

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

As the steel building industry improves its products for more efficient design, the knowledge to understand the behavior of those products must improve. The ability of a designer to accurately predict the behavior of a structural system is very important in order to have confidence in the design.

In the field of floor vibrations, understanding of the behavior of a vibrating floor can lead to better floor designs. Thus, through the use of accurate design equations and better finite element models, floors can be designed so that human activity will not induce annoying vibrations. This project succeeded in increasing the knowledge of how to predict the behavior of steel joist-concrete slab systems by studying three aspects: 1) computer modeling of joist-slab tee-beams, 2) viability of proposed equations for computing the effective moment of inertia of composite joists and joist girders, and 3) finite element modeling of floors.

5.1.1 Computer Modeling of Joist-Slab Tee-Beams

Two studies were done to determine the best way to model steel joist-concrete slab tee-beams. The first study determined that frame elements can be used to model the slab instead of shell elements for slabs that have a length to width aspect ratio greater than two. The second study investigated the ability of four different computer modeling techniques to predict the experimental results of deflection and first natural frequency of six setups. The model which best predicted the behavior of the setups was the full joist model using frame elements to model both the members in the joist and the concrete slab. This model was used in subsequent studies in this research.

5.1.2 Viability of Proposed Equations for I_{eff}

The relationships proposed for the effective moment of inertia of joist-slab tee-beams were developed from a variety of sources. This study used the finite element model chosen above to determine if indeed Equation (1.7) was accurately predicting the effective moment of inertia of a steel joist-concrete slab tee-beam. This study included 130 different cases, some with round bar web joists and others with angle web joists. The moment of inertia for every case was determined from Equation (1.7) and from the finite element model. The following conclusions were made.

For the round bar web cases, Equation (1.7) gave values which were, on average, 12% lower than the values given by the finite element models. For these types of joists, Equation (1.7) did not predict I_{eff} as accurately as would be liked. However, for the angle web joists, Equation (1.7) gave values within 5%. For these types of joists, this equation provided results within an acceptable range.

A second parameter was tracked in this study, which was the first natural frequency. This parameter was calculated using the moment of inertia from Equation (1.7) in Equation (1.1). The first natural frequency was also obtained from the finite element model for each case. In both the round bar and angle web cases, Equation (1.1) gave values within 5% of the finite element model. Therefore, Equation (1.1), using the results from Equation (1.7), is accurately predicting the value for first natural frequency of steel joist-concrete slab tee-beams.

5.1.3 Finite Element Modeling of Floors

This study determined if a finite element model could be developed which would accurately predict the first natural frequency of a steel joist supported floor. The finite element model was used to predict the first natural frequency of seven in-situ floors. Also, the first natural frequency of the floors was determined experimentally and compared to the predicted values. In addition, Equations (1.1), (1.2), and (1.7) were used to calculate the first natural frequency of the floors. Both the hand calculations and the finite element model were able to predict the first natural frequencies of the in-situ floors

within 10%. The finite element model was slightly more accurate than the hand calculations.

5.2 Recommendations and Future Research

Based on the investigations of the three aspects of this study, several recommendations can be made. First, the best way to model a steel joist-concrete slab tee-beam is to model every member in the joist and use frame elements to model the slab. Also, the use of joint offsets should be used to accurately model the load path of the joist.

Second, Equation (1.7) is able to accurately calculate the effective moment of inertia of steel joist-concrete slab tee-beams. This equation is better at calculating joists fabricated with angle webs versus those fabricated with round bar webs. Further study should be done to investigate why Equation (1.7) underestimates the moment of inertia of the round bar web joists.

Third, the finite element model developed for floors in this study is able to accurately predict the first natural frequency of a floor. However, at this point the model is fairly complex. Further study should be done to simplify the model so that it can be more easily used by designers. Also, the ability of this model to predict the response of a floor to an impact loading should be investigated.