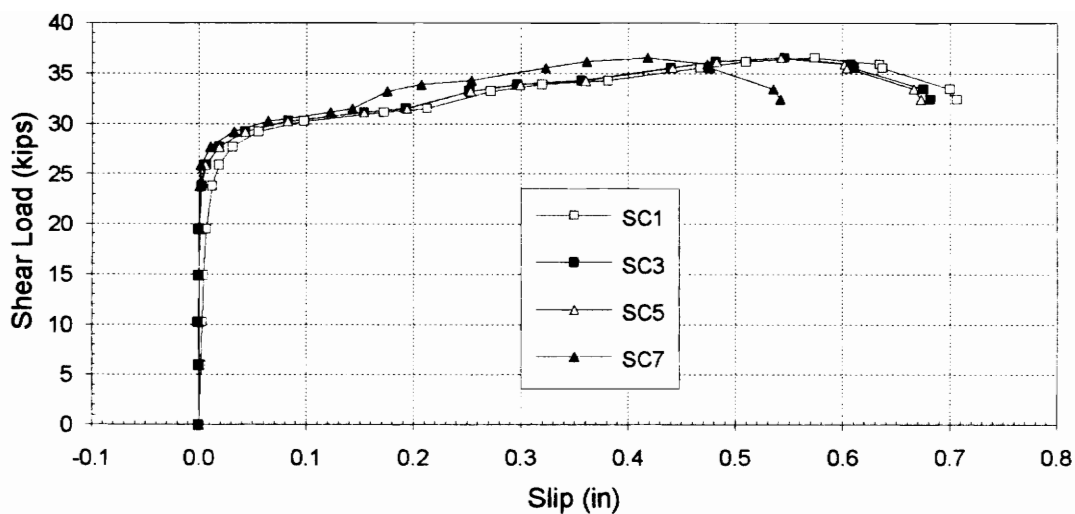
Peak Shear Load:	<u>36.60 kips</u>	
Peak Shear Load Per Fastener:	<u>4.58 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.574 in.</u>	SC2: <u>0.719 in.</u>
	SC3: <u>0.546 in.</u>	SC4: <u>0.610 in.</u>
	SC5: <u>0.542 in.</u>	SC6: <u>0.646 in.</u>
	SC7: <u>0.418 in.</u>	SC8: <u>0.527 in.</u>

DAMAGE

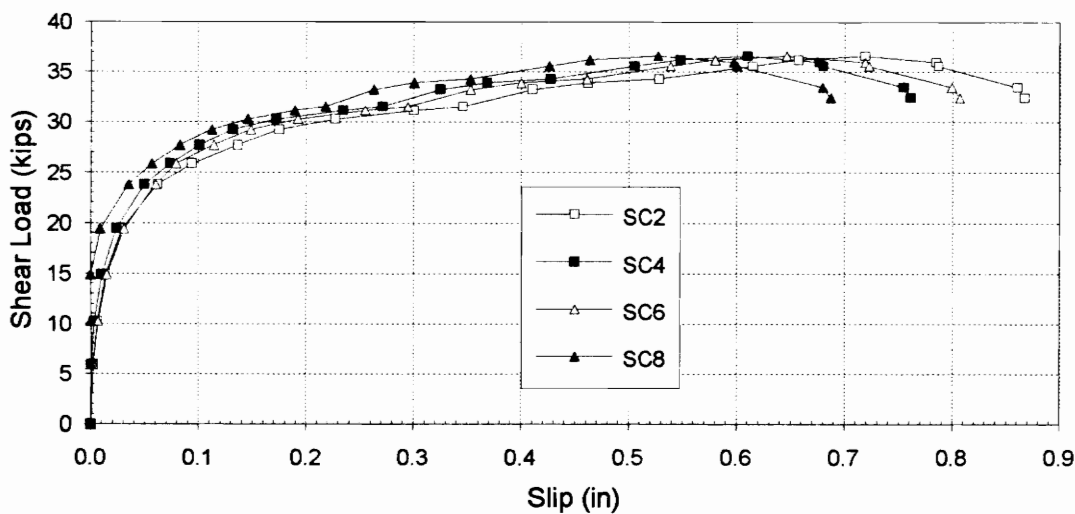


COMMENTS

Bulges in deck below screw at all locations
Concrete rib failure at SC2, SC4, SC6, SC7, SC8
Screw rotation $\approx 5^\circ$



(a) Test 4-3-1 - Load vs. North Slip



(b) Test 4-3-1 - Load vs. South Slip

Fig. A.51 Test 4-3-1 Load vs. Slip Plots

Table A.51 Test 4-3-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.95	-0.58	0.002	0.002	0.000	0.001	0.000	0.002	0.000	0.000
-10.22	-1.04	0.003	0.006	-0.001	0.004	0.000	0.007	0.000	0.000
-14.87	-1.49	0.004	0.014	0.000	0.010	0.000	0.015	0.000	0.000
-19.40	-1.95	0.007	0.029	0.000	0.024	0.001	0.031	0.000	0.009
-23.80	-2.37	0.012	0.062	0.002	0.050	0.001	0.061	0.001	0.036
-25.87	-2.59	0.018	0.094	0.007	0.074	0.006	0.079	0.002	0.057
-27.68	-2.77	0.031	0.136	0.019	0.101	0.019	0.114	0.011	0.083
-29.23	-2.92	0.056	0.175	0.043	0.132	0.043	0.149	0.032	0.113
-30.26	-3.03	0.098	0.228	0.083	0.172	0.083	0.192	0.064	0.146
-31.17	-3.12	0.172	0.300	0.154	0.234	0.154	0.255	0.122	0.189
-31.56	-3.17	0.212	0.346	0.193	0.271	0.194	0.295	0.143	0.218
-33.24	-3.32	0.272	0.410	0.252	0.325	0.253	0.353	0.176	0.263
-33.89	-3.38	0.320	0.462	0.297	0.369	0.300	0.400	0.207	0.301
-34.27	-3.42	0.381	0.528	0.357	0.427	0.360	0.461	0.254	0.353
-35.57	-3.56	0.467	0.615	0.440	0.506	0.442	0.539	0.323	0.426
-36.21	-3.63	0.510	0.658	0.482	0.548	0.483	0.580	0.361	0.464
-36.60	-3.66	0.574	0.719	0.546	0.610	0.542	0.646	0.418	0.527
-35.95	-3.60	0.634	0.785	0.608	0.677	0.602	0.719	0.474	0.597
-35.57	-3.55	0.637	0.787	0.610	0.680	0.604	0.723	0.476	0.600
-33.50	-3.36	0.700	0.861	0.675	0.755	0.666	0.800	0.535	0.680
-32.46	-3.32	0.707	0.867	0.682	0.761	0.673	0.807	0.542	0.687

PUSHOUT TEST SUMMARY SHEET

Test: 4-3-2
Test Designation: SC-8-2-0.245-1.5VL-4-2

Test Date: 04 FEB 93

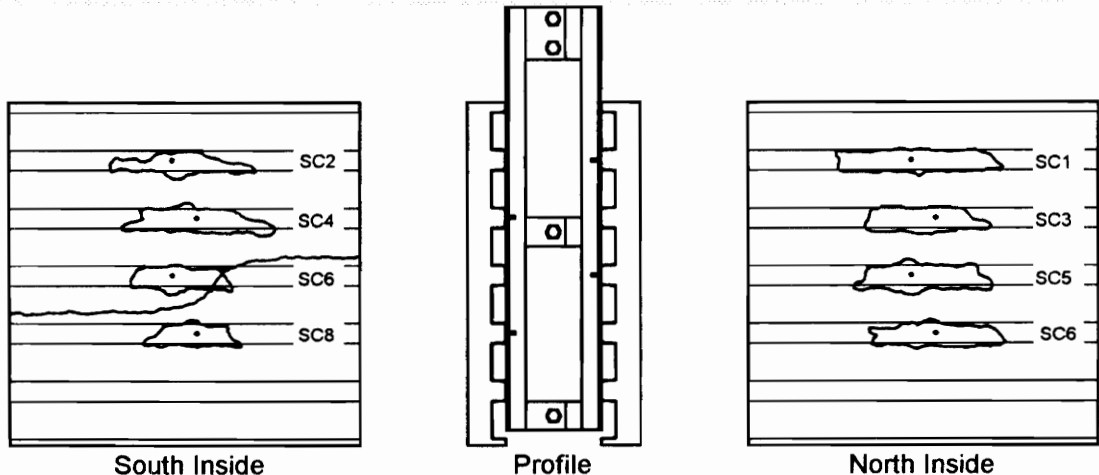
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 2.00x2.00x0.245</u>
	F_y : <u>57.7 ksi</u> F_u : <u>83.6 ksi</u>
Slab:	Thickness: <u>4 in.</u> f'_c : <u>5290 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

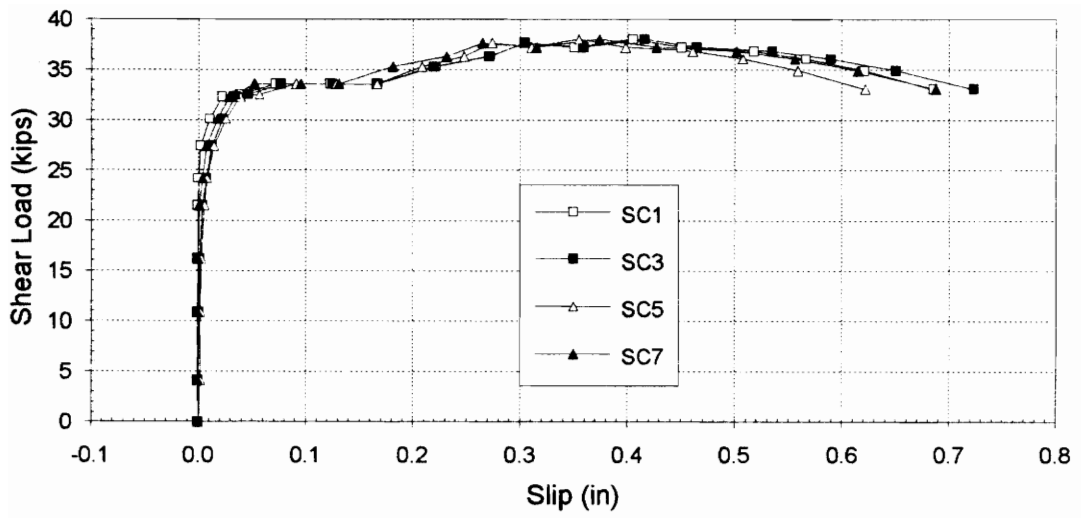
Peak Shear Load:	<u>38.02 kips</u>	
Peak Shear Load Per Fastener:	<u>4.75 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.405 in.</u>	SC2: <u>0.547 in.</u>
	SC3: <u>0.416 in.</u>	SC4: <u>0.448 in.</u>
	SC5: <u>0.355 in.</u>	SC6: <u>0.425 in.</u>
	SC7: <u>0.374 in.</u>	SC8: <u>0.375 in.</u>

DAMAGE

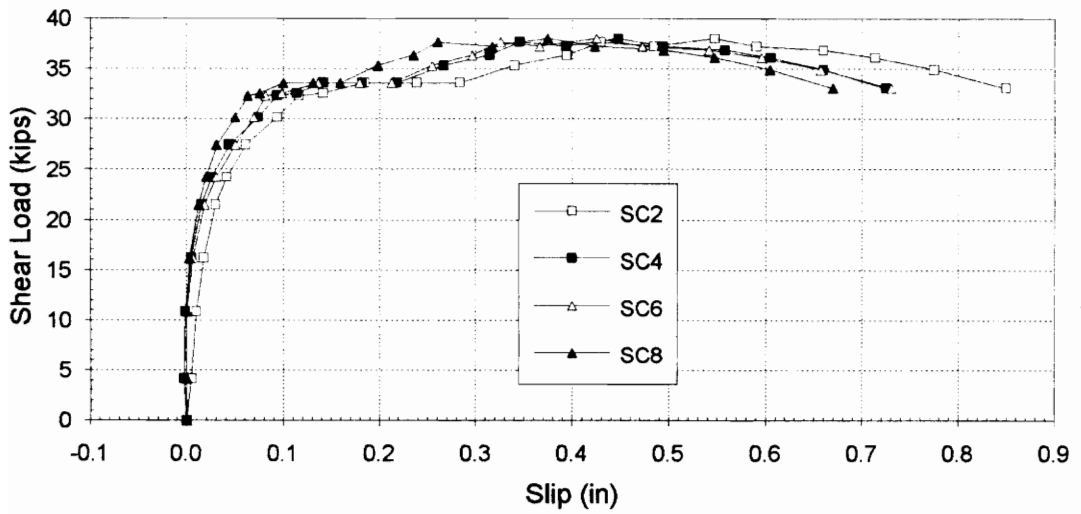


COMMENTS

Bulges in deck below screw at all locations
Concrete rib failure at all screw locations
Crack running parallel to deck span on south slab; Screw rotation $\approx 5^\circ$



(a) Test 4-3-2 - Load vs. North Slip



(b) Test 4-3-2 - Load vs. South Slip

Fig. A.52 Test 4-3-2 Load vs. Slip Plots

Table A.52 Test 4-3-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.14	-0.41	-0.001	0.005	0.000	-0.003	0.002	0.000	-0.001	0.000
-10.86	-1.09	-0.001	0.010	0.001	-0.001	0.002	0.000	-0.001	0.000
-16.17	-1.62	-0.001	0.018	0.001	0.005	0.002	0.007	-0.001	0.003
-21.47	-2.14	-0.001	0.030	0.004	0.015	0.006	0.019	0.001	0.013
-24.19	-2.40	0.000	0.042	0.007	0.026	0.008	0.031	0.004	0.020
-27.42	-2.74	0.002	0.061	0.012	0.044	0.014	0.050	0.007	0.031
-30.13	-3.03	0.010	0.094	0.023	0.074	0.026	0.070	0.018	0.050
-32.33	-3.24	0.022	0.116	0.034	0.093	0.039	0.081	0.029	0.063
-32.59	-3.26	0.039	0.141	0.046	0.114	0.056	0.098	0.034	0.075
-33.63	-3.37	0.072	0.184	0.077	0.142	0.091	0.136	0.052	0.100
-33.63	-3.35	0.122	0.239	0.125	0.182	0.128	0.180	0.095	0.131
-33.63	-3.37	0.167	0.284	0.166	0.218	0.166	0.213	0.131	0.159
-35.31	-3.53	0.221	0.340	0.219	0.267	0.209	0.254	0.181	0.198
-36.34	-3.63	0.272	0.395	0.271	0.314	0.248	0.297	0.232	0.235
-37.64	-3.76	0.304	0.429	0.305	0.346	0.274	0.326	0.265	0.260
-37.25	-3.71	0.351	0.485	0.359	0.394	0.311	0.366	0.315	0.317
-38.02	-3.80	0.405	0.547	0.416	0.448	0.355	0.425	0.374	0.375
-37.25	-3.71	0.451	0.590	0.465	0.494	0.399	0.473	0.427	0.423
-36.86	-3.70	0.517	0.660	0.535	0.558	0.461	0.542	0.502	0.495
-36.08	-3.62	0.566	0.713	0.590	0.605	0.508	0.595	0.556	0.548
-34.92	-3.50	0.620	0.775	0.650	0.660	0.559	0.657	0.615	0.604
-33.11	-3.32	0.685	0.850	0.723	0.725	0.622	0.730	0.688	0.670

PUSHOUT TEST SUMMARY SHEET

Test: 4-3-3
 Test Designation: SC-8-2-0.239-1.5VL-4-3

Test Date: 04 FEB 93

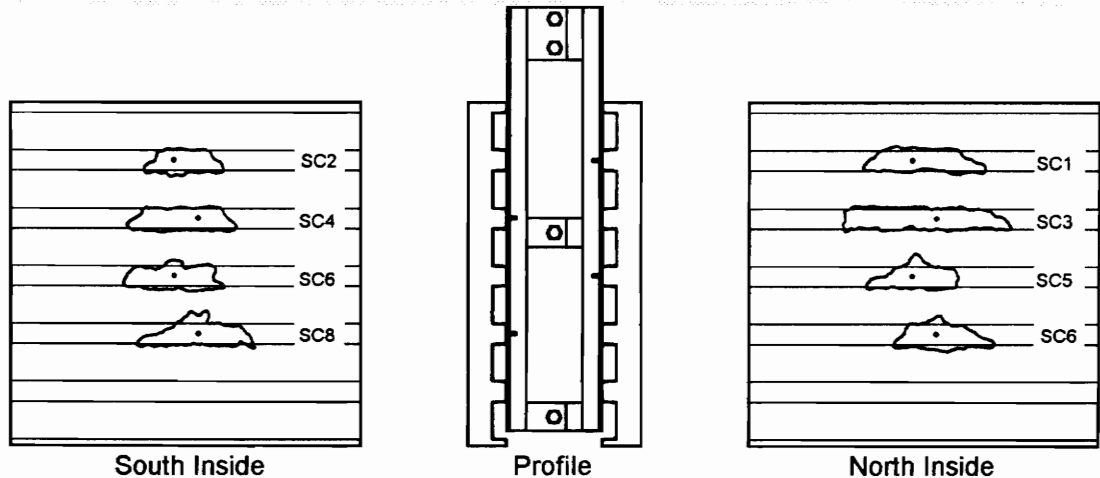
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.5VL, 22 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u>	F_u : <u>53.4 ksi</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.239</u>		
	F_y : <u>57.7 ksi</u>	F_u : <u>83.6 ksi</u>	
Slab:	Thickness: <u>4 in.</u>		
	f'_c : <u>5290 psi</u>		
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

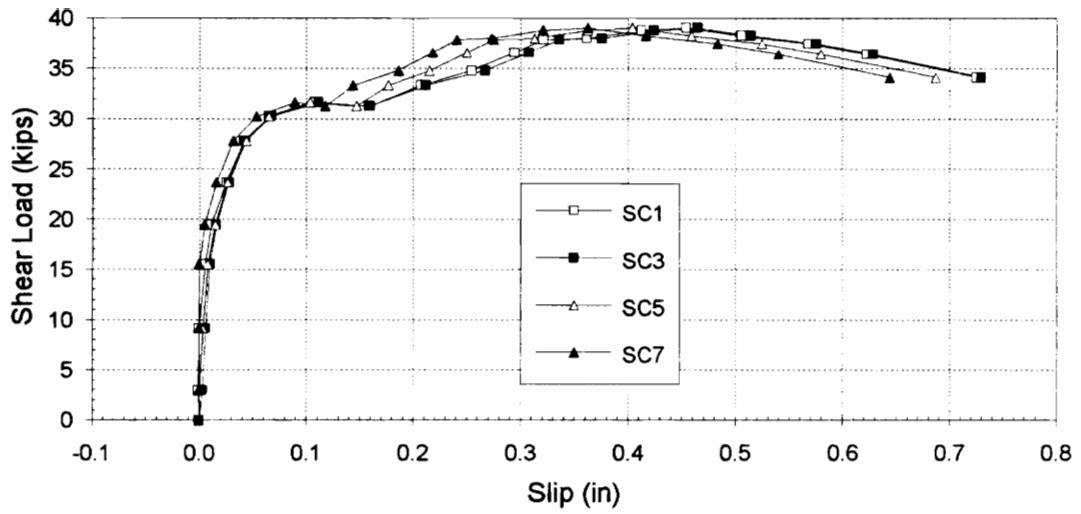
Peak Shear Load: <u>39.06 kips</u>	
Peak Shear Load Per Fastener: <u>4.88 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.454 in.</u> SC3: <u>0.465 in.</u> SC5: <u>0.404 in.</u> SC7: <u>0.363 in.</u> SC2: <u>0.521 in.</u> SC4: <u>0.499 in.</u> SC6: <u>0.478 in.</u> SC8: <u>0.393 in.</u>

DAMAGE

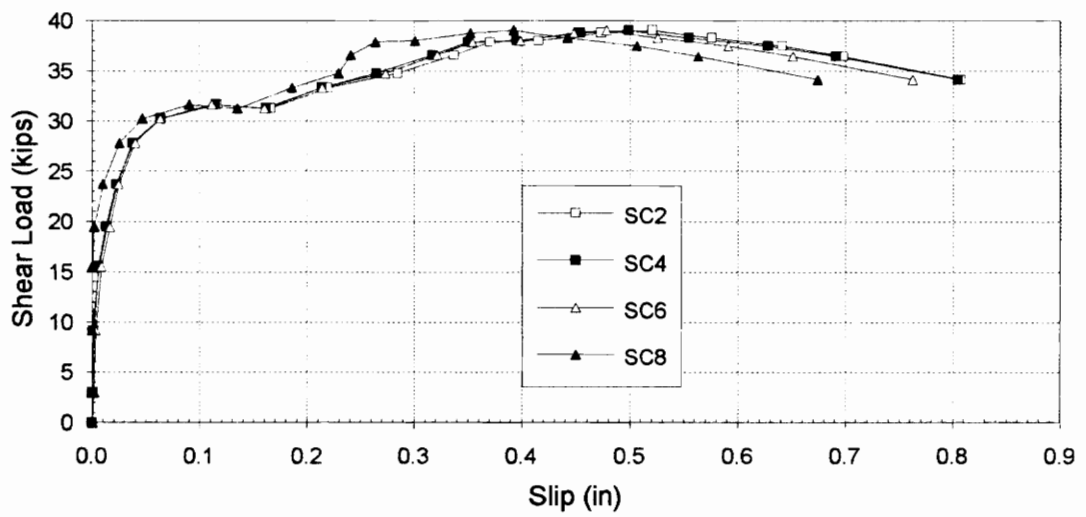


COMMENTS

Bulges in deck below screw at all locations
 Concrete rib failure at all screw locations
 Screw rotation $\approx 5^\circ$



(a) Test 4-3-3 - Load vs. North Slip



(b) Test 4-3-3 - Load vs. South Slip

Fig. A.53 Test 4-3-3 Load vs. Slip Plots

Table A.53 Test 4-3-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-2.97	-0.31	-0.001	0.001	0.003	0.000	0.000	0.002	0.000	0.000
-9.18	-0.92	0.000	0.001	0.006	0.001	0.004	0.003	0.000	0.000
-15.52	-1.55	0.006	0.006	0.010	0.006	0.008	0.009	0.000	0.000
-19.40	-1.94	0.011	0.013	0.016	0.014	0.015	0.017	0.005	0.002
-23.67	-2.38	0.025	0.023	0.028	0.023	0.026	0.025	0.016	0.010
-27.81	-2.78	0.042	0.039	0.043	0.038	0.043	0.040	0.032	0.026
-30.26	-3.03	0.065	0.064	0.067	0.064	0.065	0.064	0.053	0.047
-31.69	-3.17	0.109	0.116	0.111	0.115	0.103	0.111	0.089	0.091
-31.30	-3.14	0.159	0.166	0.160	0.162	0.147	0.160	0.118	0.135
-33.37	-3.32	0.207	0.220	0.212	0.214	0.177	0.214	0.144	0.186
-34.79	-3.48	0.254	0.285	0.267	0.265	0.215	0.273	0.186	0.230
-36.60	-3.67	0.294	0.337	0.308	0.317	0.250	0.322	0.218	0.241
-37.89	-3.79	0.321	0.371	0.336	0.350	0.275	0.354	0.241	0.264
-38.02	-3.81	0.362	0.415	0.375	0.395	0.313	0.399	0.273	0.301
-38.80	-3.87	0.412	0.473	0.424	0.454	0.363	0.448	0.321	0.352
-39.06	-3.91	0.454	0.521	0.465	0.499	0.404	0.478	0.363	0.393
-38.28	-3.83	0.505	0.576	0.514	0.555	0.459	0.526	0.416	0.442
-37.51	-3.75	0.568	0.641	0.575	0.628	0.524	0.591	0.483	0.506
-36.47	-3.67	0.622	0.698	0.628	0.691	0.580	0.651	0.540	0.563
-34.14	-3.42	0.725	0.807	0.730	0.805	0.687	0.762	0.644	0.674

PUSHOUT TEST SUMMARY SHEET

Test: 4-4-1
Test Designation: SC-8-2-0.252-1.5VL-3.5-1

Test Date: 04 FEB 93

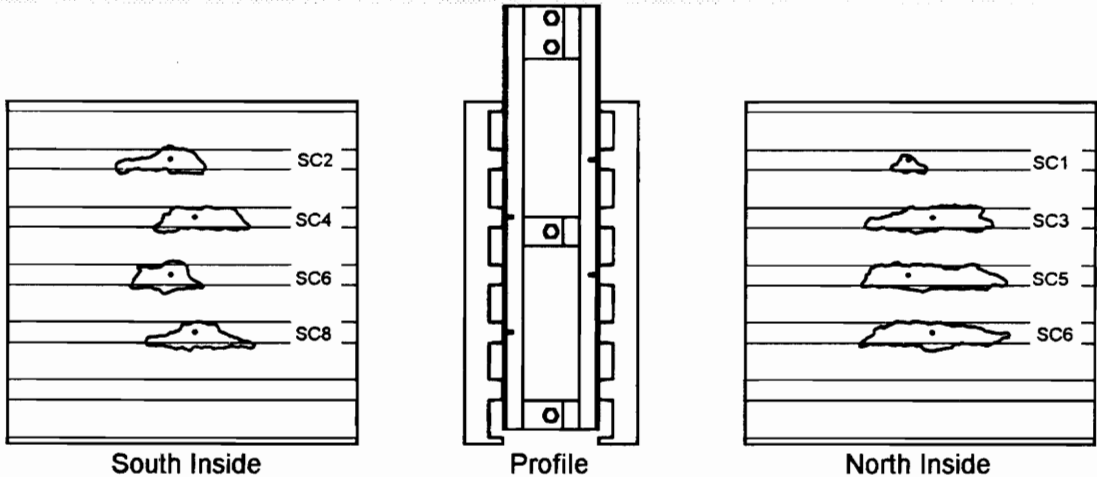
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 2.00x2.00x0.252</u>
	F_y : <u>53.1 ksi</u> F_u : <u>80.1 ksi</u>
Slab:	Thickness: <u>3.5 in.</u> f'_c : <u>4810 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

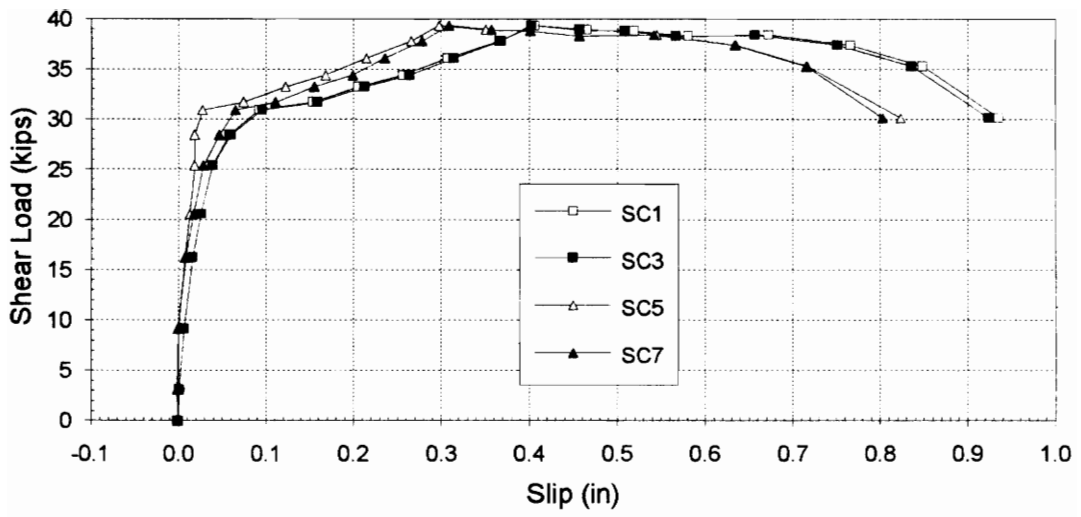
Peak Shear Load:	<u>39.32 kips</u>	
Peak Shear Load Per Fastener:	<u>4.92 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.406 in.</u>	SC2: <u>0.354 in.</u>
	SC3: <u>0.402 in.</u>	SC4: <u>0.351 in.</u>
	SC5: <u>0.298 in.</u>	SC6: <u>0.371 in.</u>
	SC7: <u>0.309 in.</u>	SC8: <u>0.330 in.</u>

DAMAGE

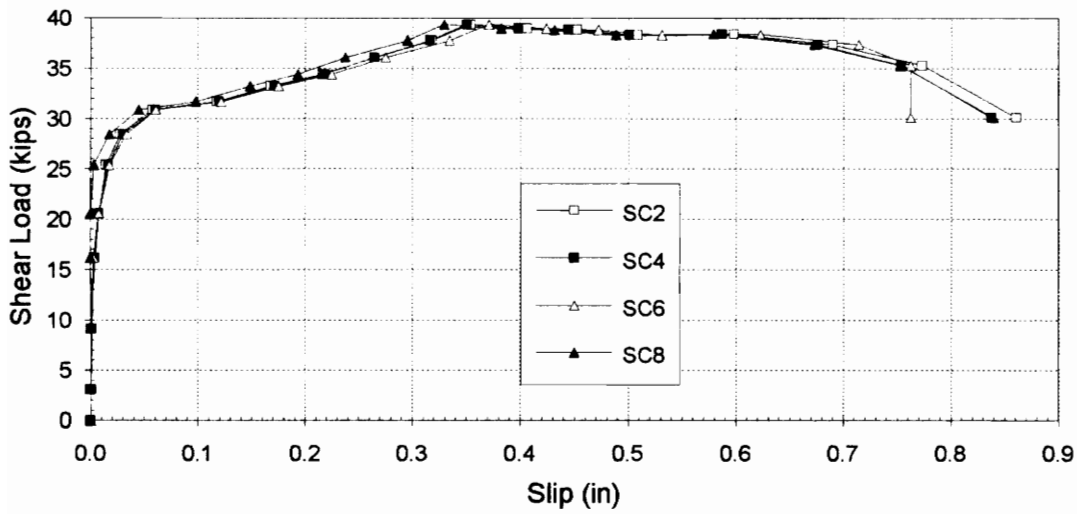


COMMENTS

Bulges in deck below screw at all locations
Concrete rib failure at SC2, SC3, SC4, SC5, SC6, SC7, SC8
Screw rotation $\approx 5^\circ$



(a) Test 4-4-1 - Load vs. North Slip



(b) Test 4-4-1 - Load vs. South Slip

Fig. A.54 Test 4-4-1 Load vs. Slip Plots

Table A.54 Test 4-4-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.00	0.01	-0.001	0.000	0.000	0.000	0.000	0.000	-0.001	0.000
-3.10	-0.31	0.001	0.000	0.001	0.001	0.000	0.000	-0.001	0.000
-9.18	-0.91	0.007	0.001	0.007	0.001	0.000	0.000	0.000	0.000
-16.17	-1.62	0.017	0.004	0.017	0.003	0.007	0.003	0.009	0.000
-20.56	-2.06	0.026	0.008	0.025	0.007	0.013	0.008	0.017	0.000
-25.35	-2.53	0.039	0.015	0.039	0.016	0.018	0.018	0.028	0.004
-28.45	-2.85	0.058	0.028	0.060	0.031	0.018	0.034	0.047	0.018
-30.91	-3.09	0.092	0.057	0.095	0.060	0.028	0.061	0.065	0.045
-31.69	-3.17	0.154	0.117	0.159	0.120	0.074	0.122	0.111	0.098
-33.24	-3.32	0.206	0.168	0.213	0.171	0.122	0.175	0.155	0.148
-34.40	-3.46	0.256	0.217	0.264	0.218	0.168	0.225	0.199	0.193
-36.08	-3.61	0.307	0.265	0.314	0.264	0.215	0.275	0.236	0.238
-37.77	-3.79	0.366	0.318	0.368	0.316	0.265	0.334	0.278	0.295
-39.32	-3.93	0.406	0.354	0.402	0.351	0.298	0.371	0.309	0.330
-38.93	-3.89	0.465	0.406	0.457	0.398	0.350	0.424	0.357	0.382
-38.80	-3.88	0.519	0.453	0.508	0.444	0.401	0.472	0.402	0.431
-38.28	-3.84	0.581	0.508	0.567	0.501	0.457	0.531	0.457	0.488
-38.41	-3.84	0.672	0.598	0.657	0.587	0.545	0.622	0.542	0.579
-37.38	-3.72	0.766	0.690	0.751	0.676	0.635	0.714	0.633	0.673
-35.31	-3.52	0.848	0.773	0.836	0.754	0.717	0.762	0.715	0.753
-30.13	-3.00	0.935	0.861	0.924	0.838	0.823	0.762	0.803	0.840

PUSHOUT TEST SUMMARY SHEET

Test: 4-4-2
Test Designation: SC-8-2-0.252-1.5VL-3.5-2

Test Date: 04 FEB 93

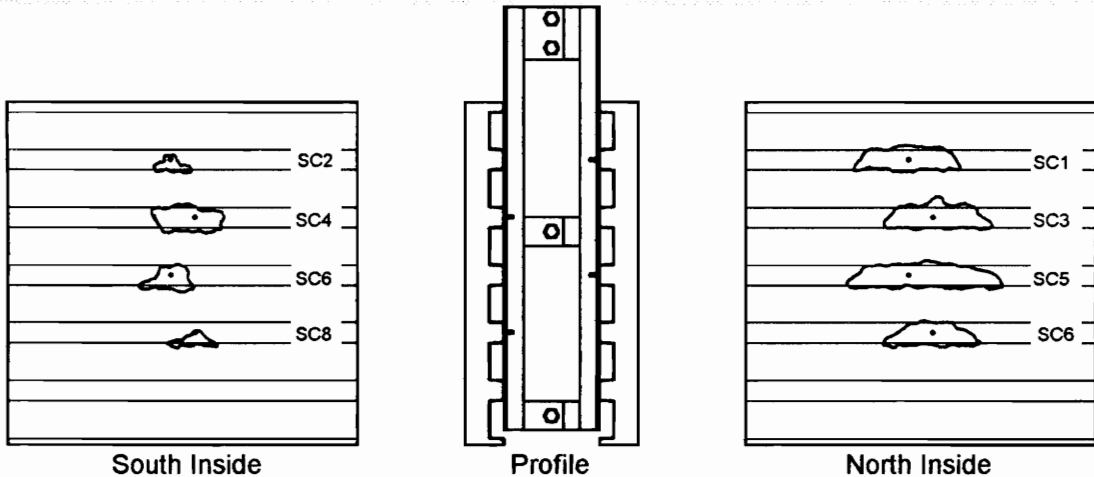
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 2.00x2.00x0.252</u>
	F_y : <u>53.1 ksi</u> F_u : <u>80.1 ksi</u>
Slab:	Thickness: <u>3.5 in.</u> f'_c : <u>4810 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

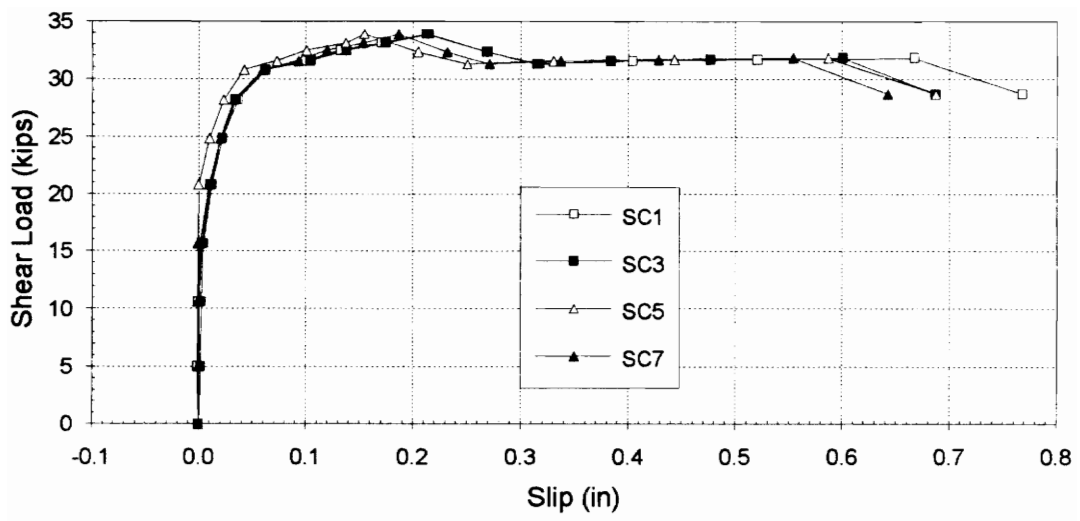
Peak Shear Load:	<u>33.89 kips</u>	
Peak Shear Load Per Fastener:	<u>4.24 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.212 in.</u>	SC2: <u>0.231 in.</u>
	SC3: <u>0.215 in.</u>	SC4: <u>0.294 in.</u>
	SC5: <u>0.155 in.</u>	SC6: <u>0.245 in.</u>
	SC7: <u>0.187 in.</u>	SC8: <u>0.222 in.</u>

DAMAGE

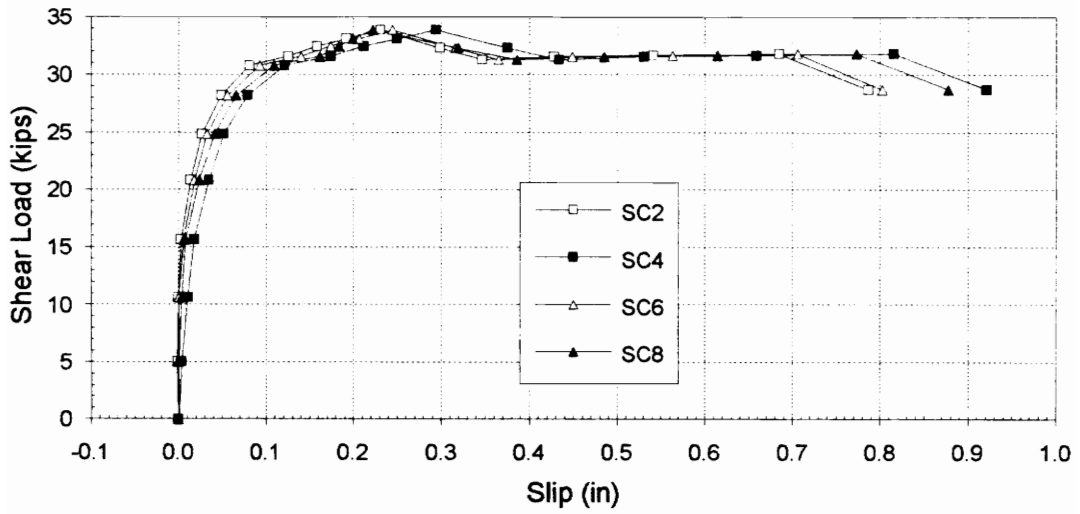


COMMENTS

Bulges in deck below screw at all locations
Concrete rib failure at SC1, SC3, SC5, SC7; SC8 sheared off
Screw rotation $\approx 5^\circ$



(a) Test 4-4-2 - Load vs. North Slip



(b) Test 4-4-2 - Load vs. South Slip

Fig. A.55 Test 4-4-2 Load vs. Slip Plots

Table A.55 Test 4-4-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.04	-0.50	-0.001	-0.001	0.002	0.004	0.000	-0.001	0.000	0.000
-10.61	-1.05	0.000	0.000	0.002	0.011	-0.001	0.001	0.000	0.004
-15.65	-1.56	0.003	0.003	0.004	0.018	-0.001	0.006	0.001	0.009
-20.82	-2.09	0.011	0.014	0.012	0.035	0.000	0.018	0.010	0.024
-24.83	-2.48	0.022	0.027	0.022	0.052	0.010	0.033	0.020	0.042
-28.19	-2.81	0.037	0.049	0.034	0.079	0.023	0.056	0.033	0.066
-30.78	-3.08	0.062	0.081	0.062	0.122	0.042	0.093	0.059	0.109
-31.56	-3.16	0.100	0.125	0.105	0.174	0.073	0.140	0.093	0.162
-32.46	-3.25	0.133	0.158	0.138	0.212	0.101	0.174	0.120	0.184
-33.11	-3.32	0.171	0.192	0.175	0.250	0.138	0.207	0.154	0.199
-33.89	-3.38	0.212	0.231	0.215	0.294	0.155	0.245	0.187	0.222
-32.33	-3.25	0.269	0.298	0.270	0.376	0.205	0.316	0.232	0.319
-31.30	-3.12	0.317	0.347	0.315	0.434	0.251	0.365	0.271	0.386
-31.56	-3.16	0.404	0.428	0.384	0.530	0.331	0.449	0.337	0.485
-31.69	-3.18	0.521	0.541	0.477	0.659	0.443	0.563	0.429	0.614
-31.82	-3.19	0.667	0.684	0.601	0.816	0.587	0.705	0.554	0.773
-28.71	-2.83	0.768	0.787	0.687	0.922	0.687	0.802	0.642	0.878

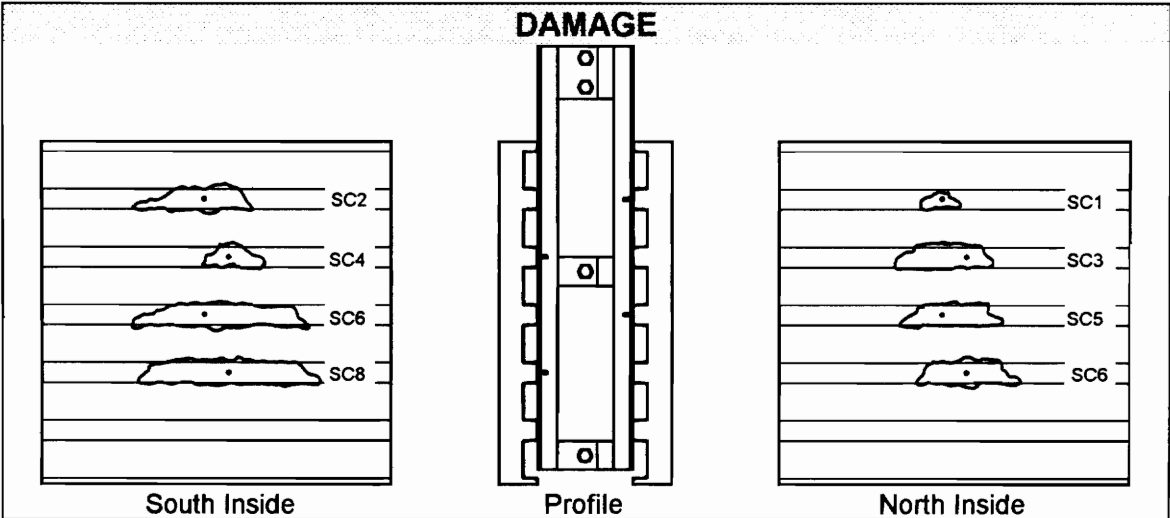
PUSHOUT TEST SUMMARY SHEET

Test: 4-4-3
Test Designation: SC-8-2-0.252-1.5VL-3.5-3

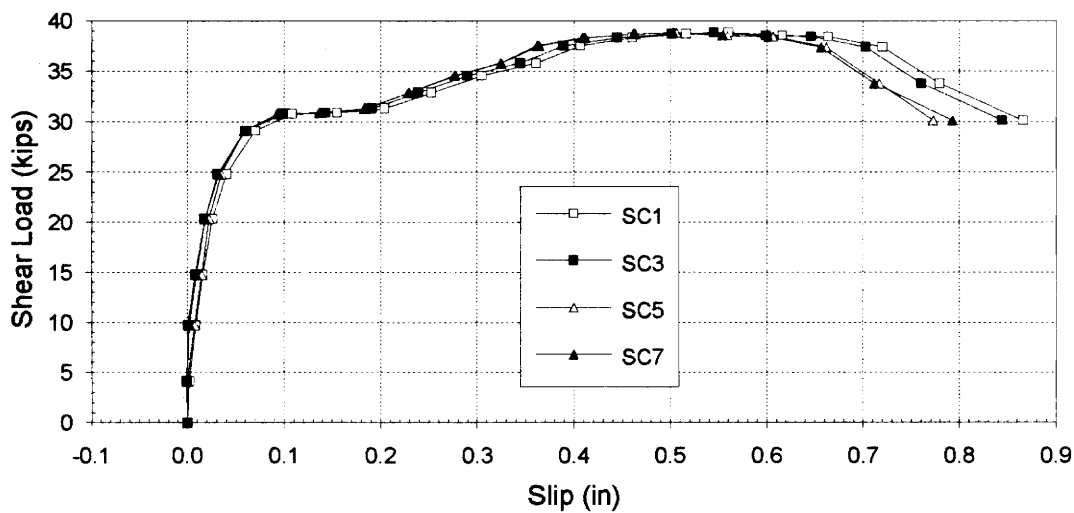
Test Date: 05 FEB 93

SPECIMEN DESCRIPTION			
Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.5VL, 22 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u>	F_u : <u>53.4 ksi</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.252</u>		
	F_y : <u>53.1 ksi</u>	F_u : <u>80.1 ksi</u>	
Slab:	Thickness: <u>3.5 in.</u>	f'_c : <u>4810 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

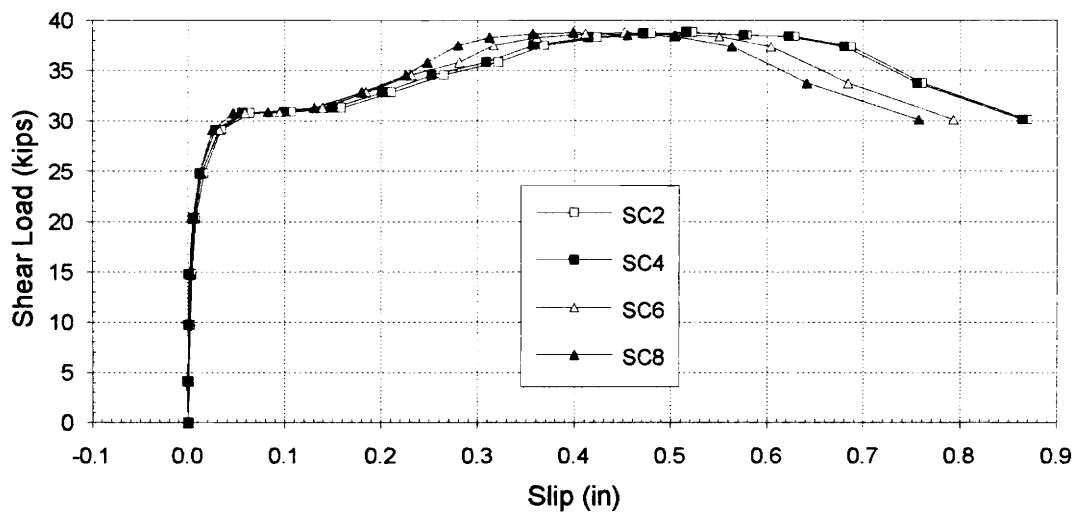
TEST RESULTS			
Peak Shear Load:	<u>38.80 kips</u>		
Peak Shear Load Per Fastener:	<u>4.85 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.560 in.</u>	SC2: <u>0.523 in.</u>	
	SC3: <u>0.545 in.</u>	SC4: <u>0.516 in.</u>	
	SC5: <u>0.506 in.</u>	SC6: <u>0.452 in.</u>	
	SC7: <u>0.502 in.</u>	SC8: <u>0.399 in.</u>	



COMMENTS
Bulges in deck below screw at all locations
Concrete rib failure at SC2, SC3, SC4, SC5, SC6, SC7, SC8; SC6 sheared off
Screw rotation $\approx 5^\circ$



(a) Test 4-4-3 - Load vs. North Slip



(b) Test 4-4-3 - Load vs. South Slip

Fig. A.56 Test 4-4-3 Load vs. Slip Plots

Table A.56 Test 4-4-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.14	-0.45	0.002	-0.001	-0.001	0.000	0.000	0.000	-0.001	0.001
-9.70	-0.99	0.009	0.002	0.001	0.000	0.007	0.002	0.002	0.001
-14.74	-1.48	0.016	0.004	0.008	0.001	0.015	0.003	0.009	0.003
-20.31	-2.03	0.026	0.008	0.018	0.006	0.022	0.007	0.018	0.005
-24.83	-2.44	0.040	0.017	0.031	0.012	0.035	0.014	0.032	0.012
-29.10	-2.99	0.070	0.034	0.060	0.028	0.059	0.032	0.059	0.025
-30.78	-3.08	0.108	0.064	0.098	0.057	0.093	0.059	0.094	0.047
-30.91	-3.12	0.155	0.107	0.143	0.100	0.138	0.095	0.137	0.083
-31.30	-3.16	0.204	0.159	0.191	0.150	0.184	0.139	0.184	0.131
-32.85	-3.33	0.253	0.211	0.239	0.202	0.229	0.185	0.229	0.180
-34.53	-3.44	0.305	0.265	0.290	0.252	0.277	0.231	0.276	0.226
-35.83	-3.59	0.361	0.322	0.344	0.309	0.325	0.281	0.325	0.248
-37.51	-3.77	0.406	0.369	0.389	0.358	0.362	0.317	0.364	0.279
-38.28	-3.84	0.460	0.423	0.445	0.414	0.409	0.361	0.411	0.312
-38.67	-3.88	0.517	0.480	0.502	0.472	0.463	0.411	0.462	0.357
-38.80	-3.91	0.560	0.523	0.545	0.516	0.506	0.452	0.502	0.399
-38.54	-3.89	0.616	0.579	0.599	0.576	0.559	0.505	0.554	0.455
-38.41	-3.88	0.664	0.629	0.647	0.623	0.606	0.550	0.602	0.504
-37.38	-3.87	0.720	0.687	0.703	0.680	0.662	0.604	0.657	0.564
-33.76	-3.37	0.779	0.761	0.760	0.755	0.717	0.684	0.712	0.642
-30.13	-3.08	0.866	0.869	0.845	0.865	0.773	0.793	0.793	0.757

PUSHOUT TEST SUMMARY SHEET

Test: 5-1-1
 Test Designation: SC-8-2.5-0.109-1.5VL-3.5-1

Test Date: 19 MAR 93

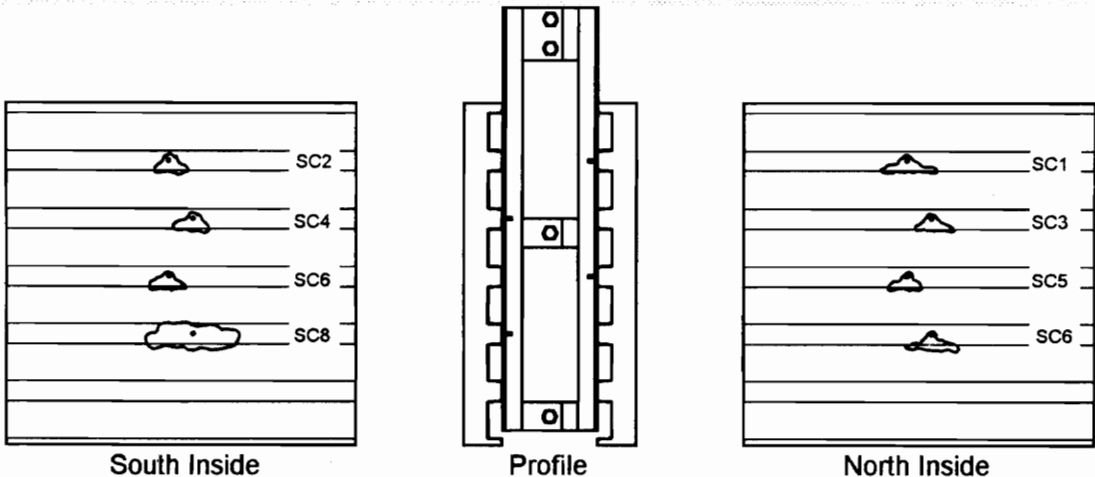
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.5VL, 22 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u>	F_u : <u>53.4 ksi</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>		
	F_y : <u>57.3 ksi</u>	F_u : <u>82.2 ksi</u>	
Slab:	Thickness: <u>3.5 in.</u> f'_c : <u>4420 psi</u>		
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

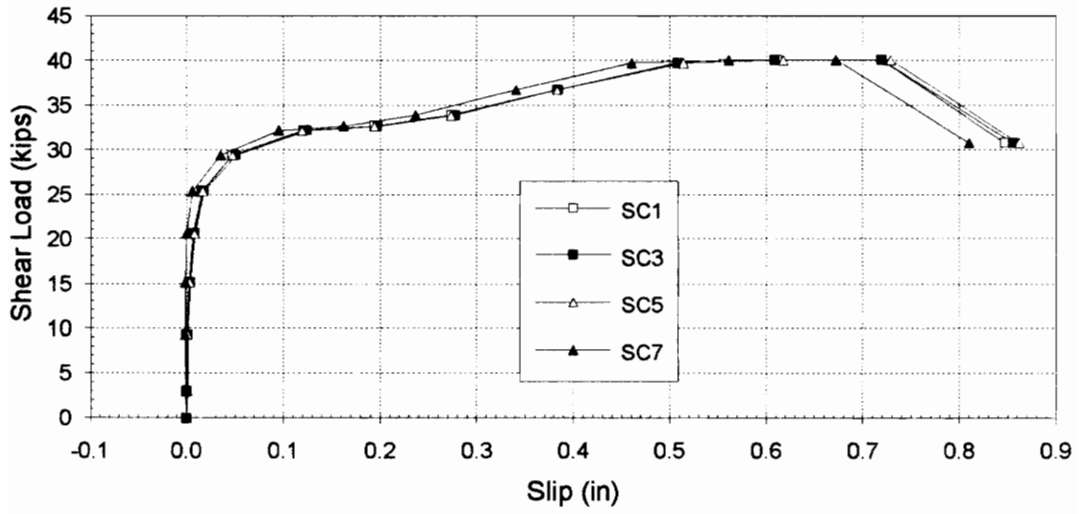
Peak Shear Load: <u>40.09 kips</u>		
Peak Shear Load Per Fastener: <u>5.01 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.719 in.</u>	SC2: <u>0.794 in.</u>
	SC3: <u>0.719 in.</u>	SC4: <u>0.786 in.</u>
	SC5: <u>0.728 in.</u>	SC6: <u>0.778 in.</u>
	SC7: <u>0.673 in.</u>	SC8: <u>0.659 in.</u>

DAMAGE

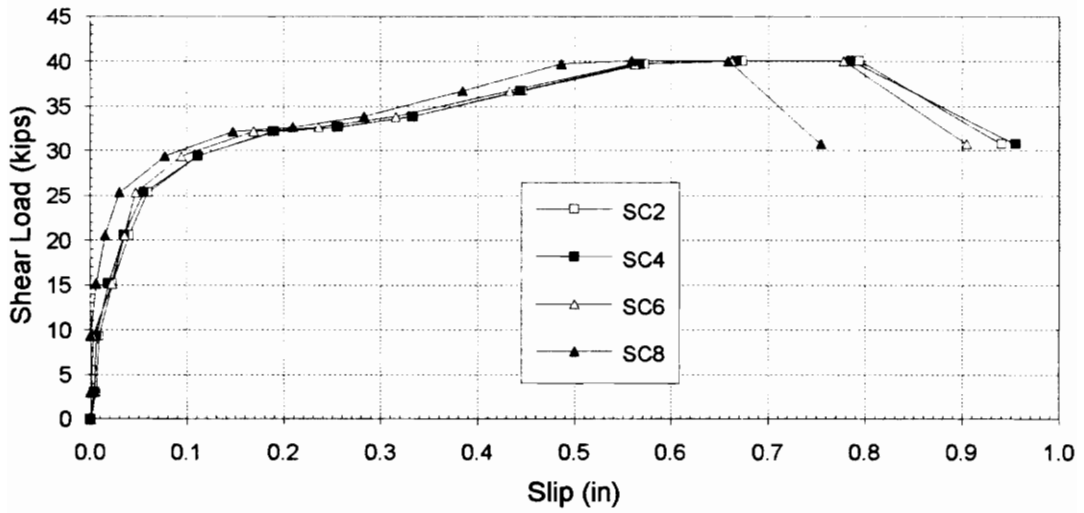


COMMENTS

Bulges in deck below screw at all locations
 Angle deformed at all locations; SC1 and SC3 pulling out of angle
 Screw rotation $\geq 45^\circ$



(a) Test 5-1-1 - Load vs. North Slip



(b) Test 5-1-1 - Load vs. South Slip

Fig. A.57 Test 5-1-1 Load vs. Slip Plots

Table A.57 Test 5-1-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-2.97	-0.31	0.000	0.006	0.000	0.004	0.001	0.001	-0.001	0.000
-9.31	-0.93	0.000	0.009	0.001	0.007	0.001	0.003	-0.001	0.000
-15.13	-1.50	0.002	0.023	0.004	0.019	0.003	0.023	-0.001	0.006
-20.56	-2.07	0.007	0.040	0.009	0.035	0.008	0.036	0.000	0.016
-25.35	-2.54	0.016	0.060	0.018	0.056	0.017	0.047	0.006	0.031
-29.36	-2.94	0.047	0.111	0.051	0.112	0.047	0.095	0.035	0.078
-32.20	-3.22	0.121	0.189	0.124	0.191	0.119	0.169	0.095	0.148
-32.72	-3.29	0.194	0.255	0.198	0.257	0.194	0.236	0.162	0.210
-33.89	-3.39	0.273	0.333	0.278	0.334	0.273	0.316	0.237	0.283
-36.73	-3.67	0.384	0.446	0.384	0.444	0.383	0.433	0.341	0.385
-39.71	-3.97	0.510	0.572	0.508	0.567	0.514	0.562	0.460	0.486
-40.09	-4.01	0.611	0.673	0.609	0.667	0.618	0.663	0.561	0.559
-40.09	-4.02	0.719	0.794	0.719	0.786	0.728	0.778	0.673	0.659
-30.78	-3.09	0.847	0.941	0.856	0.955	0.862	0.904	0.810	0.755

PUSHOUT TEST SUMMARY SHEET

Test: 5-1-2
Test Designation: SC-8-2.5-0.109-1.5VL-3.5-2

Test Date: 19 MAR 93

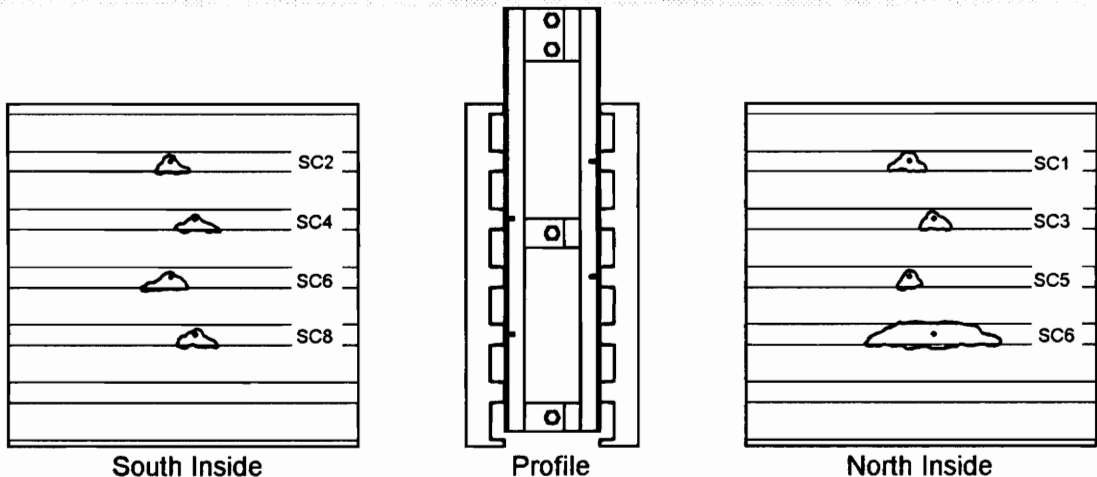
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2.5 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>
	F_y : <u>57.3 ksi</u> F_u : <u>82.2 ksi</u>
Slab:	Thickness: <u>3.5 in.</u> f'_c : <u>4420 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

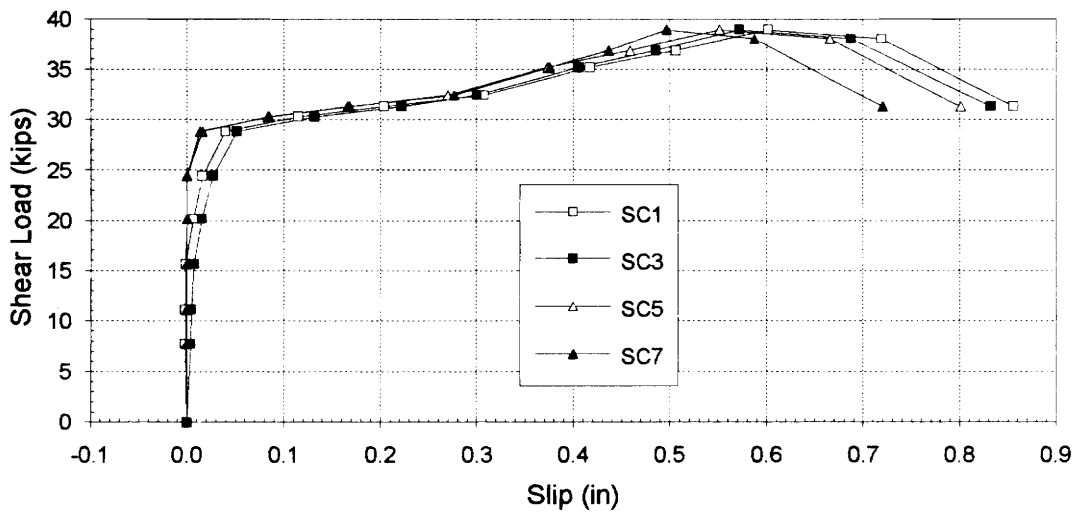
Peak Shear Load:	<u>38.93 kips</u>	
Peak Shear Load Per Fastener:	<u>4.87 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.602 in.</u>	SC2: <u>0.652 in.</u>
	SC3: <u>0.572 in.</u>	SC4: <u>0.668 in.</u>
	SC5: <u>0.551 in.</u>	SC6: <u>0.651 in.</u>
	SC7: <u>0.497 in.</u>	SC8: <u>0.603 in.</u>

DAMAGE

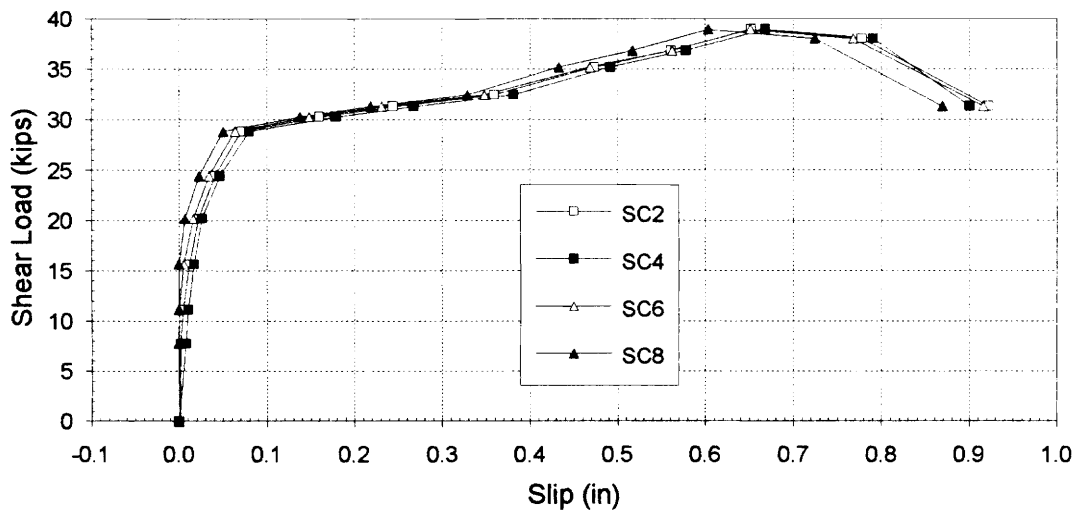


COMMENTS

Bulges in deck below screw at all locations
Angle deformed at all locations; SC1 and SC3 pulling out of angle
Concrete rib failure at SC7; Screw rotation $\geq 45^\circ$



(a) Test 5-1-2 - Load vs. North Slip



(b) Test 5-1-2 - Load vs. South Slip

Fig. A.58 Test 5-1-2 Load vs. Slip Plots

Table A.58 Test 5-1-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-7.76	-0.78	-0.002	0.002	0.004	0.008	-0.001	-0.001	-0.001	-0.001
-11.12	-1.12	-0.002	0.005	0.004	0.010	-0.001	0.001	0.000	0.000
-15.65	-1.56	-0.001	0.012	0.007	0.017	-0.001	0.006	-0.001	0.000
-20.18	-2.02	0.007	0.023	0.015	0.026	0.000	0.017	0.000	0.007
-24.44	-2.44	0.016	0.041	0.027	0.046	0.000	0.034	0.000	0.023
-28.84	-2.88	0.039	0.072	0.051	0.080	0.013	0.064	0.016	0.051
-30.26	-3.03	0.115	0.160	0.132	0.179	0.085	0.148	0.084	0.138
-31.30	-3.13	0.204	0.244	0.222	0.268	0.168	0.231	0.167	0.219
-32.46	-3.25	0.308	0.359	0.300	0.381	0.270	0.348	0.277	0.328
-35.18	-3.53	0.417	0.473	0.406	0.491	0.373	0.468	0.376	0.433
-36.86	-3.69	0.507	0.561	0.486	0.578	0.459	0.562	0.437	0.517
-38.93	-3.89	0.602	0.652	0.572	0.668	0.551	0.651	0.497	0.603
-38.02	-3.80	0.718	0.778	0.687	0.791	0.666	0.768	0.587	0.725
-31.30	-3.13	0.856	0.922	0.832	0.901	0.801	0.916	0.720	0.869

PUSHOUT TEST SUMMARY SHEET

Test: 5-1-3
Test Designation: SC-8-2.5-0.109-1.5VL-3.5-3

Test Date: 19 MAR 93

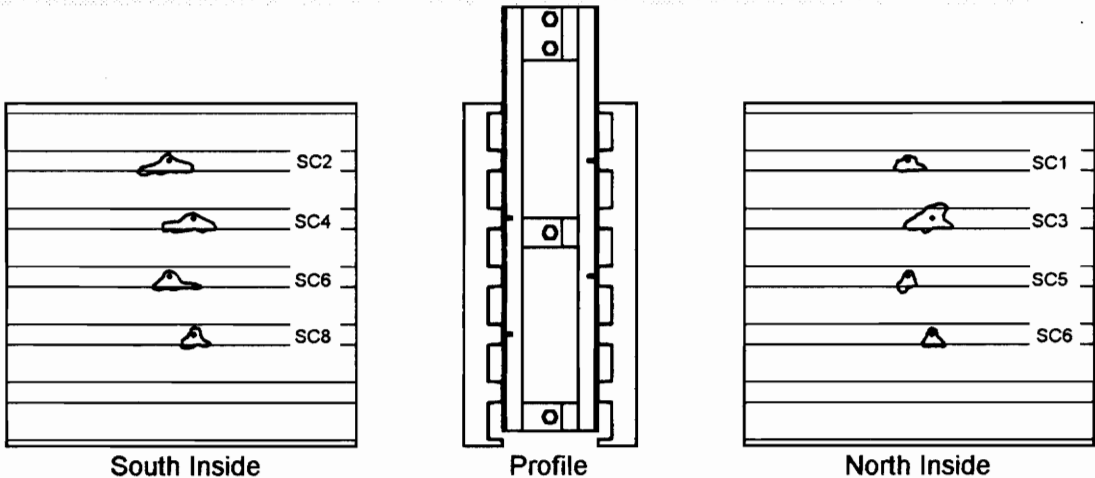
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2.5 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 1.25x1.25x0.109</u>
	F_y : <u>57.3 ksi</u> F_u : <u>82.2 ksi</u>
Slab:	Thickness: <u>3.5 in.</u> f'_c : <u>4420 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

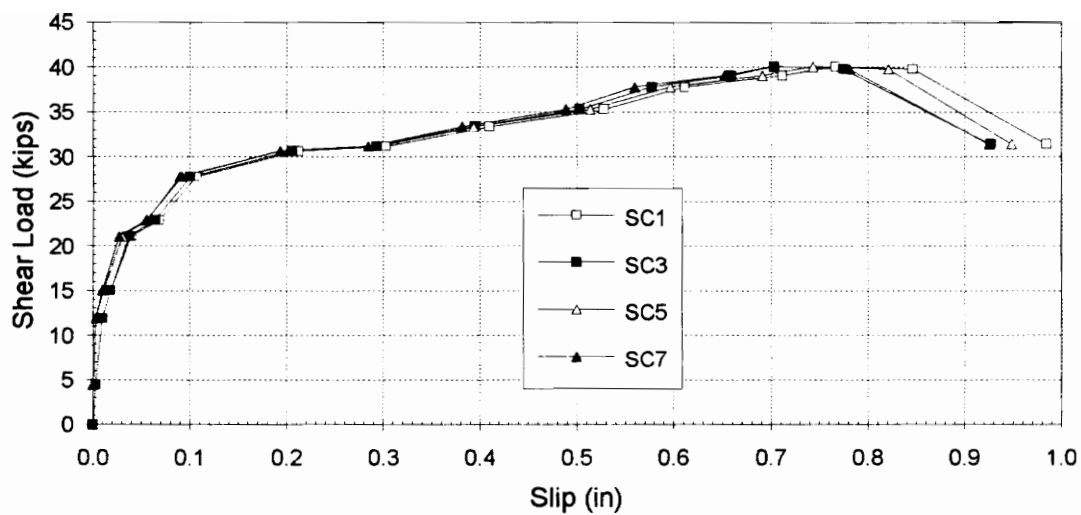
Peak Shear Load:	<u>40.09 kips</u>	
Peak Shear Load Per Fastener:	<u>5.01 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.767 in.</u>	SC2: <u>0.595 in.</u>
	SC3: <u>0.703 in.</u>	SC4: <u>0.653 in.</u>
	SC5: <u>0.744 in.</u>	SC6: <u>0.669 in.</u>
	SC7: <u>0.703 in.</u>	SC8: <u>0.598 in.</u>

DAMAGE

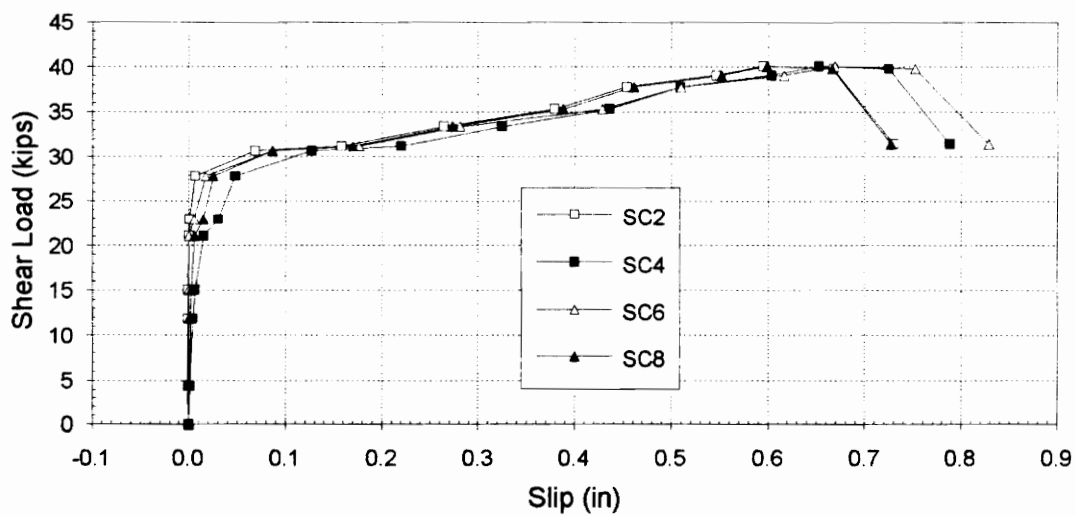


COMMENTS

Bulges in deck below screw at all locations; Angle deformed at all locations
Deck rupturing below SC1 and SC5
Concrete rib failure at SC3; Screw rotation $\geq 45^\circ$



(a) Test 5-1-3 - Load vs. North Slip



(b) Test 5-1-3 - Load vs. South Slip

Fig. A.59 Test 5-1-3 Load vs. Slip Plots

Table A.59 Test 5-1-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.40	-0.45	0.003	-0.001	0.003	0.001	0.000	0.000	0.000	0.001
-11.90	-1.20	0.010	-0.001	0.010	0.004	0.003	0.000	0.003	0.002
-15.00	-1.51	0.018	-0.001	0.018	0.007	0.011	0.000	0.010	0.002
-21.08	-2.11	0.039	0.000	0.037	0.015	0.031	0.000	0.027	0.006
-22.89	-2.28	0.069	0.001	0.064	0.030	0.056	0.006	0.055	0.015
-27.81	-2.78	0.107	0.007	0.101	0.048	0.090	0.017	0.092	0.025
-30.65	-3.08	0.212	0.069	0.205	0.127	0.193	0.087	0.194	0.086
-31.17	-3.13	0.303	0.158	0.293	0.220	0.284	0.176	0.285	0.170
-33.37	-3.33	0.410	0.264	0.394	0.325	0.393	0.281	0.382	0.273
-35.31	-3.53	0.528	0.379	0.503	0.435	0.514	0.428	0.489	0.388
-37.77	-3.78	0.611	0.454	0.577	0.509	0.596	0.510	0.560	0.461
-39.06	-3.91	0.712	0.546	0.659	0.603	0.691	0.616	0.652	0.552
-40.09	-4.01	0.767	0.595	0.703	0.653	0.744	0.669	0.703	0.598
-39.83	-3.97	0.846	0.667	0.775	0.724	0.821	0.751	0.781	0.666
-31.43	-3.15	0.984	0.730	0.927	0.788	0.949	0.829	0.925	0.727

PUSHOUT TEST SUMMARY SHEET

Test: 5-2-1
Test Designation: SC-8-2.5-0.155-1.5VL-3.5-1

Test Date: 17 MAR 93

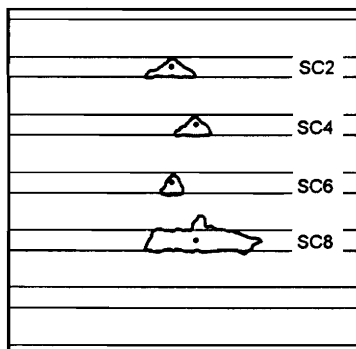
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2.5 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 1.50x1.50x0.155</u>
	F_y : <u>54.5 ksi</u> F_u : <u>79.8 ksi</u>
Slab:	Thickness: <u>3.5 in.</u> f'_c : <u>4400 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

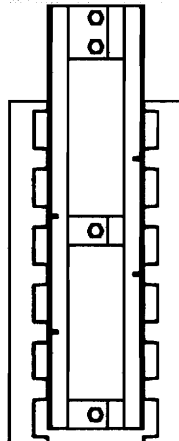
TEST RESULTS

Peak Shear Load:	<u>43.71 kips</u>	
Peak Shear Load Per Fastener:	<u>5.46 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.769 in.</u>	SC2: <u>0.800 in.</u>
	SC3: <u>0.838 in.</u>	SC4: <u>0.831 in.</u>
	SC5: <u>0.665 in.</u>	SC6: <u>0.819 in.</u>
	SC7: <u>0.826 in.</u>	SC8: <u>0.711 in.</u>

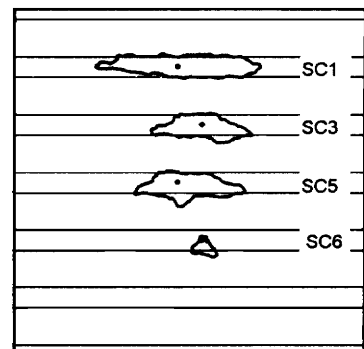
DAMAGE



South Inside



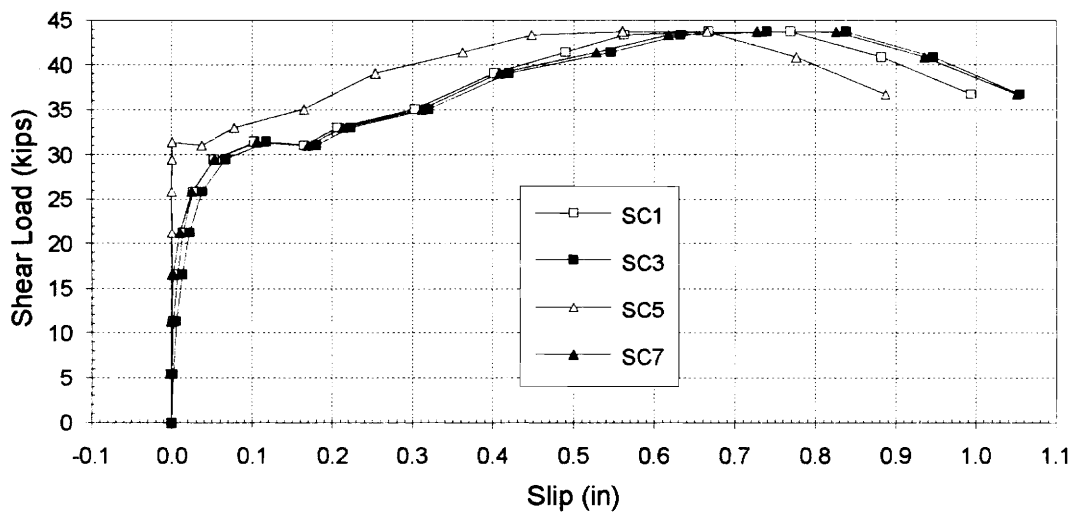
Profile



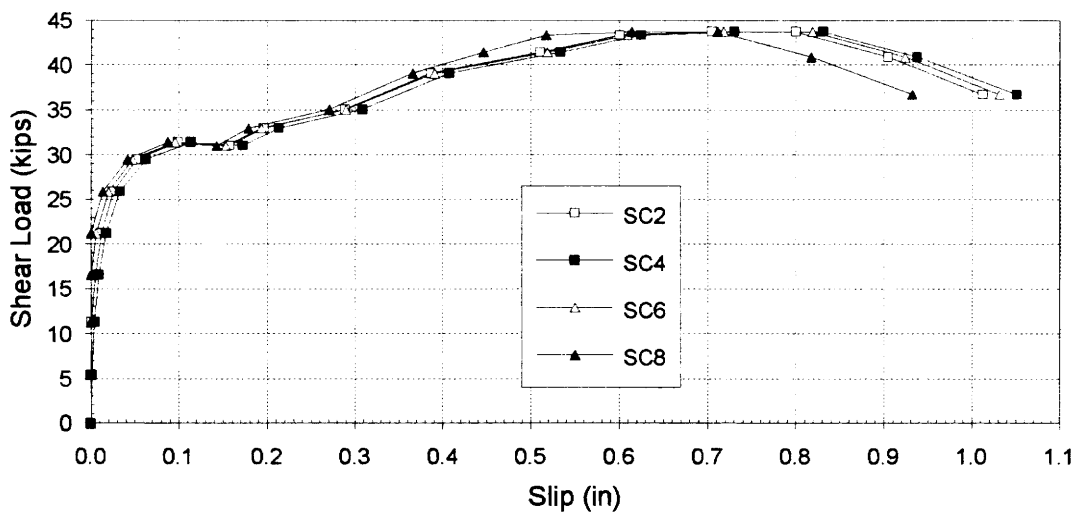
North Inside

COMMENTS

Bulges in deck below screw at all locations
Concrete rib failure at SC1, SC3, SC5, SC8
Screw rotation $\approx 45^\circ$



(a) Test 5-2-1 - Load vs. North Slip



(b) Test 5-2-1 - Load vs. South Slip

Fig. A.60 Test 5-2-1 Load vs. Slip Plots

Table A.60 Test 5-2-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.43	-0.53	-0.001	0.000	0.002	0.001	0.000	0.000	-0.001	0.000
-11.25	-1.13	0.002	0.001	0.006	0.004	0.001	0.000	-0.001	0.000
-16.55	-1.66	0.007	0.006	0.013	0.009	0.001	0.001	0.002	0.000
-21.21	-2.13	0.014	0.012	0.023	0.018	0.001	0.006	0.010	0.001
-25.87	-2.59	0.026	0.025	0.038	0.033	0.000	0.020	0.025	0.013
-29.49	-2.95	0.053	0.052	0.067	0.063	0.001	0.048	0.053	0.042
-31.43	-3.14	0.103	0.099	0.117	0.114	0.001	0.095	0.105	0.088
-31.04	-3.12	0.165	0.157	0.180	0.172	0.037	0.153	0.170	0.143
-32.98	-3.32	0.206	0.196	0.223	0.213	0.077	0.193	0.213	0.179
-35.05	-3.50	0.302	0.289	0.319	0.309	0.164	0.290	0.311	0.271
-39.06	-3.89	0.402	0.386	0.420	0.408	0.253	0.391	0.408	0.366
-41.39	-4.14	0.490	0.511	0.546	0.534	0.362	0.519	0.528	0.446
-43.33	-4.33	0.562	0.601	0.633	0.625	0.448	0.610	0.617	0.517
-43.71	-4.37	0.667	0.705	0.740	0.730	0.560	0.718	0.727	0.614
-43.71	-4.37	0.769	0.800	0.838	0.831	0.665	0.819	0.826	0.711
-40.87	-4.09	0.882	0.904	0.946	0.938	0.776	0.924	0.936	0.817
-36.73	-3.67	0.994	1.012	1.055	1.051	0.887	1.031	1.051	0.932

PUSHOUT TEST SUMMARY SHEET

Test: 5-2-2
Test Designation: SC-8-2.5-0.155-1.5VL-3.5-2

Test Date: 18 MAR 93

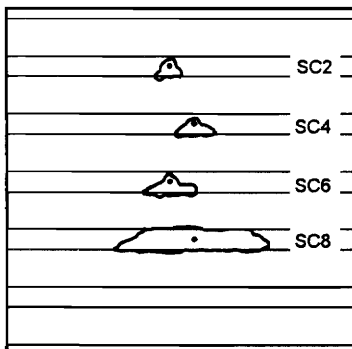
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2.5 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 1.50x1.50x0.155</u>
	F_y : <u>54.5 ksi</u> F_u : <u>79.8 ksi</u>
Slab:	Thickness: <u>3.5 in.</u> f'_c : <u>4390 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

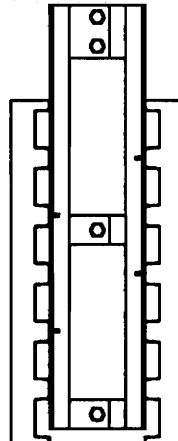
TEST RESULTS

Peak Shear Load:	<u>43.97 kips</u>	
Peak Shear Load Per Fastener:	<u>5.50 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.836 in.</u>	SC2: <u>0.832 in.</u>
	SC3: <u>0.865 in.</u>	SC4: <u>0.821 in.</u>
	SC5: <u>0.849 in.</u>	SC6: <u>0.876 in.</u>
	SC7: <u>0.768 in.</u>	SC8: <u>0.743 in.</u>

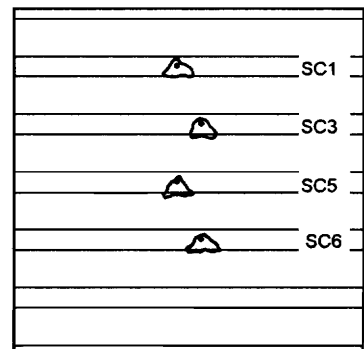
DAMAGE



South Inside



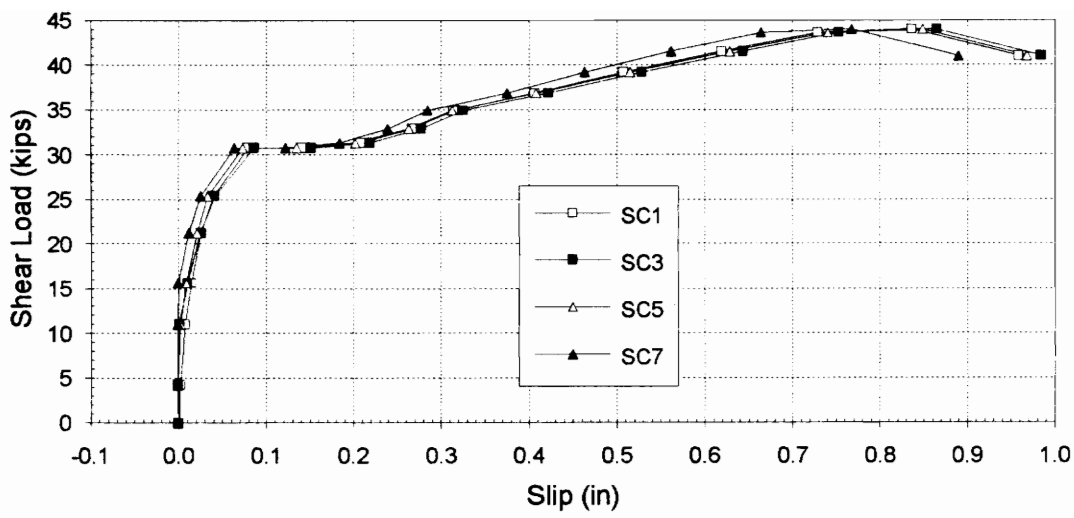
Profile



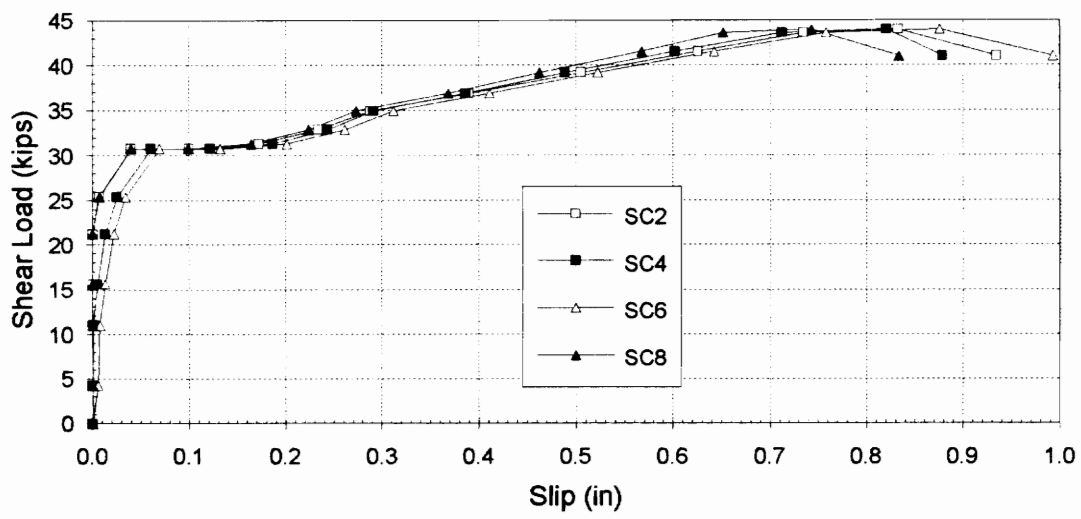
North Inside

COMMENTS

Bulges in deck below screw at all locations
Concrete rib failure at SC8
Screw rotation $\approx 45^\circ$



(a) Test 5-2-2 - Load vs. North Slip



(b) Test 5-2-2 - Load vs. South Slip

Fig. A.61 Test 5-2-2 Load vs. Slip Plots

Table A.61 Test 5-2-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.27	-0.44	0.002	0.001	-0.001	0.000	-0.001	0.006	-0.001	0.000
-10.99	-1.10	0.007	0.001	0.001	0.001	0.002	0.008	-0.001	0.001
-15.65	-1.56	0.015	0.001	0.010	0.005	0.009	0.013	0.000	0.001
-21.21	-2.12	0.026	0.001	0.025	0.013	0.021	0.023	0.012	0.001
-25.35	-2.53	0.040	0.007	0.042	0.026	0.034	0.034	0.025	0.008
-30.78	-3.08	0.080	0.040	0.086	0.061	0.073	0.070	0.064	0.040
-30.78	-3.08	0.141	0.100	0.152	0.122	0.135	0.133	0.122	0.100
-31.30	-3.13	0.208	0.172	0.219	0.186	0.203	0.201	0.184	0.164
-32.85	-3.31	0.267	0.234	0.277	0.243	0.263	0.262	0.239	0.224
-34.92	-3.49	0.315	0.288	0.325	0.291	0.313	0.312	0.285	0.273
-36.86	-3.69	0.406	0.390	0.422	0.387	0.408	0.411	0.376	0.368
-39.19	-3.92	0.507	0.505	0.528	0.489	0.515	0.522	0.463	0.463
-41.52	-4.15	0.619	0.626	0.643	0.602	0.628	0.643	0.562	0.567
-43.59	-4.36	0.729	0.735	0.753	0.712	0.740	0.758	0.664	0.652
-43.97	-4.39	0.836	0.832	0.865	0.821	0.849	0.876	0.768	0.743
-41.00	-4.11	0.959	0.935	0.984	0.879	0.968	0.993	0.890	0.833

PUSHOUT TEST SUMMARY SHEET

Test: 5-2-3
 Test Designation: SC-8-2.5-0.155-1.5VL-3.5-3

Test Date: 18 MAR 93

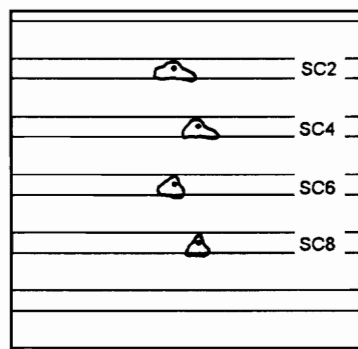
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.5VL, 22 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u>	F_u : <u>53.4 ksi</u>	
Base Member:	Section: <u>2L 1.50x1.50x0.155</u>		
	F_y : <u>54.5 ksi</u>	F_u : <u>79.8 ksi</u>	
Slab:	Thickness: <u>3.5 in.</u>	f'_c : <u>4390 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

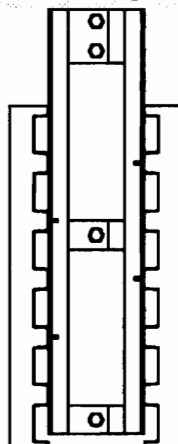
TEST RESULTS

Peak Shear Load: <u>44.36 kips</u>		
Peak Shear Load Per Fastener: <u>5.55 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.770 in.</u>	SC2: <u>0.678 in.</u>
	SC3: <u>0.752 in.</u>	SC4: <u>0.661 in.</u>
	SC5: <u>0.750 in.</u>	SC6: <u>0.651 in.</u>
	SC7: <u>0.749 in.</u>	SC8: <u>0.620 in.</u>

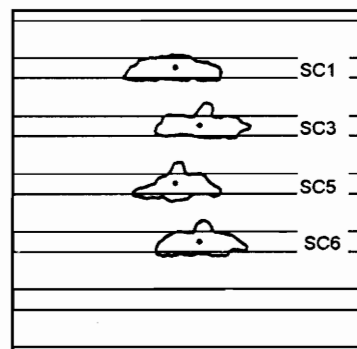
DAMAGE



South Inside



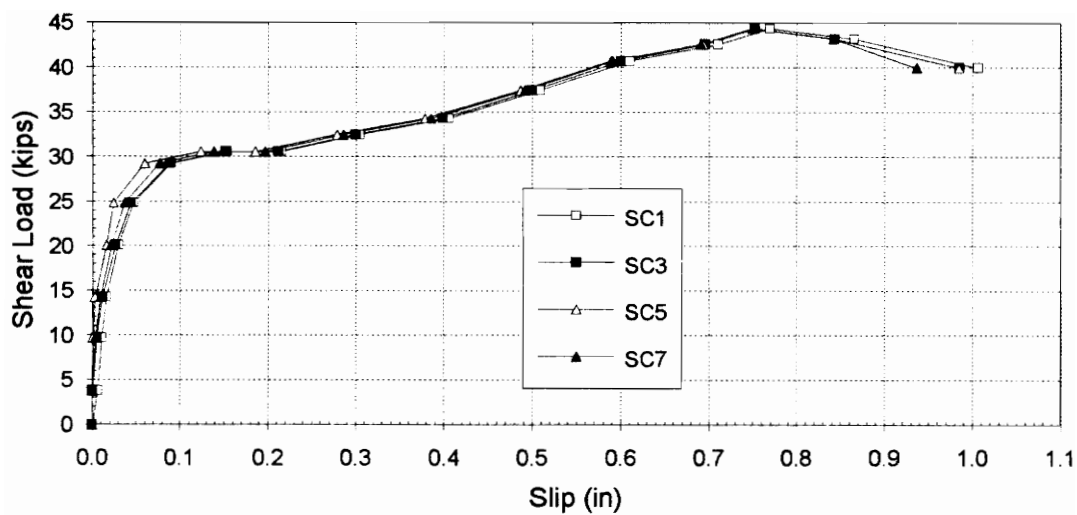
Profile



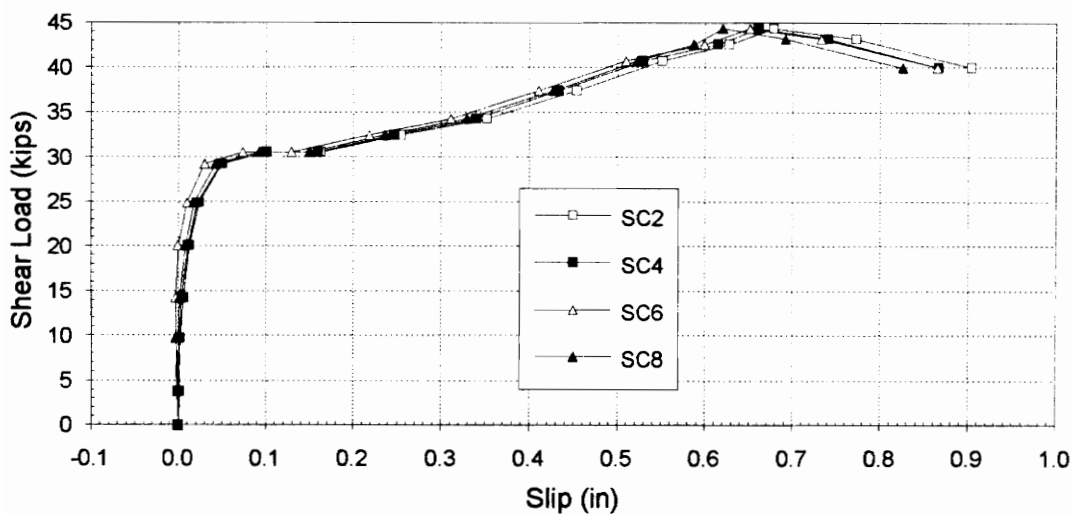
North Inside

COMMENTS

Bulges in deck below screw at all locations
 Concrete rib failure at SC1, SC3, SC5, SC7
 Screw rotation $\approx 45^\circ$



(a) Test 5-2-3 - Load vs. North Slip



(b) Test 5-2-3 - Load vs. South Slip

Fig. A.62 Test 5-2-3 Load vs. Slip Plots

Table A.62 Test 5-2-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-3.75	-0.36	0.006	0.001	0.000	0.000	0.000	-0.001	0.000	-0.001
-9.70	-0.97	0.010	0.002	0.005	0.002	0.000	-0.003	0.004	0.000
-14.23	-1.42	0.016	0.004	0.012	0.006	0.003	-0.003	0.009	0.002
-20.05	-2.01	0.029	0.012	0.026	0.013	0.016	0.000	0.021	0.008
-24.83	-2.48	0.046	0.021	0.044	0.024	0.024	0.010	0.037	0.018
-29.23	-2.91	0.089	0.048	0.088	0.050	0.059	0.030	0.077	0.042
-30.52	-3.05	0.153	0.101	0.151	0.100	0.123	0.073	0.138	0.092
-30.52	-3.05	0.214	0.163	0.212	0.159	0.185	0.129	0.197	0.150
-32.46	-3.25	0.305	0.254	0.300	0.247	0.278	0.218	0.286	0.236
-34.27	-3.43	0.406	0.352	0.399	0.340	0.379	0.311	0.385	0.329
-37.38	-3.74	0.508	0.454	0.500	0.434	0.487	0.411	0.492	0.428
-40.74	-4.07	0.611	0.552	0.600	0.530	0.589	0.510	0.591	0.523
-42.55	-4.25	0.710	0.628	0.695	0.615	0.694	0.599	0.691	0.587
-44.36	-4.45	0.770	0.678	0.752	0.661	0.750	0.651	0.749	0.620
-43.20	-4.33	0.866	0.773	0.843	0.740	0.843	0.733	0.842	0.692
-39.96	-4.01	1.006	0.904	0.985	0.866	0.985	0.865	0.936	0.826

PUSHOUT TEST SUMMARY SHEET

Test: 5-3-1
 Test Designation: SC-8-2.5-0.205-1.5VL-3.5-1

Test Date: 18 MAR 93

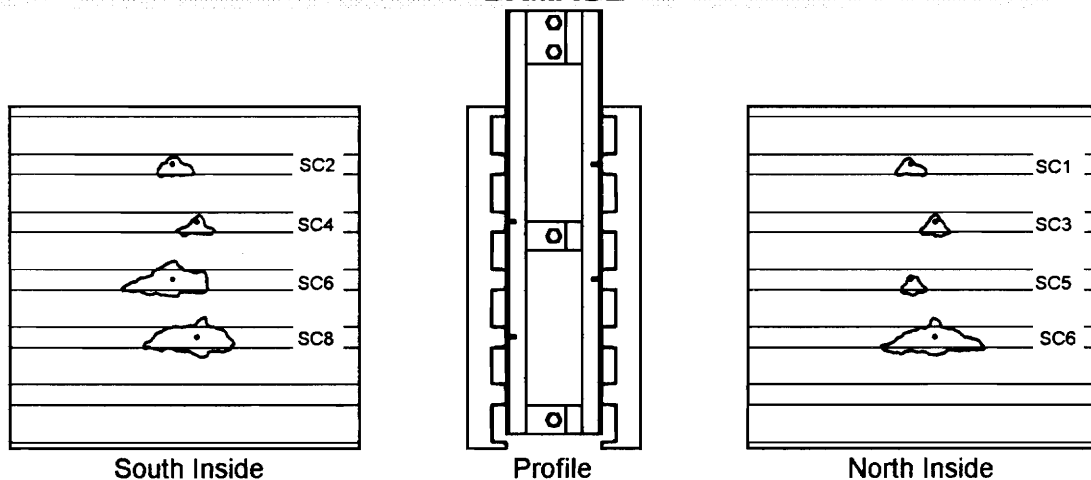
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2.5 in. standoff screw</u>		
	# Per Specimen: <u>8</u>		
Deck:	Type: <u>1.5VL, 22 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u>	F_u : <u>53.4 ksi</u>	
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>		
	F_y : <u>54.5 ksi</u>	F_u : <u>80.0 ksi</u>	
Slab:	Thickness: <u>3.5 in.</u>	f'_c : <u>4390 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

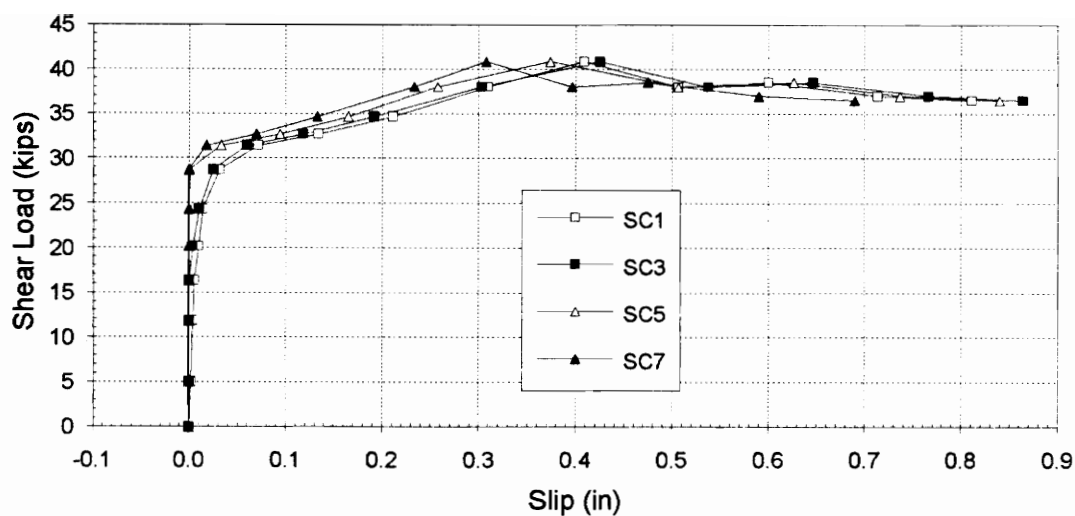
Peak Shear Load:	<u>40.87 kips</u>	
Peak Shear Load Per Fastener:	<u>5.11 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.409 in.</u>	SC2: <u>0.519 in.</u>
	SC3: <u>0.425 in.</u>	SC4: <u>0.532 in.</u>
	SC5: <u>0.374 in.</u>	SC6: <u>0.465 in.</u>
	SC7: <u>0.307 in.</u>	SC8: <u>0.510 in.</u>

DAMAGE

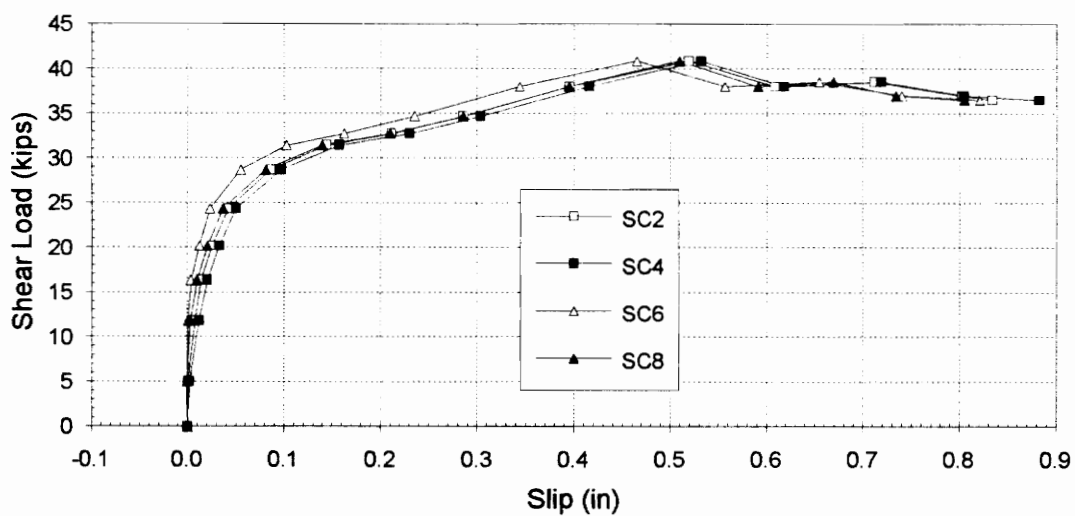


COMMENTS

Bulges in deck below screw at all locations
 Concrete rib failure at SC6, SC7, SC8; SC1 and SC5 sheared off
 Screw rotation $\approx 20^\circ$



(a) Test 5-3-1 - Load vs. North Slip



(b) Test 5-3-1 - Load vs. South Slip

Fig. A.63 Test 5-3-1 Load vs. Slip Plots

Table A.63 Test 5-3-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-5.04	-0.50	0.002	0.001	0.000	0.002	0.000	0.000	-0.001	-0.001
-11.77	-1.19	0.004	0.008	0.000	0.012	0.000	0.001	-0.001	0.003
-16.30	-1.63	0.006	0.014	0.000	0.021	0.000	0.004	-0.001	0.010
-20.18	-2.02	0.010	0.026	0.004	0.033	0.000	0.012	-0.001	0.021
-24.31	-2.44	0.014	0.042	0.010	0.050	0.000	0.023	-0.001	0.037
-28.71	-2.87	0.031	0.087	0.025	0.097	0.001	0.055	-0.001	0.081
-31.43	-3.14	0.072	0.144	0.060	0.158	0.033	0.103	0.018	0.140
-32.72	-3.25	0.134	0.212	0.118	0.230	0.094	0.163	0.069	0.210
-34.66	-3.47	0.211	0.286	0.191	0.304	0.165	0.235	0.133	0.285
-38.02	-3.80	0.310	0.395	0.303	0.415	0.257	0.344	0.233	0.395
-40.87	-4.10	0.409	0.519	0.425	0.532	0.374	0.465	0.307	0.510
-38.02	-3.80	0.507	0.609	0.537	0.618	0.506	0.557	0.396	0.591
-38.54	-3.84	0.600	0.712	0.647	0.719	0.627	0.655	0.475	0.669
-36.99	-3.68	0.713	0.802	0.766	0.804	0.736	0.740	0.590	0.734
-36.47	-3.65	0.811	0.834	0.864	0.882	0.840	0.820	0.690	0.805

PUSHOUT TEST SUMMARY SHEET

Test: 5-3-2
Test Designation: SC-8-2.5-0.205-1.5VL-3.5-2

Test Date: 18 MAR 93

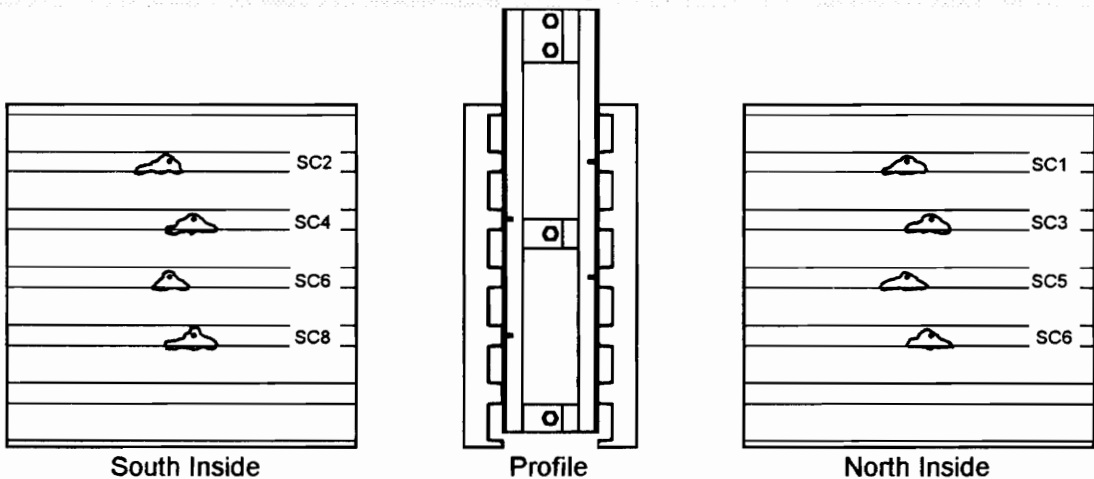
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2.5 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>
	F_y : <u>54.5 ksi</u> F_u : <u>80.0 ksi</u>
Slab:	Thickness: <u>3.5 in.</u> f'_c : <u>4390 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

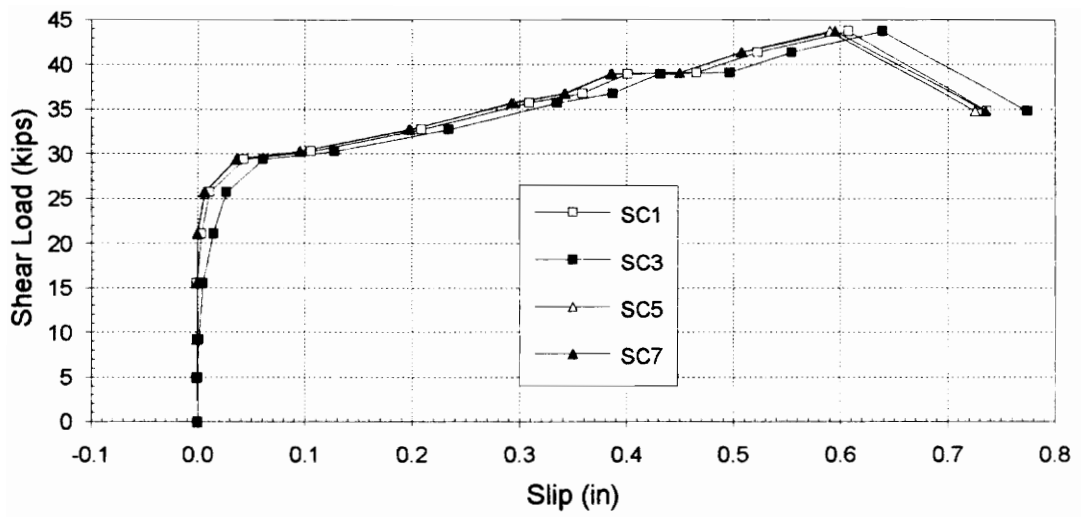
Peak Shear Load:	<u>43.71 kips</u>
Peak Shear Load Per Fastener:	<u>5.46 kips</u>
Slip at Peak Shear Load:	SC1: <u>0.607 in.</u> SC2: <u>0.646 in.</u>
	SC3: <u>0.639 in.</u> SC4: <u>0.674 in.</u>
	SC5: <u>0.590 in.</u> SC6: <u>0.542 in.</u>
	SC7: <u>0.595 in.</u> SC8: <u>0.645 in.</u>

DAMAGE

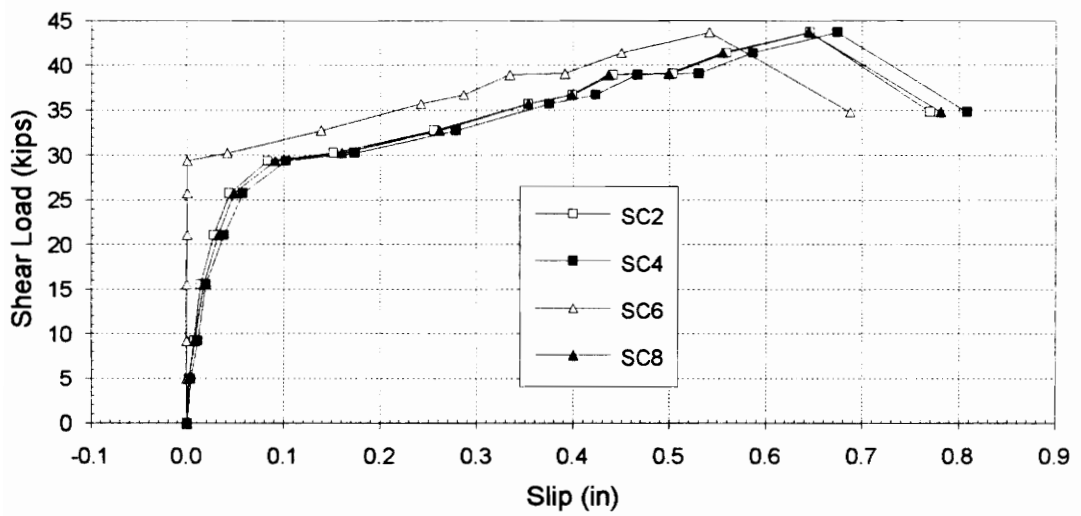


COMMENTS

Bulges in deck below screw at all locations
SC3 and SC6 sheared off
Screw rotation $\approx 20^\circ$ - 30°



(a) Test 5-3-2 - Load vs. North Slip



(b) Test 5-3-2 - Load vs. South Slip

Fig. A.64 Test 5-3-2 Load vs. Slip Plots

Table A.64 Test 5-3-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4.91	-0.49	0.000	0.002	-0.001	0.004	-0.001	-0.001	-0.001	0.002
-9.18	-0.92	0.000	0.007	0.001	0.011	-0.001	-0.001	-0.001	0.008
-15.52	-1.55	-0.001	0.014	0.005	0.020	-0.001	-0.001	-0.001	0.017
-21.08	-2.10	0.004	0.028	0.015	0.038	0.000	0.000	0.000	0.032
-25.74	-2.57	0.011	0.044	0.027	0.057	0.007	0.000	0.006	0.048
-29.36	-2.94	0.043	0.083	0.061	0.103	0.036	0.000	0.036	0.091
-30.26	-3.03	0.106	0.152	0.128	0.174	0.095	0.042	0.095	0.160
-32.72	-3.28	0.209	0.256	0.234	0.279	0.197	0.139	0.198	0.262
-35.70	-3.57	0.309	0.354	0.335	0.375	0.295	0.242	0.293	0.353
-36.73	-3.67	0.358	0.399	0.387	0.423	0.343	0.287	0.342	0.398
-38.93	-3.88	0.401	0.442	0.432	0.467	0.387	0.334	0.385	0.437
-39.06	-3.93	0.466	0.503	0.496	0.531	0.450	0.391	0.450	0.500
-41.39	-4.14	0.522	0.560	0.555	0.587	0.507	0.450	0.508	0.556
-43.71	-4.37	0.607	0.646	0.639	0.674	0.590	0.542	0.595	0.645
-34.79	-3.48	0.737	0.770	0.774	0.808	0.725	0.688	0.735	0.781

PUSHOUT TEST SUMMARY SHEET

Test: 5-3-3
Test Designation: SC-8-2.5-0.205-1.5VL-3.5-3

Test Date: 19 MAR 93

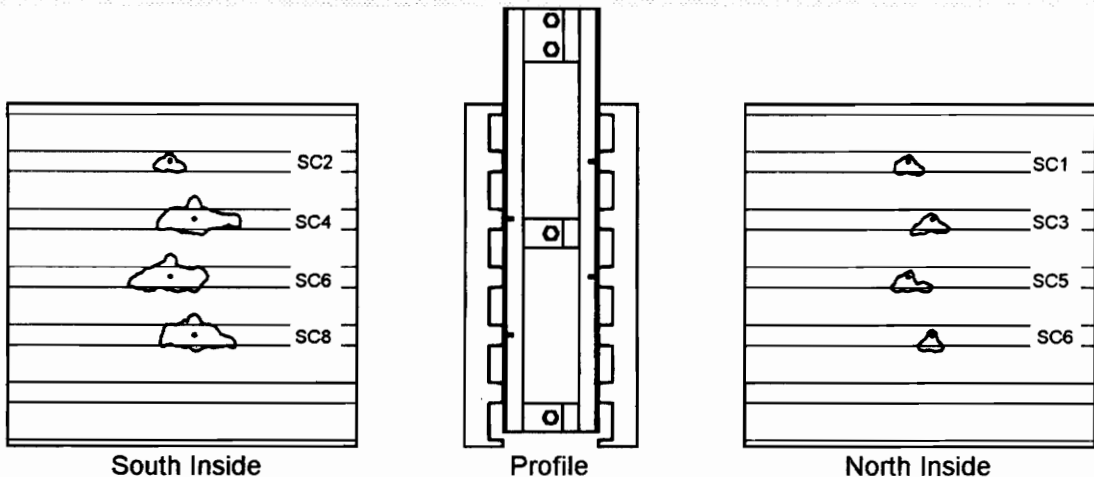
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2.5 in. standoff screw</u>
	# Per Specimen: <u>8</u>
Deck:	Type: <u>1.5VL, 22 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>45.7 ksi</u> F_u : <u>53.4 ksi</u>
Base Member:	Section: <u>2L 2.00x2.00x0.205</u>
	F_y : <u>54.5 ksi</u> F_u : <u>80.0 ksi</u>
Slab:	Thickness: <u>3.5 in.</u> f'_c : <u>4420 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

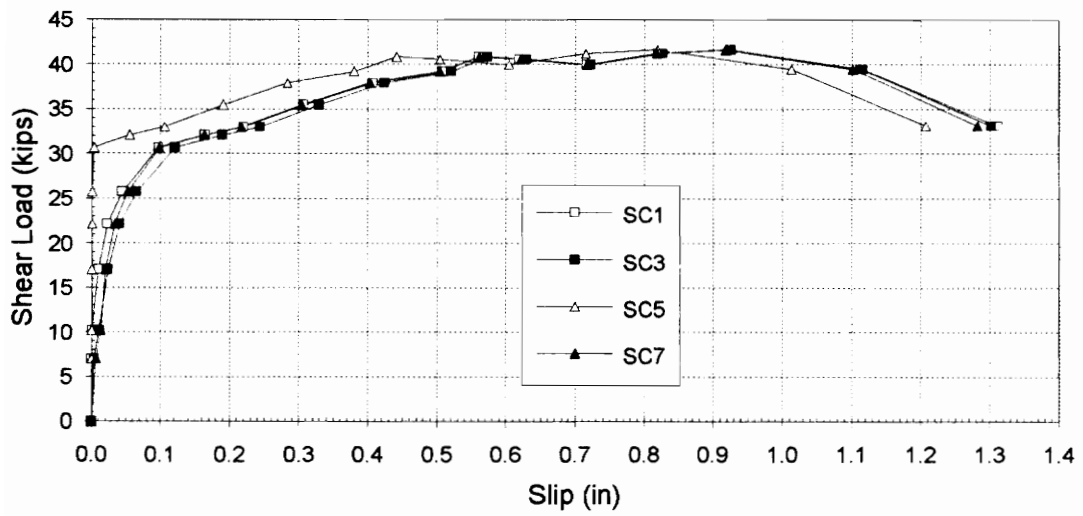
Peak Shear Load:	<u>41.65 kips</u>	
Peak Shear Load Per Fastener:	<u>5.21 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.924 in.</u>	SC2: <u>0.906 in.</u>
	SC3: <u>0.925 in.</u>	SC4: <u>0.767 in.</u>
	SC5: <u>0.819 in.</u>	SC6: <u>0.816 in.</u>
	SC7: <u>0.917 in.</u>	SC8: <u>0.717 in.</u>

DAMAGE

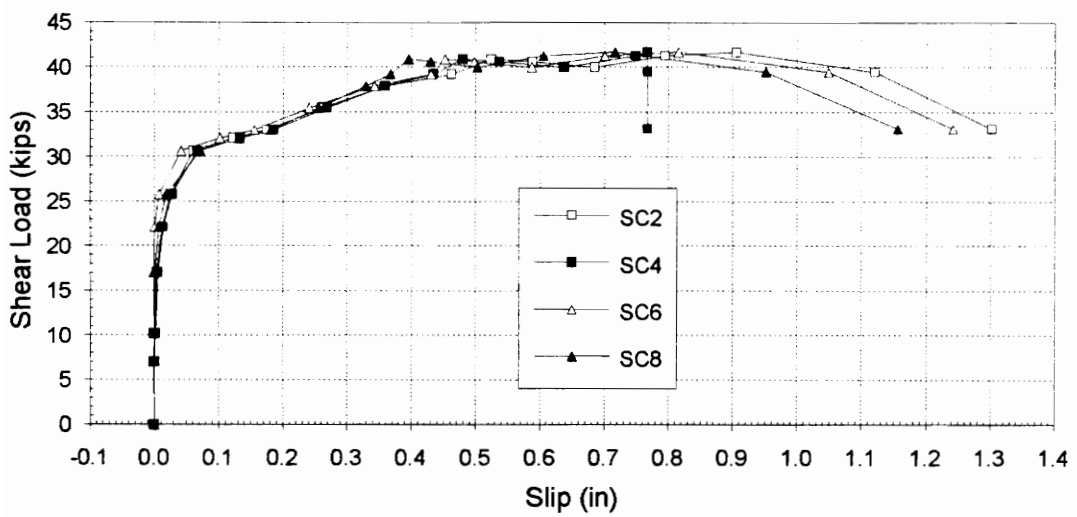


COMMENTS

Bulges in deck below screw at all locations; Deck ruptured below SC5
Concrete rib failure at SC4, SC6, SC8
Screw rotation $\approx 15^\circ$ - 25°



(a) Test 5-3-3 - Load vs. North Slip



(b) Test 5-3-3 - Load vs. South Slip

Fig. A.65 Test 5-3-3 Load vs. Slip Plots

Table A.65 Test 5-3-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)							
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-6.98	-0.69	0.000	0.000	0.004	0.001	0.000	0.000	0.006	-0.001
-10.22	-1.02	0.001	0.000	0.011	0.002	0.000	0.000	0.013	0.000
-17.07	-1.71	0.010	0.004	0.024	0.006	0.000	0.000	0.020	0.001
-22.12	-2.23	0.023	0.012	0.040	0.014	0.001	0.001	0.034	0.007
-25.74	-2.57	0.044	0.026	0.065	0.028	0.001	0.008	0.052	0.019
-30.65	-3.08	0.097	0.061	0.121	0.067	0.004	0.042	0.099	0.072
-32.07	-3.22	0.164	0.122	0.190	0.134	0.055	0.102	0.164	0.132
-32.98	-3.29	0.220	0.176	0.244	0.185	0.106	0.155	0.217	0.181
-35.44	-3.54	0.307	0.261	0.329	0.269	0.190	0.241	0.304	0.255
-37.89	-3.80	0.408	0.359	0.424	0.359	0.284	0.342	0.403	0.329
-39.19	-3.92	0.508	0.462	0.521	0.434	0.380	0.431	0.504	0.368
-40.87	-4.10	0.561	0.524	0.573	0.480	0.442	0.452	0.561	0.396
-40.61	-4.05	0.619	0.588	0.629	0.537	0.504	0.497	0.621	0.429
-39.96	-4.01	0.717	0.685	0.722	0.637	0.604	0.587	0.717	0.502
-41.26	-4.13	0.821	0.795	0.826	0.749	0.715	0.701	0.818	0.605
-41.65	-4.15	0.924	0.906	0.925	0.767	0.819	0.816	0.917	0.717
-39.45	-3.97	1.116	1.120	1.113	0.768	1.013	1.049	1.102	0.952
-33.11	-3.31	1.311	1.302	1.302	0.768	1.207	1.242	1.282	1.156

APPENDIX B

PUSHOUT TEST SUMMARY SHEET

Test: P-1-1
Test Designation: SC-B-2-0.123-1.0C-4-1

Test Date: 21 AUG 92

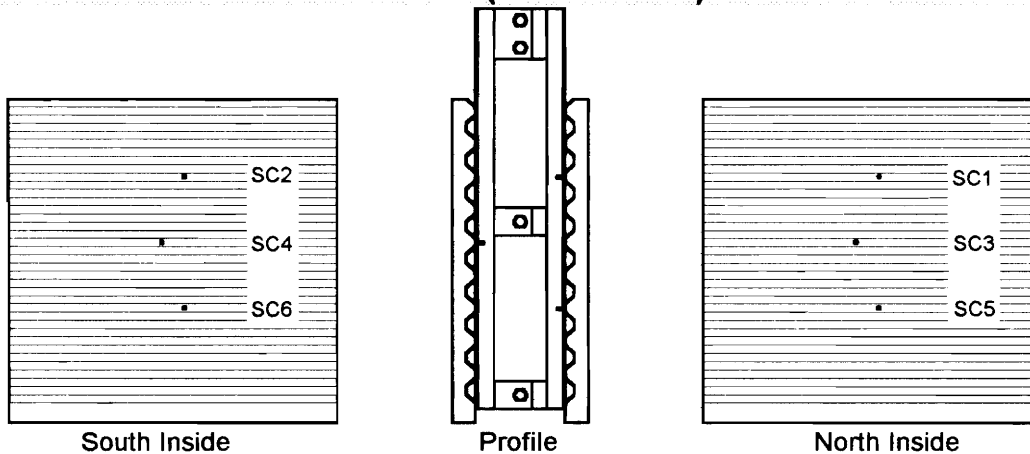
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Buildex, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>6</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.123</u>		
	F_y : <u>57.1 ksi</u>	F_u : <u>85.0 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>4090 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

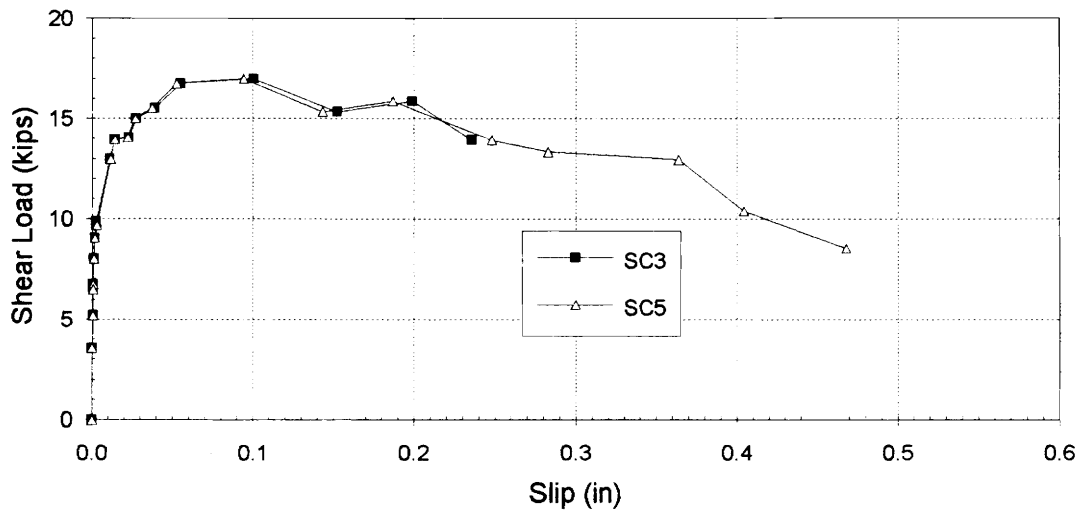
Peak Shear Load:	<u>17.00 kips</u>		
Peak Shear Load Per Fastener:	<u>2.83 kips</u>		
Slip at Peak Shear Load:	SC1: <u>xxx in.</u>	SC2: <u>0.126 in.</u>	
	SC3: <u>0.100 in.</u>	SC4: <u>0.096 in.</u>	
	SC5: <u>0.094 in.</u>	SC6: <u>0.132 in.</u>	

DAMAGE (not available)

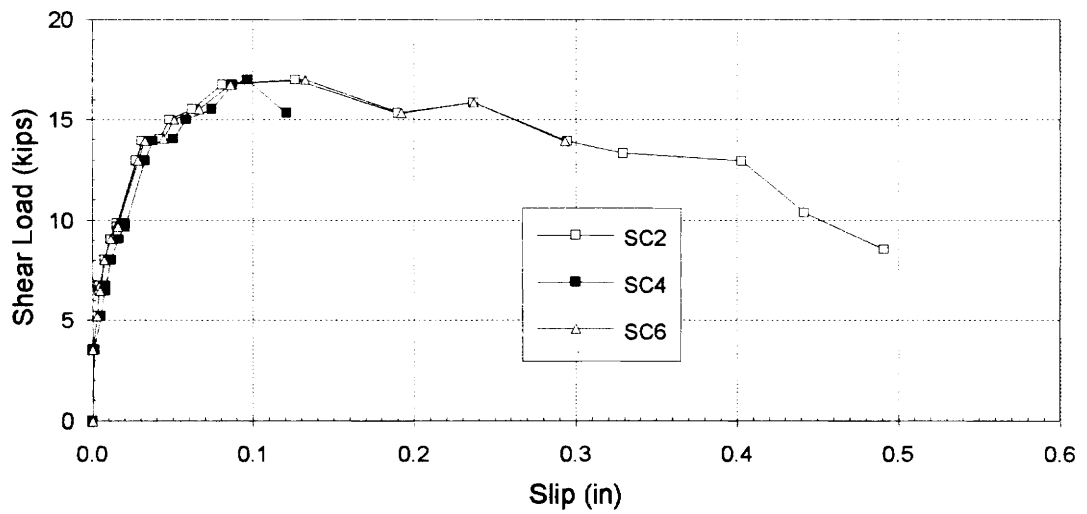


COMMENTS

Potentiometer at SC1 not responding
Deck separated from slab at $\approx 12k$; Screw shear failure
Considerable rotation at screw base was noted



(a) Test P-1-1 - Load vs. North Slip



(b) Test P-1-1 - Load vs. South Slip

Fig. B.1 Test P-1-1 Load vs. Slip Plots

Table B.1 Test P-1-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)					
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
0.00	0.00	xxx	0.000	0.000	0.000	0.000	0.000
-3.54	-0.34	xxx	0.000	0.000	0.001	0.000	0.000
-5.20	-0.50	xxx	0.003	0.001	0.005	0.001	0.003
-6.76	-0.52	xxx	0.004	0.001	0.008	0.001	0.004
-6.47	-0.65	xxx	0.004	0.001	0.008	0.001	0.005
-8.02	-0.79	xxx	0.007	0.001	0.012	0.001	0.007
-9.06	-0.90	xxx	0.011	0.002	0.016	0.002	0.012
-9.86	-0.96	xxx	0.015	0.002	0.020	0.003	0.016
-9.70	-0.93	xxx	0.015	0.002	0.021	0.003	0.016
-4.89	-0.51	xxx	0.013	0.002	0.016	0.002	0.012
-9.99	-0.98	xxx	0.016	0.004	0.020	0.004	0.016
-11.04	-1.05	xxx	0.018	0.005	0.022	0.006	0.017
-11.99	-1.21	xxx	0.020	0.007	0.024	0.007	0.020
-12.54	-1.27	xxx	0.026	0.010	0.031	0.011	0.027
-12.97	-1.31	xxx	0.027	0.011	0.033	0.012	0.029
-13.95	-1.40	xxx	0.031	0.014	0.038	0.014	0.033
-14.04	-1.49	xxx	0.042	0.023	0.051	0.022	0.045
-15.00	-1.50	xxx	0.048	0.028	0.059	0.027	0.051
-15.53	-1.59	xxx	0.062	0.039	0.074	0.037	0.067
-16.76	-1.71	xxx	0.081	0.055	0.087	0.053	0.086
-17.00	-1.83	xxx	0.126	0.100	0.096	0.094	0.132
-15.34	-1.88	xxx	0.190	0.152	0.121	0.143	0.192
-15.87	-1.95	xxx	0.237	0.199	xxx	0.187	0.237
-13.92	-1.83	xxx	0.295	0.236	xxx	0.248	0.293
-13.33	-1.88	xxx	0.329	xxx	xxx	0.283	xxx
-12.95	-1.86	xxx	0.403	xxx	xxx	0.364	xxx
-10.37	-2.03	xxx	0.442	xxx	xxx	0.404	xxx
-8.53	-2.25	xxx	0.491	xxx	xxx	0.468	xxx

PUSHOUT TEST SUMMARY SHEET

Test: P-1-2
Test Designation: SC-B-2-0.123-1.0C-4-2

Test Date: 24 AUG 92

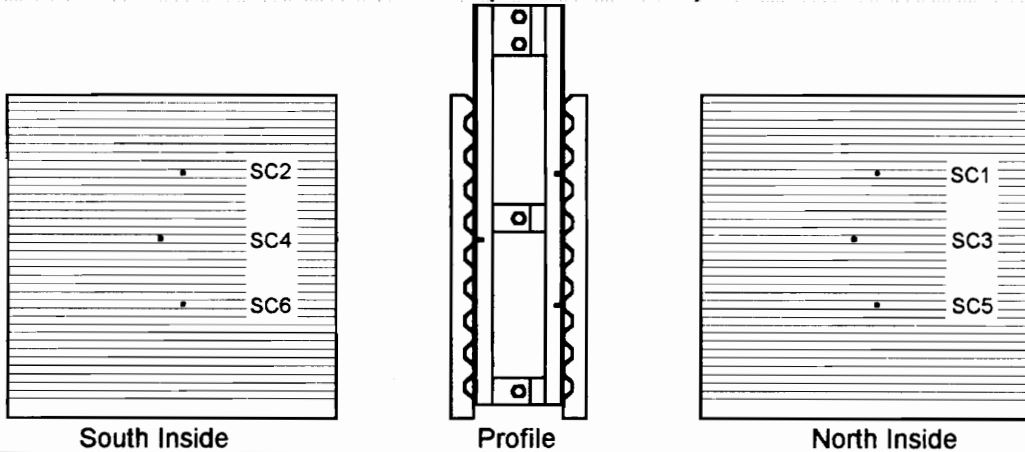
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Buildex, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>6</u>
Deck:	Type: <u>1.0C, 26 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u> F_u : <u>90.2 ksi</u>
Base Member:	Section: <u>2L 1.25x1.25x0.123</u>
	F_y : <u>57.1 ksi</u> F_u : <u>85.0 ksi</u>
Slab:	Thickness: <u>4 in.</u> f'_c : <u>4200 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

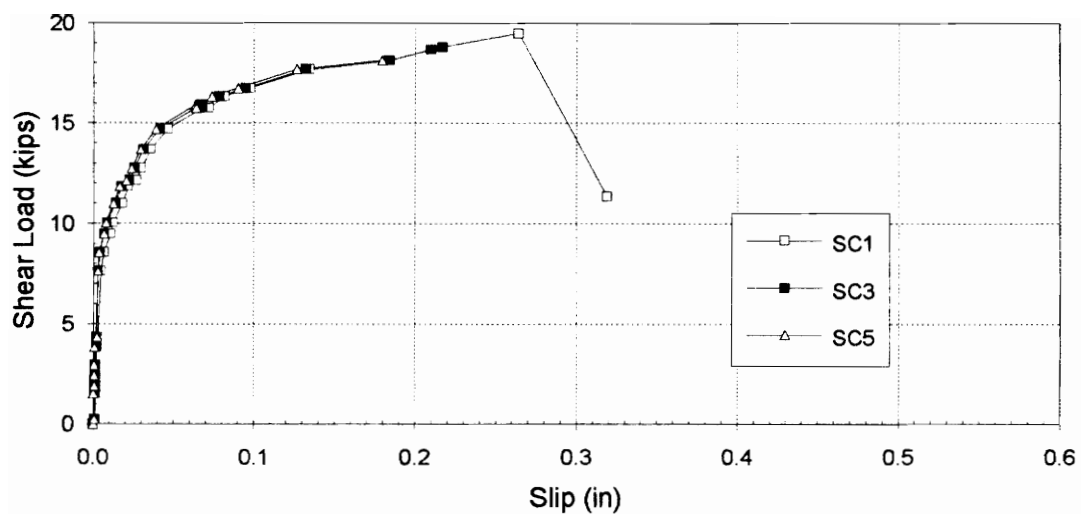
Peak Shear Load:	<u>19.47 kips</u>	
Peak Shear Load Per Fastener:	<u>3.24 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.264 in.</u>	SC2: <u>0.314 in.</u>
	SC3: <u>xxx in.</u>	SC4: <u>xxx in.</u>
	SC5: <u>xxx in.</u>	SC6: <u>0.316 in.</u>

DAMAGE (not available)

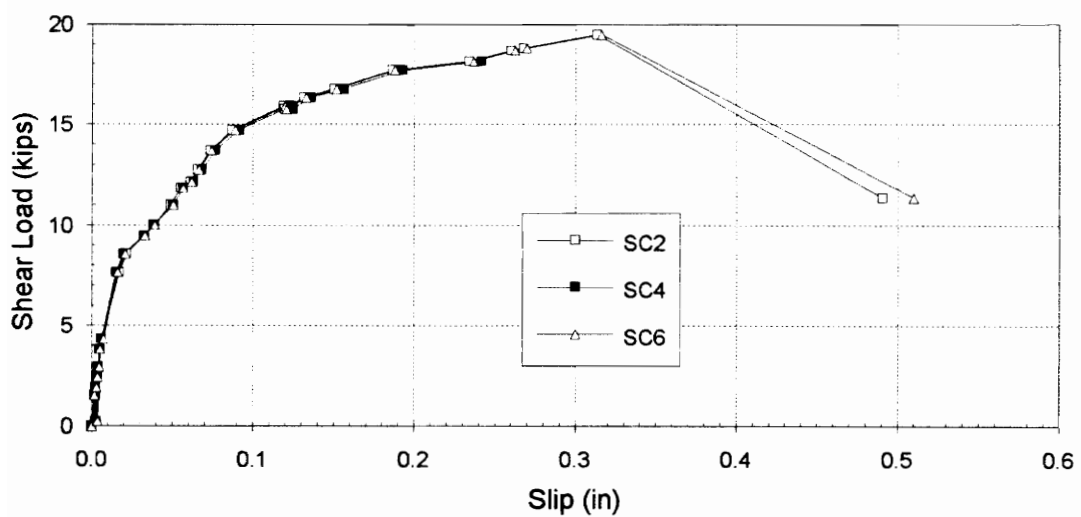


COMMENTS

Potentiometers were removed as deck interfered with nails
Deck separated from slab at $\approx 9.5k$; Screw shear failure
Slight rotation at screw base was noted



(a) Test P-1-2 - Load vs. North Slip



(b) Test P-1-2 - Load vs. South Slip

Fig. B.2 Test P-1-2 Load vs. Slip Plots

Table B.2 Test P-1-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)					
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
-1.52	-0.37	0.002	0.002	0.001	0.002	0.000	0.002
-1.90	-0.25	0.002	0.002	0.001	0.002	0.001	0.003
-0.23	-0.26	0.001	0.002	0.001	0.002	0.001	0.003
-2.42	-0.22	0.002	0.003	0.001	0.004	0.001	0.004
-0.23	-0.23	0.001	0.003	0.001	0.003	0.001	0.004
-2.95	-0.19	0.002	0.004	0.001	0.004	0.001	0.005
-3.82	-0.39	0.002	0.005	0.002	0.005	0.001	0.005
-4.33	-0.46	0.003	0.006	0.002	0.006	0.002	0.007
-1.82	-0.37	0.002	0.005	0.002	0.005	0.002	0.007
-3.95	-0.43	0.002	0.006	0.002	0.005	0.002	0.007
-4.91	-0.49	0.003	0.008	0.002	0.007	0.002	0.009
-5.82	-0.57	0.004	0.010	0.002	0.009	0.002	0.010
-6.84	-0.68	0.004	0.013	0.002	0.012	0.002	0.013
-7.65	-0.78	0.005	0.017	0.003	0.015	0.003	0.016
-8.55	-0.86	0.007	0.021	0.004	0.020	0.004	0.021
-9.49	-0.98	0.011	0.032	0.007	0.032	0.007	0.033
-10.00	-1.01	0.013	0.039	0.009	0.038	0.008	0.039
-11.01	-1.09	0.018	0.049	0.014	0.051	0.013	0.051
-11.83	-1.17	0.022	0.056	0.018	0.057	0.017	0.057
-12.16	-1.23	0.027	0.062	0.023	0.063	0.021	0.062
-12.75	-1.28	0.030	0.066	0.026	0.068	0.024	0.067
-13.70	-1.39	0.036	0.074	0.031	0.077	0.029	0.074
-14.71	-1.45	0.046	0.087	0.042	0.092	0.039	0.089
-15.91	-1.59	0.072	0.119	0.067	0.123	0.064	0.120
-15.74	-1.65	0.072	0.120	0.068	0.125	0.064	0.121
-16.34	-1.63	0.082	0.132	0.078	0.136	0.074	0.133
-16.75	-1.71	0.098	0.151	0.095	0.156	0.090	0.152
-17.71	-1.805	0.134	0.187	0.132	0.193	0.127	0.188
-18.15	-1.89	0.185	0.234	0.184	0.242	0.179	0.237
-18.67	-1.892	0.210	0.260	0.210	xxx	xxx	0.262
-18.8	-1.906	0.217	0.268	0.217	xxx	xxx	0.270
-19.47	-1.968	0.264	0.314	xxx	xxx	xxx	0.316
-11.35	-2.112	0.319	0.490	xxx	xxx	xxx	0.510

PUSHOUT TEST SUMMARY SHEET

Test: P-1-3
Test Designation: SC-B-2-0.123-1.0C-4-3

Test Date: 16 SEP 92

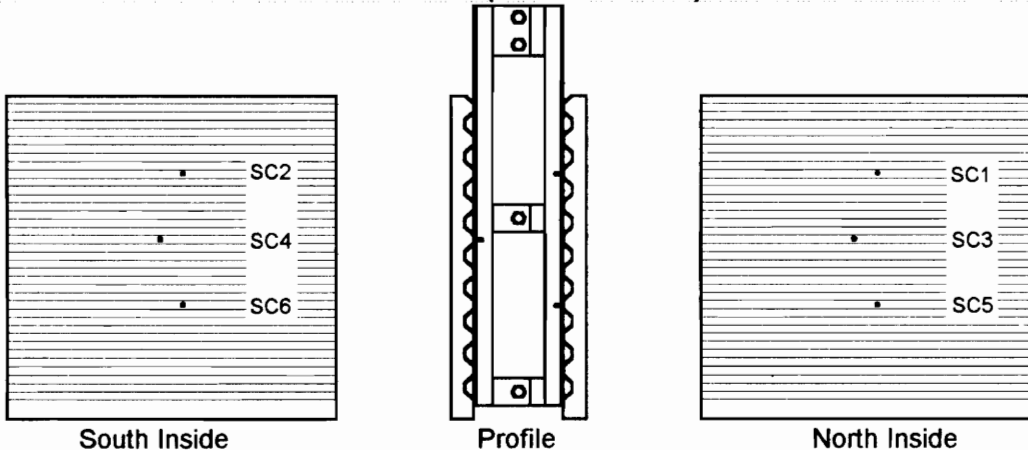
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Buildex, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>6</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.123</u>		
	F_y : <u>57.1 ksi</u>	F_u : <u>85.0 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>4110 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

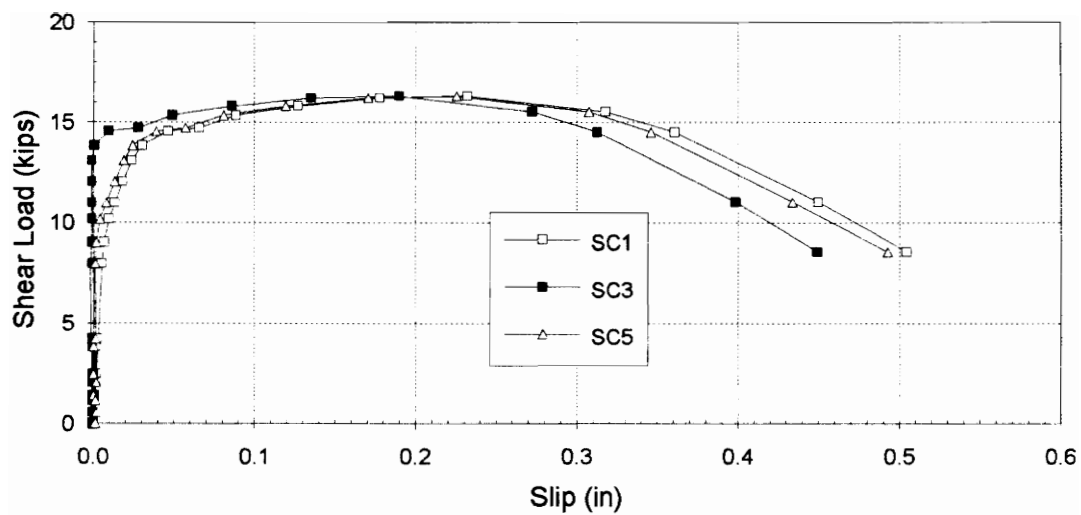
Peak Shear Load:	<u>16.32 kips</u>		
Peak Shear Load Per Fastener:	<u>2.72 kips</u>		
Slip at Peak Shear Load:	SC1: <u>0.232 in.</u>	SC2: <u>0.256 in.</u>	
	SC3: <u>0.190 in.</u>	SC4: <u>0.267 in.</u>	
	SC5: <u>0.225 in.</u>	SC6: <u>0.265 in.</u>	

DAMAGE (not available)

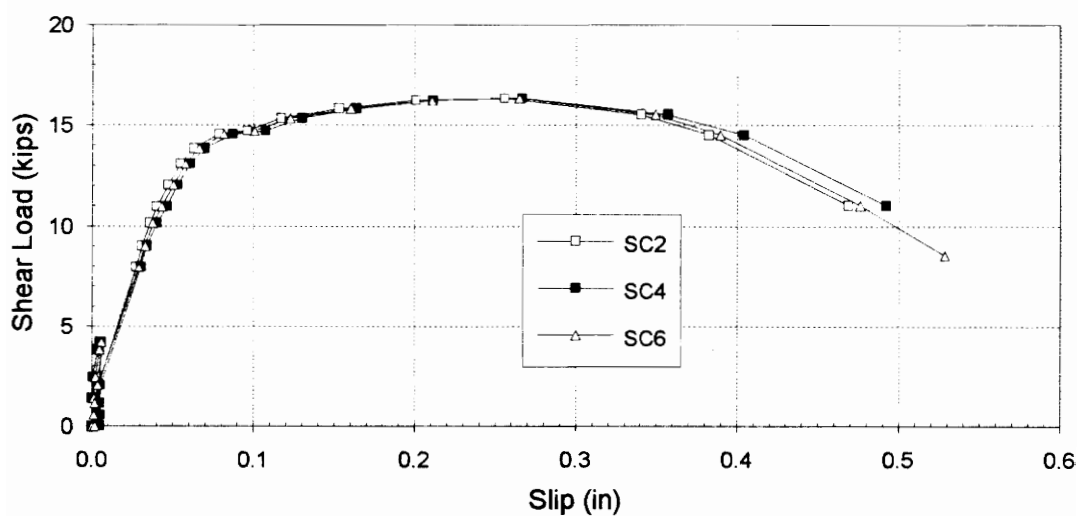


COMMENTS

Potentiometers were removed as deck interfered with nails
Deck separated from slab at $\approx 9.5k$; Screw shear failure
Slight rotation at screw base was noted



(a) Test P-1-3 - Load vs. North Slip



(b) Test P-1-3 - Load vs. South Slip

Fig. B.3 Test P-1-3 Load vs. Slip Plots

Table B.3 Test P-1-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)					
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
-1.40	-0.17	0.001	0.001	0.000	0.000	0.000	0.001
-2.46	-0.28	0.002	0.002	0.000	0.001	0.000	0.002
-3.84	-0.39	0.002	0.005	-0.001	0.004	0.000	0.005
-4.20	-0.45	0.002	0.006	-0.001	0.005	0.001	0.006
0.01	-0.37	0.000	0.003	-0.001	0.005	0.001	0.002
-0.55	-0.18	0.000	0.003	-0.001	0.005	0.002	0.001
-1.14	-0.19	0.001	0.003	-0.001	0.005	0.001	0.002
-2.05	-0.23	0.002	0.004	-0.001	0.005	0.002	0.004
-2.94	-0.31	0.002	0.005	-0.001	0.005	0.001	0.005
-4.27	-0.44	0.003	0.007	-0.001	0.005	0.001	0.007
-5.00	-0.51	0.003	0.008	-0.002	0.007	0.001	0.008
-5.84	-0.60	0.003	0.013	-0.001	0.013	0.001	0.013
-6.93	-0.73	0.004	0.024	-0.002	0.026	0.001	0.024
-7.97	-0.81	0.006	0.027	-0.002	0.031	0.001	0.029
-9.02	-0.91	0.007	0.031	-0.001	0.034	0.002	0.033
-10.16	-1.01	0.010	0.036	-0.001	0.040	0.004	0.038
-10.97	-1.08	0.013	0.040	-0.001	0.046	0.008	0.043
-12.02	-1.20	0.018	0.048	-0.001	0.053	0.013	0.051
-13.08	-1.30	0.024	0.055	-0.001	0.061	0.019	0.058
-13.84	-1.39	0.031	0.063	0.001	0.070	0.025	0.067
-14.57	-1.48	0.046	0.079	0.010	0.087	0.039	0.082
-14.71	-1.52	0.066	0.096	0.028	0.107	0.058	0.101
-15.36	-1.56	0.089	0.117	0.050	0.130	0.081	0.123
-15.81	-1.62	0.127	0.153	0.086	0.164	0.119	0.161
-16.22	-1.70	0.178	0.201	0.135	0.211	0.171	0.211
-16.32	-1.71	0.232	0.256	0.190	0.267	0.225	0.265
-15.53	-1.72	0.318	0.340	0.273	0.357	0.307	0.349
-14.52	-1.674	0.361	0.383	0.313	0.404	0.346	0.390
-11.02	-1.794	0.450	0.469	0.399	0.492	0.434	0.476
-8.546	-1.328	0.504	xxx	0.449	xxx	0.492	0.528

PUSHOUT TEST SUMMARY SHEET

Test: P-2-1
Test Designation: SC-5-2-0.123-1.0C-4-1

Test Date: 14 SEP 92

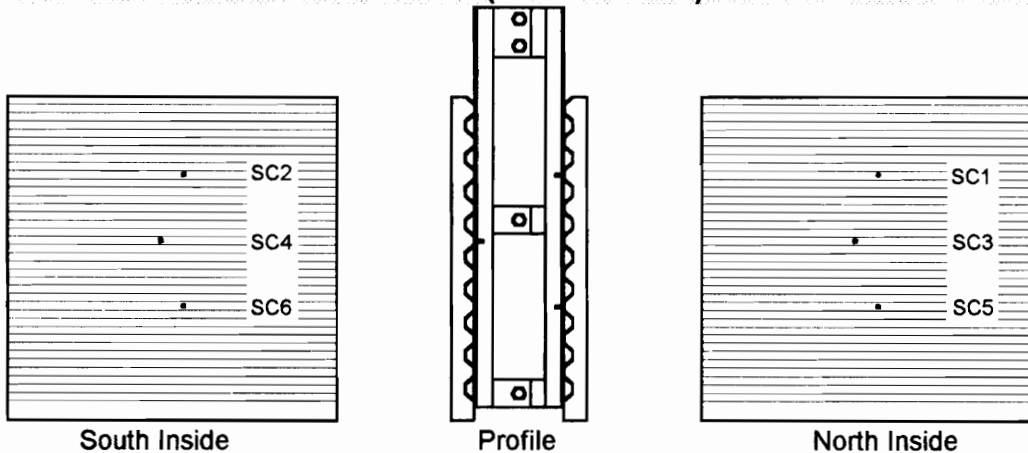
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 5, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>6</u>
Deck:	Type: <u>1.0C, 26 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u> F_u : <u>90.2 ksi</u>
Base Member:	Section: <u>2L 1.25x1.25x0.123</u>
	F_y : <u>57.1 ksi</u> F_u : <u>85.0 ksi</u>
Slab:	Thickness: <u>4 in.</u> f'_c : <u>4290 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

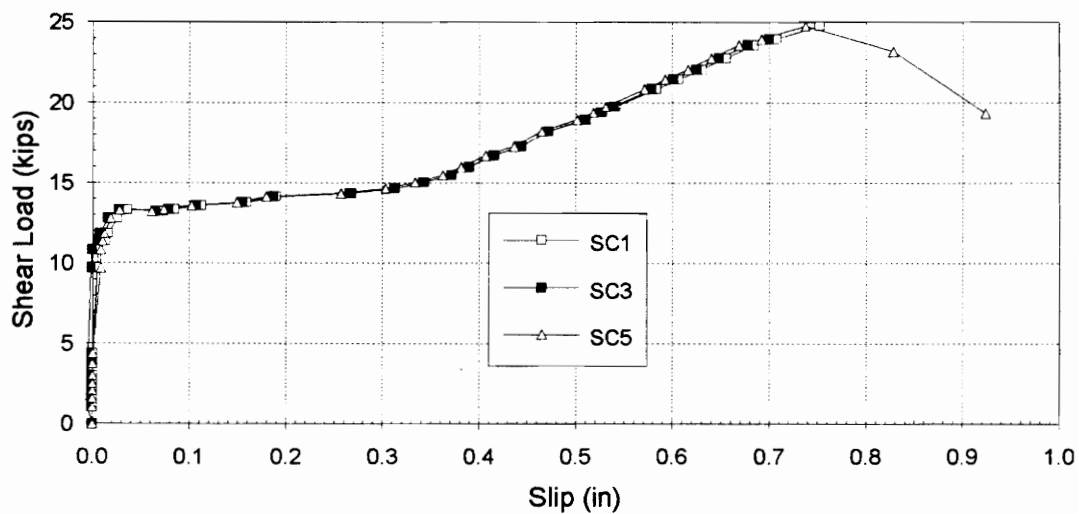
Peak Shear Load:	<u>24.75 kips</u>	
Peak Shear Load Per Fastener:	<u>4.13 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.752 in.</u>	SC2: <u>0.788 in.</u>
	SC3: <u>xxx in.</u>	SC4: <u>xxx in.</u>
	SC5: <u>0.738 in.</u>	SC6: <u>xxx in.</u>

DAMAGE (not available)

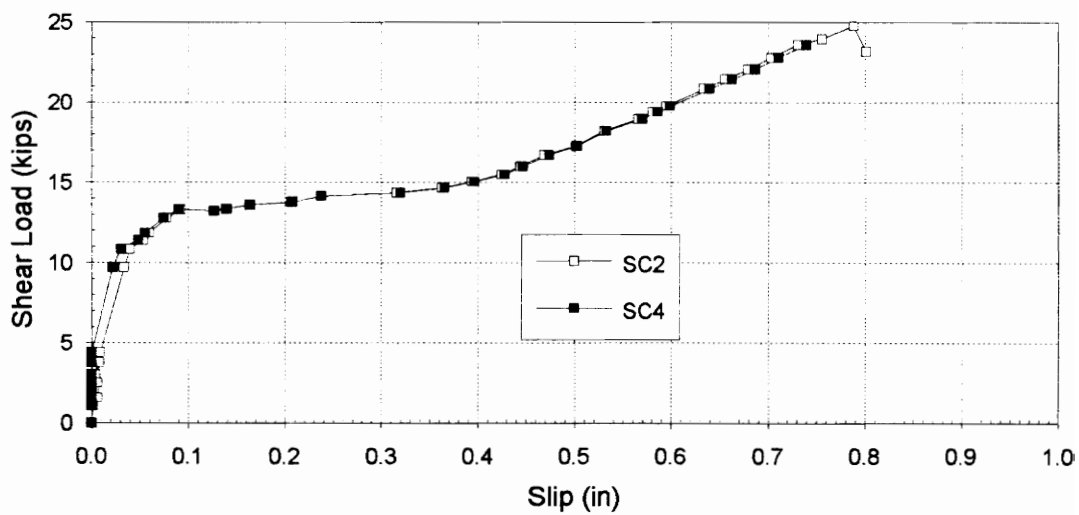


COMMENTS

Potentiometers were removed as deck interfered with nails; Potentiometer at SC6 not responding
Deck separation noted at $\approx 13k$; Screw pullout failure
Considerable rotation at screw base was noted



(a) Test P-2-1 - Load vs. North Slip



(b) Test P-2-1 - Load vs. South Slip

Fig. B.4 Test P-2-1 Load vs. Slip Plots

Table B.4 Test P-2-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)					
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
0.00	0.00	0.000	0.000	0.000	0.000	0.000	xxx
-1.05	-0.10	0.000	0.001	-0.005	0.000	0.000	xxx
-2.03	-0.26	0.000	0.002	-0.005	0.000	0.000	xxx
-2.96	-0.31	0.000	0.004	-0.005	0.000	0.000	xxx
-4.00	-0.40	0.000	0.007	-0.005	0.000	0.000	xxx
-1.58	-0.22	0.000	0.007	-0.004	0.000	0.000	xxx
-2.49	-0.27	0.000	0.007	-0.004	0.000	0.000	xxx
-3.74	-0.35	0.000	0.008	-0.004	0.000	0.000	xxx
-4.39	-0.44	0.000	0.009	-0.004	0.000	0.000	xxx
-4.89	-0.50	0.001	0.010	-0.004	0.000	0.000	xxx
-6.08	-0.58	0.001	0.013	-0.004	0.000	0.000	xxx
-6.90	-0.70	0.001	0.017	-0.002	0.000	0.000	xxx
-7.94	-0.79	0.002	0.021	-0.002	0.016	0.009	xxx
-8.96	-0.90	0.004	0.024	-0.002	0.016	0.009	xxx
-9.71	-0.98	0.005	0.034	-0.002	0.022	0.009	xxx
-10.82	-1.10	0.007	0.040	-0.001	0.031	0.009	xxx
-11.39	-1.21	0.014	0.054	0.005	0.049	0.010	xxx
-11.85	-1.22	0.017	0.060	0.008	0.056	0.012	xxx
-12.77	-1.34	0.026	0.078	0.017	0.075	0.019	xxx
-13.32	-1.44	0.037	0.093	0.027	0.090	0.028	xxx
-13.22	-1.53	0.073	0.126	0.066	0.127	0.061	xxx
-13.35	-1.48	0.086	0.139	0.078	0.140	0.073	xxx
-13.59	-1.43	0.113	0.163	0.107	0.164	0.103	xxx
-13.77	-1.48	0.159	0.207	0.155	0.207	0.149	xxx
-14.12	-1.50	0.189	0.237	0.187	0.238	0.179	xxx
-14.35	-1.56	0.268	0.316	0.266	0.320	0.257	xxx
-14.66	-1.53	0.313	0.363	0.313	0.366	0.303	xxx
-15.04	-1.58	0.342	0.394	0.343	0.396	0.334	xxx
-15.48	-1.58	0.372	0.425	0.372	0.428	0.363	xxx
-15.98	-1.70	0.389	0.444	0.390	0.447	0.381	xxx
-16.70	-1.74	0.415	0.469	0.416	0.474	0.407	xxx
-17.27	-1.81	0.443	0.501	0.444	0.503	0.437	xxx
-18.20	-1.89	0.472	0.530	0.472	0.533	0.465	xxx
-18.94	-1.97	0.511	0.566	0.509	0.570	0.502	xxx
-19.38	-2.01	0.527	0.581	0.526	0.586	0.518	xxx
-19.76	-2.06	0.541	0.595	0.539	0.599	0.531	xxx
-20.85	-2.11	0.583	0.634	0.578	0.640	0.571	xxx
-21.45	-2.20	0.606	0.656	0.601	0.663	0.593	xxx
-22.06	-2.25	0.630	0.680	0.625	0.687	0.616	xxx
-22.77	-2.29	0.655	0.703	0.648	0.711	0.640	xxx
-23.58	-2.41	0.684	0.731	0.678	0.740	0.669	xxx
-23.94	-2.47	0.708	0.755	0.700	xxx	0.692	xxx
-24.75	-2.55	0.752	0.788	xxx	xxx	0.738	xxx
-23.18	-2.80	xxx	0.801	xxx	xxx	0.828	xxx
-19.34	-2.78	xxx	xxx	xxx	xxx	0.923	xxx

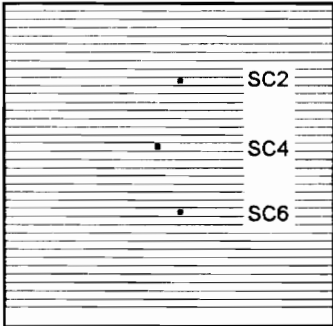
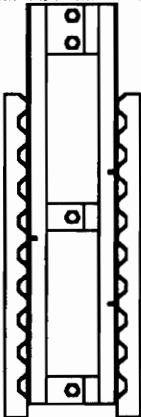
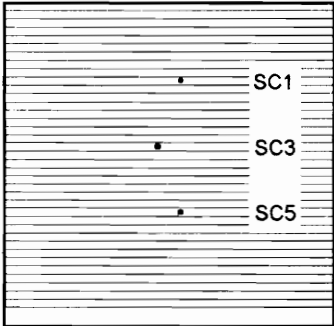
PUSHOUT TEST SUMMARY SHEET

Test: P-2-2
Test Designation: SC-5-2-0.123-1.0C-4-2

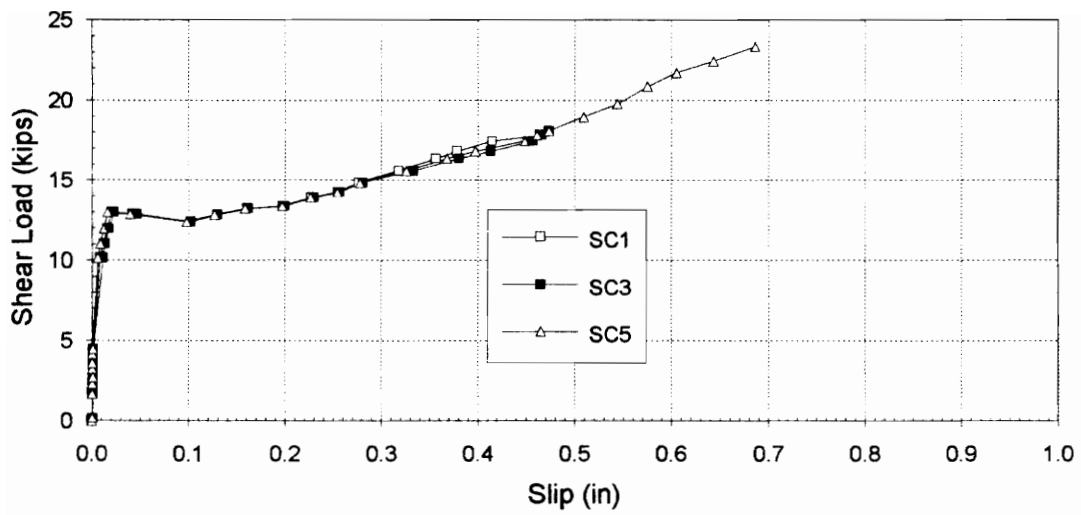
Test Date: 21 SEP 92

SPECIMEN DESCRIPTION			
Fastener:	Type: <u>Elco, grade5, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>6</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.123</u>		
	F_y : <u>57.1 ksi</u>	F_u : <u>85.0 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>4270 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

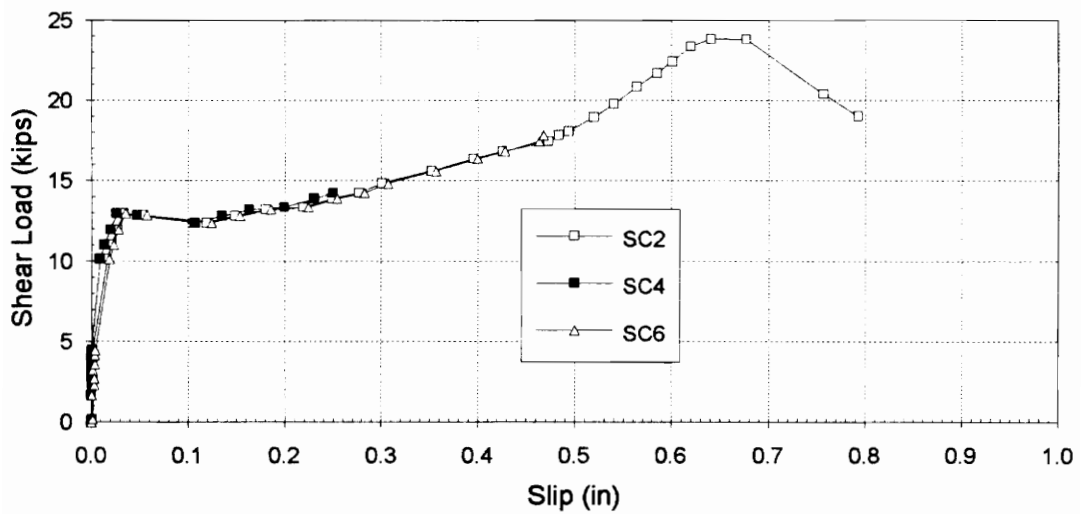
TEST RESULTS			
Peak Shear Load: <u>23.82 kips</u>			
Peak Shear Load Per Fastener: <u>3.97 kips</u>			
Slip at Peak Shear Load:	SC1: <u>xxx in.</u>	SC2: <u>0.641 in.</u>	
	SC3: <u>xxx in.</u>	SC4: <u>xxx in.</u>	
	SC5: <u>xxx in.</u>	SC6: <u>xxx in.</u>	

DAMAGE (not available)		
		
South Inside	Profile	North Inside

COMMENTS
Potentiometers were removed as deck interfered with nails
Deck separated from slab at $\approx 12.5k$; Screw pullout failure
Considerable rotation at screw base was noted



(a) Test P-2-2 - Load vs. North Slip



(b) Test P-2-2 - Load vs. South Slip

Fig. B.5 Test P-2-2 Load vs. Slip Plots

Table B.5 Test P-2-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)					
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
-1.67	-0.19	0.001	0.000	0.001	0.000	0.001	0.001
-3.23	-0.31	0.001	0.000	0.001	0.000	0.001	0.002
-4.14	-0.42	0.002	0.001	0.001	0.000	0.001	0.004
-2.31	-0.19	0.002	0.001	0.001	0.001	0.001	0.003
-0.15	-0.03	0.001	0.001	0.001	0.001	0.001	0.002
-2.70	-0.26	0.002	0.001	0.001	0.001	0.001	0.003
-3.59	-0.36	0.002	0.001	0.001	0.001	0.001	0.004
-4.47	-0.44	0.002	0.002	0.002	0.001	0.001	0.004
-5.18	-0.50	0.002	0.002	0.002	0.001	0.001	0.005
-6.24	-0.61	0.003	0.005	0.004	0.001	0.001	0.007
-7.02	-0.70	0.004	0.007	0.006	0.001	0.002	0.009
-8.04	-0.81	0.006	0.009	0.007	0.001	0.003	0.012
-9.25	-0.90	0.007	0.012	0.009	0.009	0.004	0.015
-10.14	-1.01	0.009	0.016	0.012	0.009	0.006	0.019
-11.02	-1.09	0.012	0.021	0.014	0.013	0.009	0.023
-11.95	-1.21	0.016	0.027	0.018	0.020	0.012	0.028
-12.97	-1.29	0.021	0.034	0.023	0.026	0.017	0.035
-12.86	-1.35	0.042	0.054	0.047	0.047	0.040	0.057
-12.38	-1.32	0.103	0.119	0.103	0.107	0.098	0.124
-12.81	-1.36	0.130	0.148	0.130	0.135	0.127	0.153
-13.21	-1.39	0.161	0.180	0.162	0.163	0.158	0.186
-13.38	-1.41	0.197	0.219	0.200	0.199	0.197	0.224
-13.89	-1.41	0.227	0.249	0.230	0.231	0.226	0.254
-14.25	-1.47	0.254	0.277	0.257	0.250	0.254	0.283
-14.84	-1.50	0.276	0.301	0.280	xxx	0.278	0.307
-15.60	-1.59	0.318	0.352	0.333	xxx	0.326	0.357
-16.36	-1.68	0.356	0.396	0.381	xxx	0.368	0.400
-16.82	-1.70	0.378	0.426	0.413	xxx	0.398	0.428
-17.44	-1.77	0.415	0.473	0.457	xxx	0.448	0.463
-17.82	-1.81	0.466	0.484	0.464	xxx	0.461	0.468
-18.06	-1.84	xxx	0.494	0.473	xxx	0.474	xxx
-18.94	-1.92	xxx	0.520	xxx	xxx	0.509	xxx
-19.77	-2.00	xxx	0.540	xxx	xxx	0.544	xxx
-20.86	-2.13	xxx	0.564	xxx	xxx	0.575	xxx
-21.72	-2.20	xxx	0.585	xxx	xxx	0.605	xxx
-22.42	-2.30	xxx	0.601	xxx	xxx	0.643	xxx
-23.35	-2.38	xxx	0.620	xxx	xxx	0.686	xxx
-23.82	-2.40	xxx	0.641	xxx	xxx	xxx	xxx
-23.79	-2.41	xxx	0.677	xxx	xxx	xxx	xxx
-20.40	-2.70	xxx	0.757	xxx	xxx	xxx	xxx
-19.01	-2.28	xxx	0.793	xxx	xxx	xxx	xxx

PUSHOUT TEST SUMMARY SHEET

Test: P-2-3
Test Designation: SC-5-2-0.123-1.0C-4-3

Test Date: 23 SEP 92

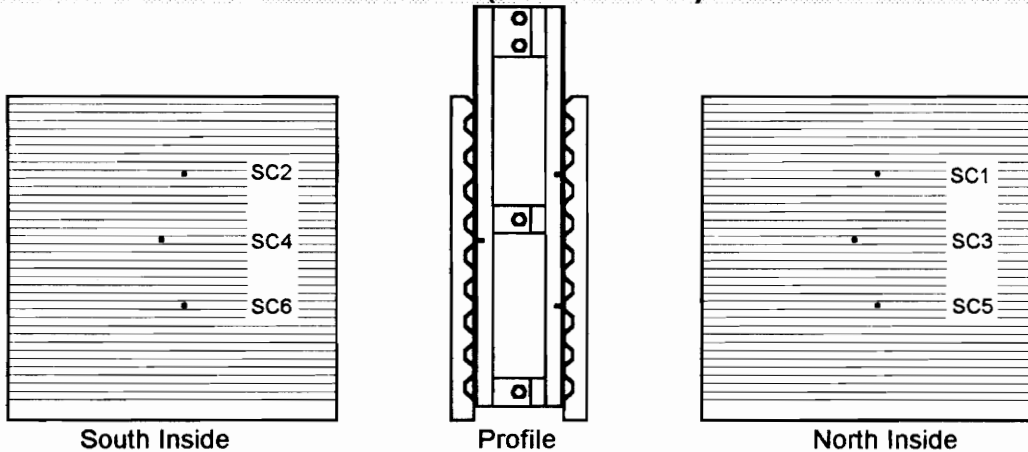
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 5, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>6</u>
Deck:	Type: <u>1.0C, 26 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u> F_u : <u>90.2 ksi</u>
Base Member:	Section: <u>2L 1.25x1.25x0.123</u>
	F_y : <u>57.1 ksi</u> F_u : <u>85.0 ksi</u>
Slab:	Thickness: <u>4 in.</u> f'_c : <u>4280 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

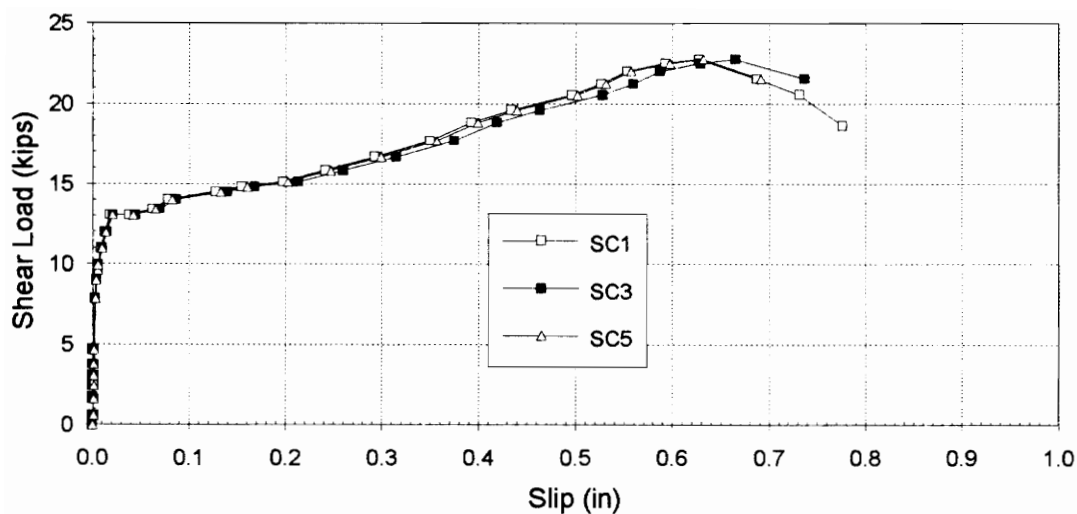
Peak Shear Load:	<u>22.81 kips</u>	
Peak Shear Load Per Fastener:	<u>3.80 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.627 in.</u>	SC2: <u>0.734 in.</u>
	SC3: <u>0.665 in.</u>	SC4: <u>xxx in.</u>
	SC5: <u>0.632 in.</u>	SC6: <u>0.741 in.</u>

DAMAGE (not available)

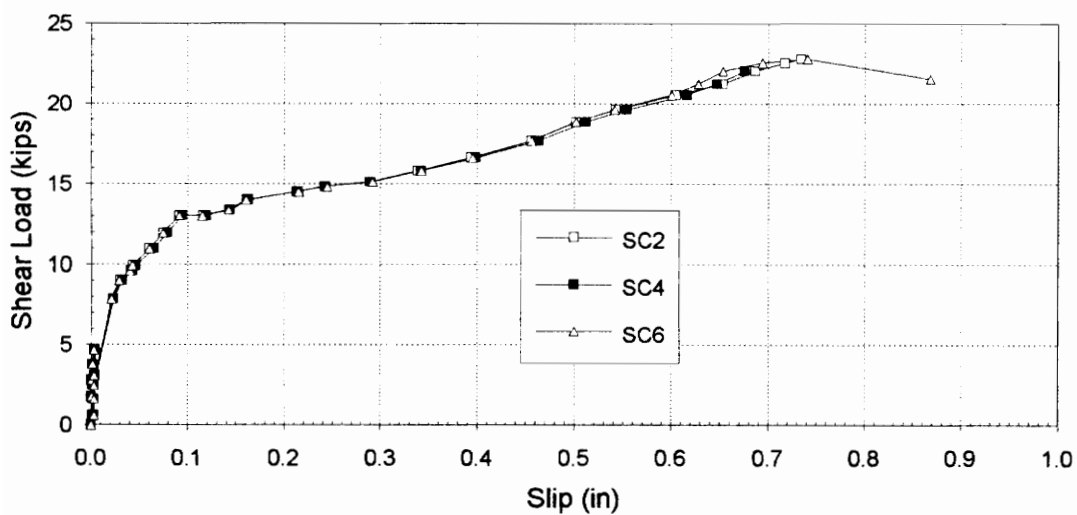


COMMENTS

Potentiometers removed as deck interfered with nail
Deck separated from slab at $\approx 9.5k$; Screw pullout failure
Considerable rotation at screw base was noted



(a) Test P-2-3 - Load vs. North Slip



(b) Test P-2-3 - Load vs. South Slip

Fig. B.6 Test P-2-3 Load vs. Slip Plots

Table B.6 Test P-2-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)					
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
-1.75	-0.18	0.000	0.000	0.000	0.000	0.001	0.001
-2.81	-0.28	0.001	0.001	0.000	0.000	0.001	0.001
-3.76	-0.37	0.001	0.002	0.000	0.002	0.001	0.002
-4.68	-0.47	0.001	0.004	0.000	0.003	0.002	0.003
-3.08	-0.35	0.001	0.004	0.000	0.003	0.001	0.003
-0.57	-0.08	0.001	0.002	0.000	0.003	0.001	0.003
-1.59	-0.18	0.001	0.002	0.000	0.003	0.001	0.003
-2.46	-0.24	0.001	0.002	0.000	0.003	0.002	0.003
-3.38	-0.34	0.001	0.003	0.000	0.003	0.001	0.003
-4.41	-0.44	0.001	0.004	0.000	0.003	0.001	0.003
-5.06	-0.50	0.001	0.005	0.000	0.004	0.002	0.004
-6.12	-0.60	0.002	0.008	0.000	0.008	0.002	0.007
-6.96	-0.70	0.002	0.013	0.002	0.014	0.002	0.013
-7.85	-0.80	0.003	0.023	0.002	0.023	0.003	0.021
-9.04	-0.91	0.004	0.030	0.004	0.032	0.004	0.029
-9.61	-0.99	0.006	0.041	0.006	0.043	0.006	0.040
-9.93	-1.01	0.006	0.043	0.006	0.046	0.006	0.043
-10.97	-1.09	0.009	0.060	0.010	0.065	0.010	0.060
-11.98	-1.20	0.013	0.075	0.015	0.079	0.014	0.074
-13.04	-1.30	0.018	0.092	0.021	0.095	0.021	0.092
-13.03	-1.39	0.038	0.117	0.044	0.119	0.042	0.115
-13.41	-1.37	0.062	0.143	0.070	0.144	0.066	0.142
-14.02	-1.41	0.078	0.162	0.086	0.163	0.083	0.161
-14.51	-1.47	0.127	0.215	0.140	0.213	0.132	0.215
-14.83	-1.50	0.154	0.243	0.168	0.242	0.160	0.245
-15.13	-1.54	0.197	0.290	0.213	0.289	0.202	0.292
-15.82	-1.60	0.241	0.339	0.260	0.343	0.247	0.343
-16.65	-1.69	0.292	0.394	0.315	0.399	0.299	0.396
-17.66	-1.79	0.350	0.456	0.375	0.463	0.357	0.456
-18.85	-1.89	0.392	0.502	0.419	0.512	0.399	0.502
-19.61	-1.98	0.433	0.542	0.463	0.554	0.440	0.542
-20.54	-2.08	0.496	0.605	0.528	0.616	0.502	0.600
-21.24	-2.15	0.526	0.654	0.560	0.647	0.531	0.628
-22.03	-2.21	0.553	0.686	0.588	0.675	0.557	0.653
-22.54	-2.28	0.592	0.718	0.629	xxx	0.597	0.694
-22.81	-2.32	0.627	0.734	0.665	xxx	0.632	0.741
-21.55	-2.45	0.687	xxx	0.737	xxx	0.691	0.868
-20.57	-2.17	0.731	xxx	xxx	xxx	xxx	xxx
-18.68	-1.97	0.776	xxx	xxx	xxx	xxx	xxx

PUSHOUT TEST SUMMARY SHEET

Test: P-3-1
Test Designation: SC-8-2-0.123-1.0C-4-1

Test Date: 25 AUG 92

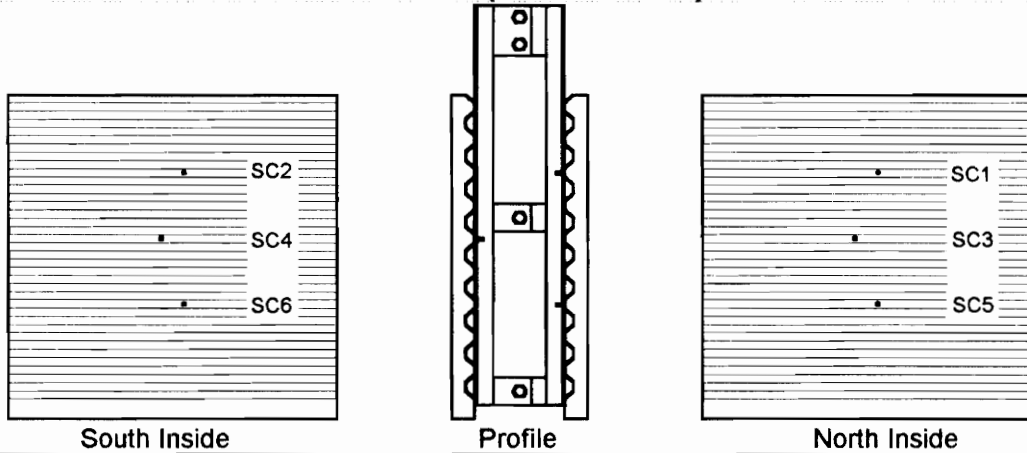
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>6</u>
Deck:	Type: <u>1.0C, 26 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u> F_u : <u>90.2 ksi</u>
Base Member:	Section: <u>2L 1.25x1.25x0.123</u>
	F_y : <u>57.1 ksi</u> F_u : <u>85.0 ksi</u>
Slab:	Thickness: <u>4 in.</u> f'_c : <u>4230 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

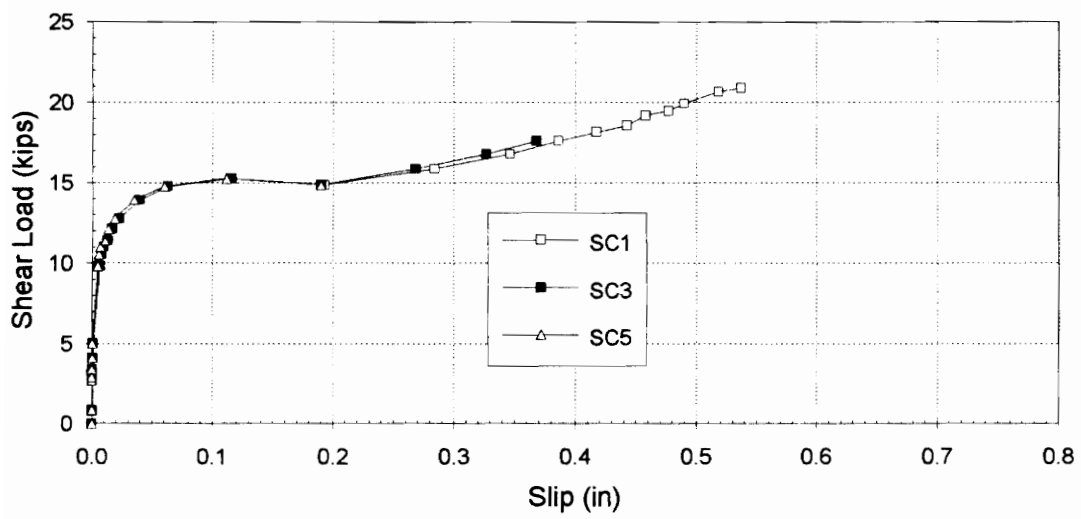
Peak Shear Load: 23.15 kips
Peak Shear Load Per Fastener: 3.86 kips
Slip at Peak Shear Load: SC1: xxx in. SC2: 0.709 in.
SC3: xxx in. SC4: xxx in.
SC5: xxx in. SC6: xxx in.

DAMAGE (not available)

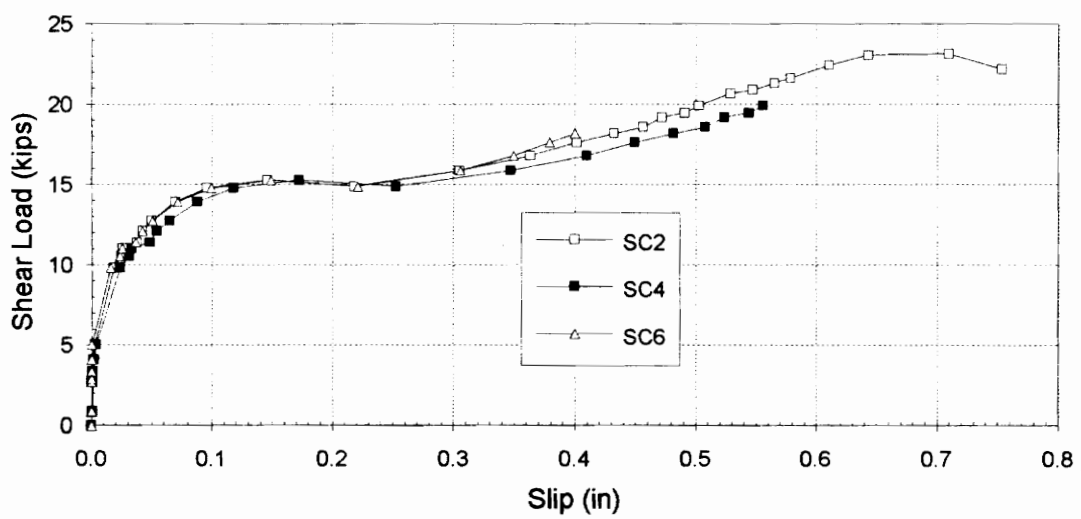


COMMENTS

Potentiometers were removed as deck interfered with nails
Deck separated from slab at $\approx 10.5k$; Screw pullout failure
Considerable rotation at screw base was noted



(a) Test P-3-1 - Load vs. North Slip



(b) Test P-3-1 - Load vs. South Slip

Fig. B.7 Test P-3-1 Load vs. Slip Plots

Table B.7 Test P-3-1 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)					
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
-2.68	-0.24	0.001	0.001	0.001	0.000	0.000	0.000
-3.05	-0.32	0.000	0.001	0.001	0.001	0.000	0.000
-0.83	-0.31	0.000	0.001	0.001	0.001	0.000	0.000
-3.37	-0.34	0.001	0.001	0.001	0.001	0.000	0.000
-0.87	-0.34	0.000	0.001	0.001	0.001	0.000	0.000
-2.88	-0.30	0.001	0.001	0.001	0.001	0.000	0.000
-4.13	-0.38	0.001	0.001	0.001	0.002	0.001	0.000
-5.01	-0.51	0.001	0.002	0.001	0.004	0.001	0.000
-5.73	-0.56	0.002	0.004	0.001	0.005	0.001	0.002
-5.82	-0.59	0.002	0.005	0.002	0.006	0.003	0.002
-6.80	-0.68	0.002	0.007	0.002	0.009	0.003	0.004
-7.77	-0.79	0.003	0.010	0.003	0.013	0.003	0.007
-8.55	-0.88	0.004	0.013	0.004	0.017	0.003	0.010
-9.83	-1.00	0.007	0.018	0.006	0.024	0.005	0.016
-10.55	-1.07	0.009	0.024	0.008	0.031	0.006	0.023
-11.03	-1.12	0.010	0.026	0.010	0.034	0.007	0.025
-11.41	-1.22	0.013	0.037	0.013	0.048	0.011	0.037
-12.12	-1.25	0.017	0.042	0.017	0.054	0.013	0.042
-12.75	-1.31	0.023	0.050	0.023	0.065	0.019	0.051
-13.92	-1.45	0.040	0.070	0.040	0.088	0.035	0.071
-14.76	-1.55	0.063	0.096	0.063	0.118	0.060	0.099
-15.28	-1.72	0.115	0.146	0.116	0.172	0.111	0.149
-14.88	-1.81	0.193	0.218	0.190	0.253	0.190	0.221
-15.88	-1.67	0.284	0.305	0.268	0.347	xxx	0.306
-16.79	-1.72	0.347	0.364	0.327	0.410	xxx	0.350
-17.60	-1.82	0.386	0.401	0.368	0.449	xxx	0.379
-18.16	-1.88	0.417	0.432	xxx	0.482	xxx	0.400
-18.57	-1.95	0.443	0.456	xxx	0.508	xxx	xxx
-19.20	-1.93	0.458	0.472	xxx	0.524	xxx	xxx
-19.47	-1.98	0.477	0.491	xxx	0.544	xxx	xxx
-19.92	-2.01	0.490	0.503	xxx	0.555	xxx	xxx
-20.66	-2.10	0.518	0.529	xxx	xxx	xxx	xxx
-20.88	-2.09	0.537	0.547	xxx	xxx	xxx	xxx
-21.30	-2.18	xxx	0.565	xxx	xxx	xxx	xxx
-21.63	-2.19	xxx	0.578	xxx	xxx	xxx	xxx
-22.43	-2.25	xxx	0.611	xxx	xxx	xxx	xxx
-23.07	-2.33	xxx	0.643	xxx	xxx	xxx	xxx
-23.15	-2.49	xxx	0.709	xxx	xxx	xxx	xxx
-22.19	-2.45	xxx	0.753	xxx	xxx	xxx	xxx
-21.76	-2.54	xxx	xxx	xxx	xxx	xxx	xxx

PUSHOUT TEST SUMMARY SHEET

Test: P-3-2
Test Designation: SC-8-2-0.123-1.0C-4-2

Test Date: 17 SEP 92

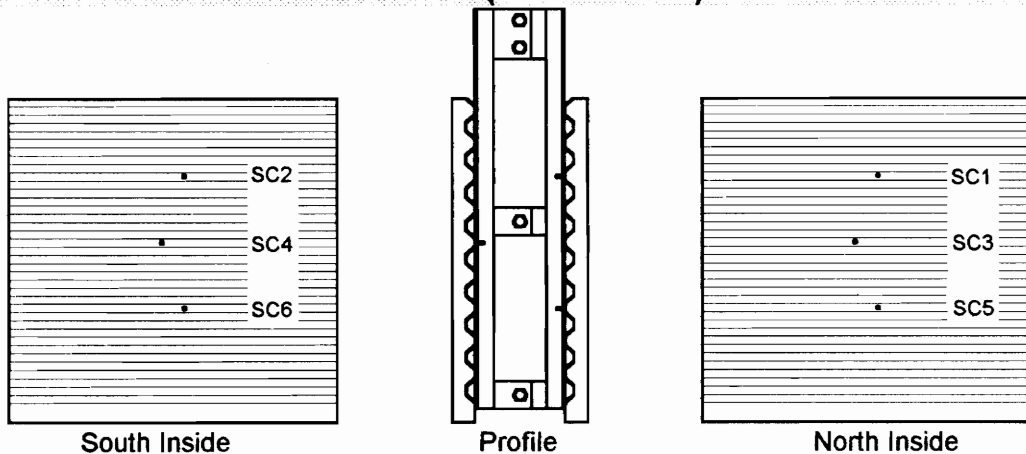
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>
	# Per Specimen: <u>6</u>
Deck:	Type: <u>1.0C, 26 ga</u> Width: <u>36 in.</u> Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u> F_u : <u>90.2 ksi</u>
Base Member:	Section: <u>2L 1.25x1.25x0.123</u>
	F_y : <u>57.1 ksi</u> F_u : <u>85.0 ksi</u>
Slab:	Thickness: <u>4 in.</u> f'_c : <u>4140 psi</u>
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>

TEST RESULTS

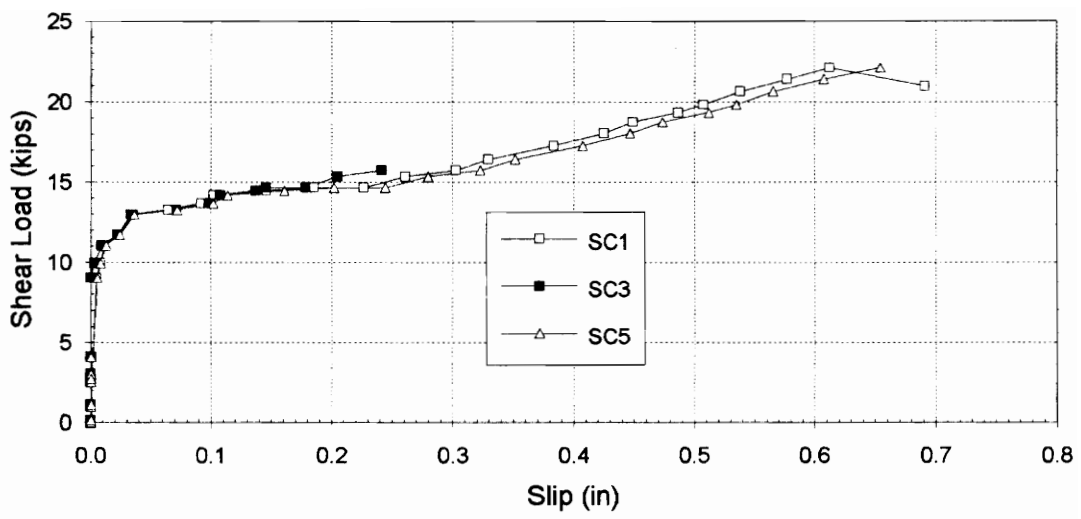
Peak Shear Load:	<u>22.13 kips</u>	
Peak Shear Load Per Fastener:	<u>3.69 kips</u>	
Slip at Peak Shear Load:	SC1: <u>0.613 in.</u>	SC2: <u>xxx in.</u>
	SC3: <u>xxx in.</u>	SC4: <u>0.644 in.</u>
	SC5: <u>0.654 in.</u>	SC6: <u>xxx in.</u>

DAMAGE (not available)

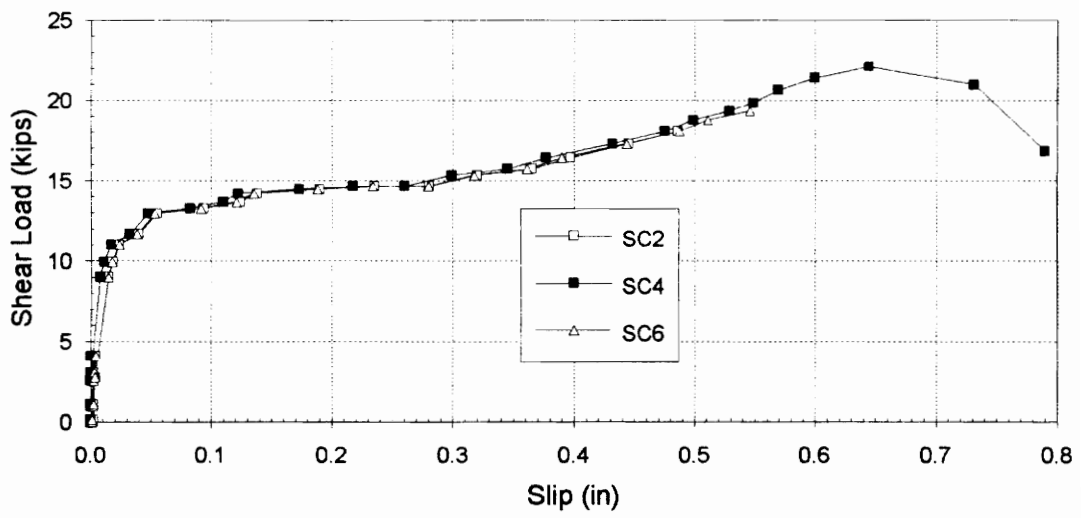


COMMENTS

Potentiometers removed as deck interfered with nails
Deck separated from slab at $\approx 11k$; Screw pullout failure
Considerable rotation at screw base was noted



(a) Test P-3-2 - Load vs. North Slip



(b) Test P-3-2 - Load vs. South Slip

Fig. B.8 Test P-3-2 Load vs. Slip Plots

Table B.8 Test P-3-2 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)					
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
-1.00	-0.20	0.000	0.000	0.000	0.000	0.001	0.002
-2.53	-0.28	0.000	0.002	0.000	0.000	0.001	0.002
-3.05	-0.30	0.000	0.002	0.000	0.000	0.001	0.003
-4.13	-0.40	0.001	0.004	0.000	0.000	0.001	0.004
0.02	-0.11	0.000	0.002	0.000	0.000	0.001	0.001
-0.13	-0.09	0.000	0.002	0.000	0.000	0.001	0.001
-1.10	-0.11	0.000	0.002	0.000	0.000	0.001	0.002
-2.74	-0.26	0.001	0.004	0.000	0.000	0.001	0.004
-3.69	-0.36	0.000	0.004	0.000	0.000	0.001	0.004
-5.07	-0.53	0.001	0.005	0.000	0.000	0.001	0.005
-6.38	-0.62	0.001	0.008	0.000	0.000	0.001	0.006
-7.42	-0.70	0.002	0.010	0.000	0.001	0.001	0.009
-7.92	-0.78	0.002	0.010	0.000	0.003	0.002	0.010
-9.03	-0.92	0.005	0.015	0.000	0.008	0.006	0.015
-9.93	-1.00	0.008	0.018	0.003	0.011	0.009	0.018
-11.04	-1.10	0.012	0.024	0.009	0.017	0.013	0.024
-11.69	-1.20	0.023	0.040	0.023	0.032	0.025	0.038
-12.97	-1.29	0.034	0.055	0.036	0.048	0.037	0.053
-13.26	-1.38	0.065	0.094	0.072	0.082	0.072	0.092
-13.67	-1.43	0.092	0.124	0.099	0.110	0.102	0.121
-14.19	-1.44	0.103	0.138	0.108	0.122	0.114	0.135
-14.46	-1.53	0.146	0.190	0.137	0.173	0.161	0.188
-14.65	-1.58	0.185	0.235	0.146	0.217	0.202	0.234
-14.65	-1.56	0.227	0.280	0.179	0.260	0.244	0.280
-15.34	-1.65	0.261	0.320	0.205	0.299	0.280	0.318
-15.74	-1.64	0.303	0.365	0.242	0.345	0.323	0.361
-16.41	-1.67	0.330	0.397	xxx	0.377	0.352	0.390
-17.26	-1.80	0.383	0.445	xxx	0.432	0.407	0.443
-18.05	-1.82	0.425	0.486	xxx	0.475	0.447	0.487
-18.76	-1.92	0.449	xxx	xxx	0.499	0.474	0.511
-19.34	-1.96	0.487	xxx	xxx	0.529	0.512	0.546
-19.84	-2.03	0.507	xxx	xxx	0.548	0.535	xxx
-20.65	-2.09	0.538	xxx	xxx	0.569	0.565	xxx
-21.41	-2.17	0.577	xxx	xxx	0.600	0.608	xxx
-22.13	-2.28	0.613	xxx	xxx	0.644	0.654	xxx
-20.98	-2.31	0.691	xxx	xxx	0.731	xxx	xxx
-16.83	-2.37	xxx	xxx	xxx	0.790	xxx	xxx

PUSHOUT TEST SUMMARY SHEET

Test: P-3-3
 Test Designation: SC-8-2-0.123-1.0C-4-3

Test Date: 29 SEP 92

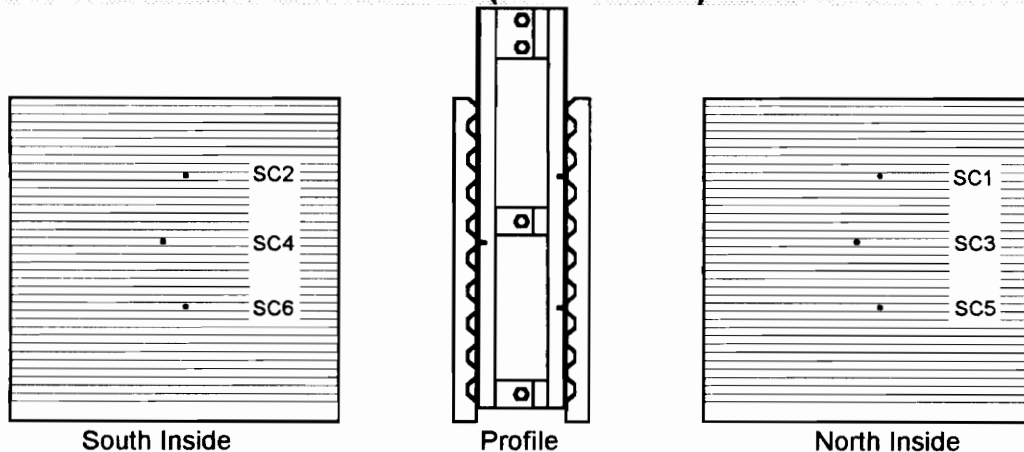
SPECIMEN DESCRIPTION

Fastener:	Type: <u>Elco, grade 8, 5/16 in. ϕ, 2 in. standoff screw</u>		
	# Per Specimen: <u>6</u>		
Deck:	Type: <u>1.0C, 26 ga</u>	Width: <u>36 in.</u>	Length: <u>36 in.</u>
	F_y : <u>82.3 ksi</u>	F_u : <u>90.2 ksi</u>	
Base Member:	Section: <u>2L 1.25x1.25x0.123</u>		
	F_y : <u>57.1 ksi</u>	F_u : <u>85.0 ksi</u>	
Slab:	Thickness: <u>4 in.</u>	f'_c : <u>4320 psi</u>	
Mesh:	Type: <u>WWF 6x6-W1.4xW1.4</u>		

TEST RESULTS

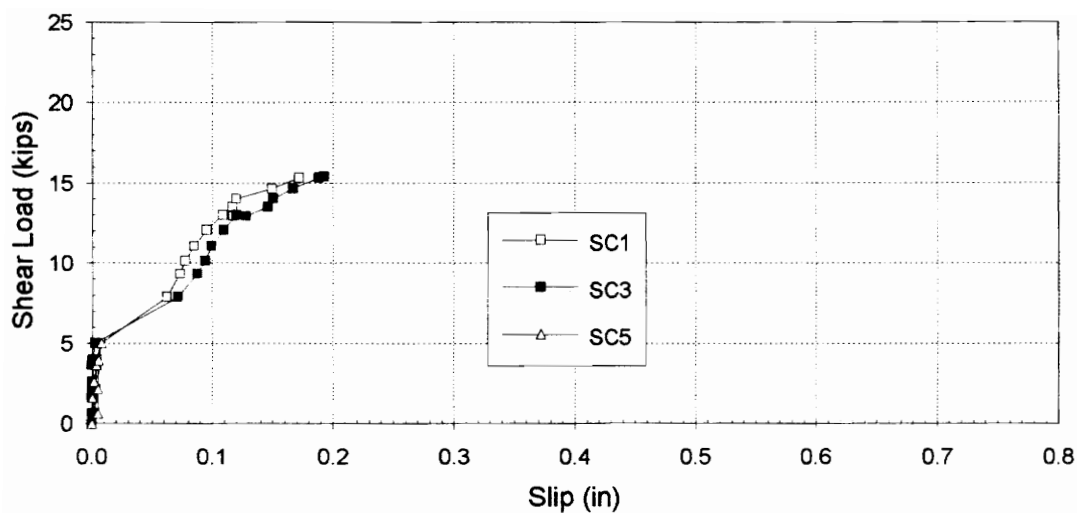
Peak Shear Load: <u>21.16 kips</u>	
Peak Shear Load Per Fastener: <u>3.53 kips</u>	
Slip at Peak Shear Load:	SC1: <u>xxx in.</u> SC3: <u>xxx in.</u> SC5: <u>xxx in.</u> SC2: <u>0.707 in.</u> SC4: <u>0.711 in.</u> SC6: <u>0.752 in.</u>

DAMAGE (not available)

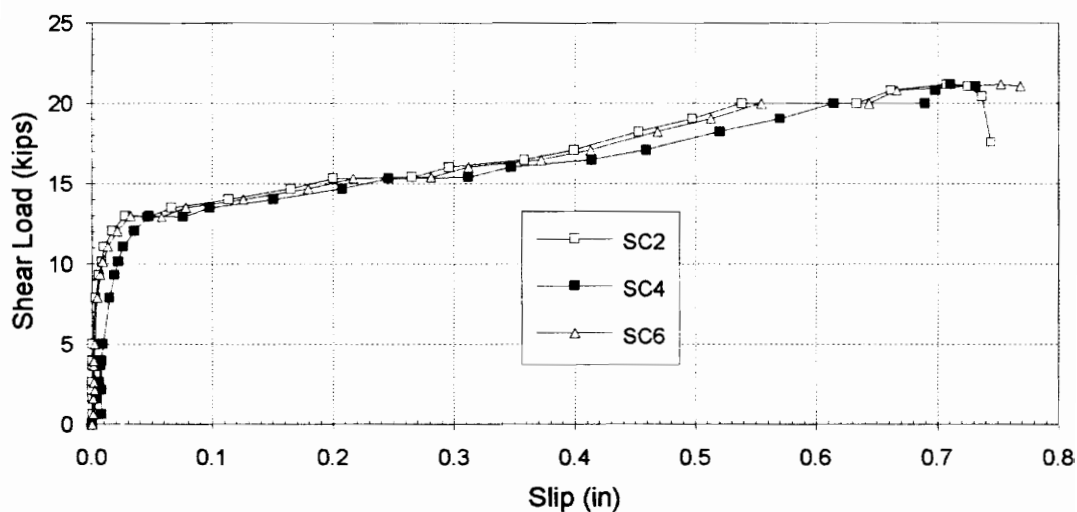


COMMENTS

Potentiometers removed as deck interfered with nails
 Deck separated from slab at $\approx 6.5k$; Screw pullout failure
 Considerable rotation at screw base was noted



(a) Test P-3-3 - Load vs. North Slip



(b) Test P-3-3 - Load vs. South Slip

Fig. B.9 Test P-3-3 Load vs. Slip Plots

Table B.9 Test P-3-3 Data

Shear Load (kips)	Normal Load (kips)	Slips (in)					
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
-1.59	-0.20	0.001	0.001	0.000	0.004	0.001	0.001
-2.62	-0.28	0.002	0.000	0.000	0.006	0.002	0.002
-3.65	-0.37	0.004	0.001	0.000	0.007	0.004	0.002
-4.00	-0.40	0.004	0.001	0.001	0.007	0.005	0.002
-0.64	-0.10	0.002	0.001	0.001	0.008	0.005	0.001
-2.16	-0.20	0.003	0.000	0.001	0.008	0.005	0.002
-3.95	-0.41	0.004	0.001	0.001	0.008	0.006	0.002
-5.01	-0.52	0.007	0.001	0.002	0.009	0.008	0.002
-6.09	-0.61	0.013	0.001	0.010	0.010	0.013	0.002
-5.82	-0.61	0.015	0.001	0.012	0.010	0.015	0.002
-6.51	-0.65	0.017	0.001	0.016	0.013	0.017	0.002
-5.74	-0.63	0.023	0.001	0.024	0.013	0.021	0.002
-7.01	-0.72	0.040	0.002	0.047	0.013	0.032	0.003
-7.90	-0.81	0.062	0.003	0.072	0.015	xxx	0.004
-9.32	-0.93	0.073	0.006	0.088	0.019	xxx	0.007
-10.13	-1.01	0.078	0.009	0.094	0.022	xxx	0.009
-11.07	-1.11	0.085	0.010	0.099	0.026	xxx	0.013
-12.05	-1.20	0.095	0.017	0.110	0.035	xxx	0.021
-13.00	-1.32	0.109	0.027	0.120	0.048	xxx	0.032
-12.92	-1.33	0.117	0.047	0.128	0.076	xxx	0.058
-13.50	-1.38	0.117	0.067	0.146	0.098	xxx	0.078
-14.02	-1.42	0.120	0.114	0.151	0.151	xxx	0.126
-14.66	-1.48	0.150	0.165	0.167	0.208	xxx	0.180
-15.33	-1.55	0.172	0.200	0.189	0.246	xxx	0.217
-15.42	-1.56	xxx	0.265	0.193	0.312	xxx	0.281
-16.03	-1.61	xxx	0.296	xxx	0.347	xxx	0.312
-16.47	-1.64	xxx	0.358	xxx	0.413	xxx	0.372
-17.07	-1.73	xxx	0.399	xxx	0.459	xxx	0.413
-18.22	-1.81	xxx	0.453	xxx	0.520	xxx	0.468
-19.05	-1.90	xxx	0.497	xxx	0.570	xxx	0.513
-20.00	-2.03	xxx	0.538	xxx	0.614	xxx	0.554
-19.98	-2.05	xxx	0.633	xxx	0.689	xxx	0.644
-20.81	-2.11	xxx	0.662	xxx	0.698	xxx	0.666
-21.16	-2.16	xxx	0.707	xxx	0.711	xxx	0.752
-21.03	-2.17	xxx	0.725	xxx	0.732	xxx	0.768
-20.42	-2.15	xxx	0.737	xxx	xxx	xxx	xxx
-17.57	-2.29	xxx	0.744	xxx	xxx	xxx	xxx

APPENDIX C

Ollgaard, et al., Stud Shear Failure

Calculate the screw shear strength, V_s , based on the Ollgaard, et al., stud shear model for the 1.5 in. Elco grade 8 screw in 0.6C deck:

$$H_s = 1.50 \text{ in.}$$

$$h_r = 0.60 \text{ in.}$$

$$f'_c = 3.00 \text{ ksi}$$

$$d_s = 0.280 \text{ in.}$$

$$w_{r1} = 0.75 \text{ in.}$$

$$w_{r2} = 1.75 \text{ in.}$$

$$w_r = 1.25 \text{ in.}$$

$$w_c = 145 \text{ pcf}$$

$$N_r = 1.00$$

$$A_{sc} = 0.062 \text{ in.}^2$$

$$E_c = w_c^{1.5} \sqrt{f'_c}$$

$$E_c = 3024 \text{ ksi}$$

$$R = \text{deck reduction factor} = \frac{0.85}{\sqrt{N_r}} \left(\frac{w_r}{h_r} \right) \left(\frac{H_s}{h_r} - 1.0 \right) \leq 1.0$$

$$R = 1.00$$

$$V_s = 1.106 R A_{sc} f'_c{}^{0.3} E_c{}^{0.44}$$

$$V_s = 3.22 \text{ kips}$$

Ollgaard, et al., Stud Shear Failure

Calculate the screw shear strength, V_s , based on the Ollgaard, et al., stud shear model for the 2.0 in. Elco grade 8 screw in 1.0C deck:

$$H_s = 2.00 \text{ in.}$$

$$h_r = 1.00 \text{ in.}$$

$$f'_c = 3.00 \text{ ksi}$$

$$d_s = 0.280 \text{ in.}$$

$$w_{r1} = 0.90 \text{ in.}$$

$$w_{r2} = 2.78 \text{ in.}$$

$$w_r = 1.84 \text{ in.}$$

$$w_c = 145 \text{ pcf}$$

$$N_r = 1.00$$

$$A_{sc} = 0.062 \text{ in.}^2$$

$$E_c = w_c^{1.5} \sqrt{f'_c}$$

$$E_c = 3024 \text{ ksi}$$

$$R = \text{deck reduction factor} = \frac{0.85}{\sqrt{N_r}} \left(\frac{w_r}{h_r} \right) \left(\frac{H_s}{h_r} - 1.0 \right) \leq 1.0$$

$$R = 1.00$$

$$V_s = 1.106 R A_{sc} f'_c{}^{0.3} E_c{}^{0.44}$$

$$V_s = 3.22 \text{ kips}$$

Ollgaard, et al., Stud Shear Failure

Calculate the screw shear strength, V_s , based on the Ollgaard, et al., stud shear model for the 2.0 in. Elco grade 8 screw in 1.5VL deck:

$$H_s = 2.00 \text{ in.}$$

$$h_r = 1.50 \text{ in.}$$

$$f'_c = 3.00 \text{ ksi}$$

$$d_s = 0.280 \text{ in.}$$

$$w_{r1} = 1.75 \text{ in.}$$

$$w_{r2} = 2.50 \text{ in.}$$

$$w_r = 2.13 \text{ in.}$$

$$w_c = 145 \text{ pcf}$$

$$N_r = 1.00$$

$$A_{sc} = 0.062 \text{ in.}^2$$

$$E_c = w_c^{1.5} \sqrt{f'_c}$$

$$E_c = 3024 \text{ ksi}$$

$$R = \text{deck reduction factor} = \frac{0.85}{\sqrt{N_r}} \left(\frac{w_r}{h_r} \right) \left(\frac{H_s}{h_r} - 1.0 \right) \leq 1.0$$

$$R = 0.40$$

$$V_s = 1.106 R A_{sc} f'_c{}^{0.3} E_c{}^{0.44}$$

$$V_s = 1.29 \text{ kips}$$

Ollgaard, et al., Stud Shear Failure

Calculate the screw shear strength, V_s , based on the Ollgaard, et al., stud shear model for the 2.5 in. Elco grade 8 screw in 1.5VL deck:

$$H_s = 2.50 \text{ in.}$$

$$h_r = 1.50 \text{ in.}$$

$$f'_c = 3.00 \text{ ksi}$$

$$d_s = 0.280 \text{ in.}$$

$$w_{r1} = 1.75 \text{ in.}$$

$$w_{r2} = 2.50 \text{ in.}$$

$$w_r = 2.13 \text{ in.}$$

$$w_c = 145 \text{ pcf}$$

$$N_r = 1.00$$

$$A_{sc} = 0.062 \text{ in.}^2$$

$$E_c = w_c^{1.5} \sqrt{f'_c}$$

$$E_c = 3024 \text{ ksi}$$

$$R = \text{deck reduction factor} = \frac{0.85}{\sqrt{N_r}} \left(\frac{w_r}{h_r} \right) \left(\frac{H_s}{h_r} - 1.0 \right) \leq 1.0$$

$$R = 0.80$$

$$V_s = 1.106 R A_{sc} f'_c{}^{0.3} E_c{}^{0.44}$$

$$V_s = 2.58 \text{ kips}$$

Oehlers Concrete Splitting Failure

Calculate the force, P_s , based on Oehlers research, at which a splitting crack develops in a solid concrete slab at a screw location for the 2.0 in. Elco grade 8 screw:

$$H_s = 50.80 \text{ mm} \qquad d_s = 7.11 \text{ mm}$$

$$b = 914.4 \text{ mm}$$

$$f'_c = 20.68 \text{ N/mm}^2$$

$$h_a = \text{effective connector height} = 1.8d_s$$

$$h_a = 12.80 \text{ mm}$$

$$f_t = \text{indirect tensile strength of concrete} \approx 0.5\sqrt{f'_c}$$

$$f_t = 2.27 \text{ N/mm}^2$$

$$P_s = \frac{0.6h_af_tb\pi}{\left(1 - \frac{d_s}{b}\right)^2}$$

$$P_s = 50965 \text{ N}$$

$$P_s = 11458 \text{ lbs}$$

Hawkins and Mitchell Cone Pullout Failure

Calculate the screw shear strength, V_c , based on the Hawkins and Mitchell pyramidal shear cone model for the 1.5 in. Elco grade 8 screw in 0.6C deck:

$$H_s = 1.50 \text{ in.}$$

$$w_{r1} = 0.75 \text{ in.}$$

$$h_r = 0.60 \text{ in.}$$

$$w_{r2} = 1.75 \text{ in.}$$

$$f'_c = 3000 \text{ psi}$$

$$w_r = 1.25 \text{ in.}$$

$$H_s - h_r = 0.90 >$$

$$\frac{w_{r2}}{2} = 0.88$$

$$A_c = \begin{cases} 2\sqrt{2}(H_s - w_r) & \text{if } (H_s - h_r) < \frac{w_{r2}}{2} \\ 2\sqrt{2}(2(H_s - h_r)^2 + h_r w_r) & \text{if } (H_s - h_r) > \frac{w_{r2}}{2} \end{cases}$$

$$A_c = 6.70 \text{ in.}^2$$

$$V_c = 5.4 A_c \sqrt{f'_c}$$

$$V_c = 1983 \text{ lbs}$$

Hawkins and Mitchell Cone Pullout Failure

Calculate the screw shear strength, V_c , based on the Hawkins and Mitchell pyramidal shear cone model for the 2.0 in. Elco grade 8 screw in 1.0C deck:

$$H_s = 2.00 \text{ in.}$$

$$w_{r1} = 0.90 \text{ in.}$$

$$h_r = 1.00 \text{ in.}$$

$$w_{r2} = 2.78 \text{ in.}$$

$$f'_c = 3000 \text{ psi}$$

$$w_r = 1.84 \text{ in.}$$

$$H_s - h_r = 1.00 < \frac{w_{r2}}{2} = 1.39$$

$$A_c = \begin{cases} 2\sqrt{2}(H_s - w_r) & \text{if } (H_s - h_r) < \frac{w_{r2}}{2} \\ 2\sqrt{2}\left(2(H_s - h_r)^2 + h_r w_r\right) & \text{if } (H_s - h_r) > \frac{w_{r2}}{2} \end{cases}$$

$$A_c = 10.41 \text{ in.}^2$$

$$V_c = 5.4 A_c \sqrt{f'_c}$$

$$V_c = 3079 \text{ lbs}$$

Hawkins and Mitchell Cone Pullout Failure

Calculate the screw shear strength, V_c , based on the Hawkins and Mitchell pyramidal shear cone model for the 2.0 in. Elco grade 8 screw in 1.5VL deck:

$$H_s = 2.00 \text{ in.}$$

$$w_{r1} = 1.75 \text{ in.}$$

$$h_r = 1.50 \text{ in.}$$

$$w_{r2} = 2.50 \text{ in.}$$

$$f'_c = 3000 \text{ psi}$$

$$w_r = 2.13 \text{ in.}$$

$$H_s - h_r = 0.50 < \frac{w_{r2}}{2} = 1.25$$

$$A_c = \begin{cases} 2\sqrt{2}(H_s - w_r) & \text{if } (H_s - h_r) < \frac{w_{r2}}{2} \\ 2\sqrt{2}\left(2(H_s - h_r)^2 + h_r w_r\right) & \text{if } (H_s - h_r) > \frac{w_{r2}}{2} \end{cases}$$

$$A_c = 12.02 \text{ in.}^2$$

$$V_c = 5.4 A_c \sqrt{f'_c}$$

$$V_c = 3555 \text{ lbs}$$

Hawkins and Mitchell Cone Pullout Failure

Calculate the screw shear strength, V_c , based on the Hawkins and Mitchell pyramidal shear cone model for the 2.5 in. Elco grade 8 screw in 1.5VL deck:

$$\begin{aligned}H_s &= 2.50 \text{ in.} & w_{r1} &= 1.75 \text{ in.} \\h_r &= 1.50 \text{ in.} & w_{r2} &= 2.50 \text{ in.} \\f'_c &= 3000 \text{ psi}\end{aligned}$$

$$w_r = 2.13 \text{ in.}$$

$$H_s - h_r = 1.00 < \frac{w_{r2}}{2} = 1.25$$

$$A_c = \begin{cases} 2\sqrt{2}(H_s - w_r) & \text{if } (H_s - h_r) < \frac{w_{r2}}{2} \\ 2\sqrt{2}\left(2(H_s - h_r)^2 + h_r w_r\right) & \text{if } (H_s - h_r) > \frac{w_{r2}}{2} \end{cases}$$

$$A_c = 15.03 \text{ in.}^2$$

$$V_c = 5.4 A_c \sqrt{f'_c}$$

$$V_c = 4444 \text{ lbs}$$

Lloyd and Wright Wedged Cone Pullout Failure

Calculate the screw shear strength, V_{wc} , based on the Lloyd and Wright wedged shear cone model for the 1.5 in. Elco grade 8 screw in 0.6C deck:

$$H_s = 38.10 \text{ mm}$$

$$w_{r1} = 19.05 \text{ mm}$$

$$h_r = 15.24 \text{ mm}$$

$$w_{r2} = 44.45 \text{ mm}$$

$$f'_c = 20.68 \text{ N/mm}^2$$

$$w_r = 31.75 \text{ mm}$$

$$A_{wc} = 2w_{r2}\sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} + w_{r2}\sqrt{w_{r2}^2 + 2(H_s - h_r)^2} + 2w_{r1}\sqrt{3h_r^2}$$

$$A_{wc} = 6283 \text{ mm}^2$$

$$V_{wc} = 0.92(A_{wc}\sqrt{f'_c})^{0.349}$$

$$V_{wc} = 33.03 \text{ kN}$$

$$V_{wc} = 7426 \text{ lbs}$$

Lloyd and Wright Wedged Cone Pullout Failure

Calculate the screw shear strength, V_{wc} , based on the Lloyd and Wright wedged shear cone model for the 2.0 in. Elco grade 8 screw in 1.0C deck:

$$H_s = 50.80 \text{ mm}$$

$$w_{r1} = 22.86 \text{ mm}$$

$$h_r = 25.40 \text{ mm}$$

$$w_{r2} = 70.61 \text{ mm}$$

$$f'_c = 20.68 \text{ N/mm}^2$$

$$w_r = 46.74 \text{ mm}$$

$$A_{wc} = 2w_{r2}\sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} + w_{r2}\sqrt{w_{r2}^2 + 2(H_s - h_r)^2} + 2w_{r1}\sqrt{3h_r^2}$$

$$A_{wc} = 13748 \text{ mm}^2$$

$$V_{wc} = 0.92(A_{wc}\sqrt{f'_c})^{0.349}$$

$$V_{wc} = 43.4 \text{ kN}$$

$$V_{wc} = 9759 \text{ lbs}$$

Lloyd and Wright Wedged Cone Pullout Failure

Calculate the screw shear strength, V_{wc} , based on the Lloyd and Wright wedged shear cone model for the 2.0 in. Elco grade 8 screw in 1.5VL deck:

$$H_s = 50.80 \text{ mm}$$

$$w_{r1} = 44.45 \text{ mm}$$

$$h_r = 38.10 \text{ mm}$$

$$w_{r2} = 63.50 \text{ mm}$$

$$f'_c = 20.68 \text{ N/mm}^2$$

$$w_r = 53.98 \text{ mm}$$

$$A_{wc} = 2w_{r2}\sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} + w_{r2}\sqrt{w_{r2}^2 + 2(H_s - h_r)^2} + 2w_{r1}\sqrt{3h_r^2}$$

$$A_{wc} = 14400 \text{ mm}^2$$

$$V_{wc} = 0.92(A_{wc}\sqrt{f'_c})^{0.349}$$

$$V_{wc} = 44.1 \text{ kN}$$

$$V_{wc} = 9919 \text{ lbs}$$

Lloyd and Wright Wedged Cone Pullout Failure

Calculate the screw shear strength, V_{WC} , based on the Lloyd and Wright wedged shear cone model for the 2.5 in. Elco grade 8 screw in 1.5VL deck:

$$H_s = 63.50 \text{ mm}$$

$$w_{r1} = 44.45 \text{ mm}$$

$$h_r = 38.10 \text{ mm}$$

$$w_{r2} = 63.50 \text{ mm}$$

$$f'_c = 20.68 \text{ N/mm}^2$$

$$w_r = 53.98 \text{ mm}$$

$$A_{WC} = 2w_{r2}\sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} + w_{r2}\sqrt{w_{r2}^2 + 2(H_s - h_r)^2} + 2w_{r1}\sqrt{3h_r^2}$$

$$A_{WC} = 15663 \text{ mm}^2$$

$$V_{WC} = 0.92(A_{WC}\sqrt{f'_c})^{0.349}$$

$$V_{WC} = 45.4 \text{ kN}$$

$$V_{WC} = 10214 \text{ lbs}$$

Modified Lloyd and Wright Wedged Cone Pullout Failure

Calculate the screw shear strength, V_{wc} , based on the modified Lloyd and Wright wedged shear cone model for the 1.5 in. Elco grade 8 screw in 0.6C deck:

$$H_s = 1.50 \text{ in.} \qquad w_{r1} = 0.75 \text{ in.}$$

$$h_r = 0.60 \text{ in.} \qquad w_{r2} = 1.75 \text{ in.}$$

$$f'_c = 3000 \text{ psi}$$

$$A_{wc} = 2w_{r2}\sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} + w_{r2}\sqrt{w_{r2}^2 + 2(H_s - h_r)^2} + 2w_{r1}\sqrt{3h_r^2}$$

$$A_{wc} = 9.74 \text{ in.}^2$$

$$V_{wc} = 0.1207(A_{wc}\sqrt{f'_c})^{0.4852}$$

$$V_{wc} = 2.54 \text{ kips}$$

Modified Lloyd and Wright Wedged Cone Pullout Failure

Calculate the screw shear strength, V_{wc} , based on the modified Lloyd and Wright wedged shear cone model for the 2.0 in. Elco grade 8 screw in 1.0C deck:

$$H_s = 2.00 \text{ in.} \qquad w_{r1} = 0.90 \text{ in.}$$

$$h_r = 1.00 \text{ in.} \qquad w_{r2} = 2.78 \text{ in.}$$

$$f'_c = 3000 \text{ psi}$$

$$A_{wc} = 2w_{r2}\sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} + w_{r2}\sqrt{w_{r2}^2 + 2(H_s - h_r)^2} + 2w_{r1}\sqrt{3h_r^2}$$

$$A_{wc} = 21.31 \text{ in.}^2$$

$$V_{wc} = 0.1207(A_{wc}\sqrt{f'_c})^{0.4852}$$

$$V_{wc} = 3.71 \text{ kips}$$

Modified Lloyd and Wright Wedged Cone Pullout Failure

Calculate the screw shear strength, V_{wc} , based on the modified Lloyd and Wright wedged shear cone model for the 2.0 in. Elco grade 8 screw in 1.5VL deck:

$$H_s = 2.00 \text{ in.} \qquad w_{r1} = 1.75 \text{ in.}$$

$$h_r = 1.50 \text{ in.} \qquad w_{r2} = 2.50 \text{ in.}$$

$$f'_c = 3000 \text{ psi}$$

$$A_{wc} = 2w_{r2}\sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} + w_{r2}\sqrt{w_{r2}^2 + 2(H_s - h_r)^2} + 2w_{r1}\sqrt{3h_r^2}$$

$$A_{wc} = 22.32 \text{ in.}^2$$

$$V_{wc} = 0.1207(A_{wc}\sqrt{f'_c})^{0.4852}$$

$$V_{wc} = 3.80 \text{ kips}$$

Modified Lloyd and Wright Wedged Cone Pullout Failure

Calculate the screw shear strength, V_{wc} , based on the modified Lloyd and Wright wedged shear cone model for the 2.5 in. Elco grade 8 screw in 1.5VL deck:

$$H_s = 2.50 \text{ in.} \qquad w_{r1} = 1.75 \text{ in.}$$

$$h_r = 1.50 \text{ in.} \qquad w_{r2} = 2.50 \text{ in.}$$

$$f'_c = 3000 \text{ psi}$$

$$A_{wc} = 2w_{r2}\sqrt{\frac{w_{r2}^2}{4} + (H_s - h_r)^2} + w_{r2}\sqrt{w_{r2}^2 + 2(H_s - h_r)^2} + 2w_{r1}\sqrt{3h_r^2}$$

$$A_{wc} = 24.28 \text{ in.}^2$$

$$V_{wc} = 0.1207(A_{wc}\sqrt{f'_c})^{0.4852}$$

$$V_{wc} = 3.96 \text{ kips}$$

VITA

Steven C. Hankins was born to Stan and Susan Hankins in Springfield, MO, June 30, 1968. Born into a military family, much of his youth was spent moving around the country; tours of duty included Corpus Christie, TX, Virginia Beach, VA, Monterey, CA, and Washington, DC.

Steve graduated from Woodbridge Senior High School in 1986. As an undergraduate at Virginia Tech, he completed three years of the Building Construction curriculum before transferring into Civil Engineering. Steve received his B.S. from Virginia Tech in May 1991.

After a summer spent working at Mattern & Craig in Roanoke, VA, Steve began pursuing his M.S. in Civil Engineering at Virginia Tech. Areas of research included: cold formed sound barrier panel tests, cold formed wall panel tests, cantilever diaphragm tests, tests of a web tapered column-rafter moment connection, full scale composite joist tests, and the pushout tests reported in this study.

Currently, Steve is employed as a Structural Engineer, specializing in bridge design, by Sverdrup Civil, Inc. in Falls Church, VA.

A handwritten signature in black ink, consisting of stylized, overlapping loops and lines, likely representing the initials 'SH'.