Numerical Analysis of Reinforced Masonry Shear Walls Using the Nonlinear Truss Approach

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Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Master of Science

In

Civil Engineering

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12/09/13

Blacksburg, VA

Keywords: Shear Wall Numerical Model Reinforced Masonry
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This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams

Description of item under review for fair use: (Figure 2.1 Fiber model. Source: A Fiber Beam-Column Element For Seismic Response Analysis of Reinforced Concrete Structures, December 1991)

Based on the information you provided:

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Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

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Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
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This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams

Description of item under review for fair use: (Figure 2.2: Fiber section with shear spring model. Source: Trial Application: Reinforced Masonry Shear Wall Structures. In Evaluation of the FEMA P-695 Methodology for Quantification of Building Seismic Performance Factors, 2010)

Report generated on: 01-23-2014 at : 22:38:51

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams
Description of item under review for fair use: (Figure 2.4. Truss model with single cell per story without tension diagonal. Source: Hysteric Behavior of Reinforced Concrete Structural Walls, 1979)

Based on the information you provided:

Factor 1
Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2
Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3
Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4
Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

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This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams

Description of item under review for fair use: (Figure 2.5: Truss model with multi cell truss configuration. Source: A New Modelling Strategy for the Behaviour of Shear Walls under Dynamic Loading, 2002)

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

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Virginia Tech ETD Fair Use Analysis Results

*This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.*

Name: Scott Williams

Description of item under review for fair use: (Figure 2.6. Modified compression field theory factor. Source: Nonlinear Cyclic Truss Model for Reinforced Concrete Walls, 2012)


**Based on the information you provided:**

**Factor 1**

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

**Factor 2**

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

**Factor 3**

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

**Factor 4**

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams

Description of item under review for fair use: (Figure 2.7. Three vertical line element model. Source: Analysis of the Full-Scale Seven-Story Reinforced Concrete Test Structure, 1983)


Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
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Name: Scott Williams

Description of item under review for fair use: (Figure 2.8. TVLEM with nonlinear springs at the base. Source: Modeling of Reinforced Concrete Structural Walls, 1999)


Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

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Factor 3

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Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
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Name: Scott Williams

Description of item under review for fair use: (Figure 3.3. Diagonal truss element effective width. Source: Nonlinear Cyclic Truss Model for Reinforced Concrete Walls, 2012)

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Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

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Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
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Name: Scott Williams

Description of item under review for fair use: (Figure 4.1. Experimentally applied displacement history. Source: Response of Sing-Story Reinforced Masonry Shear Walls to In-Plane Lateral Loads, 1991)

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

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Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
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Name: Scott Williams

Description of item under review for fair use: (Figure 4.2. Isolated single story wall experimental configuration. Source: Response of Sing-Story Reinforced Masonry Shear Walls to In-Plane Lateral Loads, 1991)

Report generated on: 01-23-2014 at : 22:54:46

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams

Description of item under review for fair use: (Figure 4.6: Experimentally observed damage pattern of the shear-dominated wall. Source: Response of Sing-Story Reinforced Masonry Shear Walls to In-Plane Lateral Loads, 1991)


Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

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Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams

Description of item under review for fair use: (Figure 4.10. Experimentally observed damage pattern of the sliding-dominated wall. Source: Response of Sing-Story Reinforced Masonry Shear Walls to In-Plane Lateral Loads, 1991)

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
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Name: Scott Williams

Description of item under review for fair use: (Figure 5.1. Two story structure plan view. Source: Personal Communication with Mavros, 2013)

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Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams
Description of item under review for fair use: (Figure 5.2 Elevation view of web walls. Source: Personal Communication with Mavros, 2013)
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Based on the information you provided:

Factor 1
Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2
Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3
Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4
Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams

Description of item under review for fair use: (Figure 5.3. Elevation view of one set of flange walls. Source: Personal Communication with Mavros, 2013)


Based on the information you provided:

Factor 1
Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2
Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3
Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4
Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Draft 09/01/2009

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Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams

Description of item under review for fair use: (Figure 5.4. Reinforcement detail for web walls. Source: Personal Communication with Mavros, 2013)

Report generated on: 01-23-2014 at : 23:00:09

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams

Description of item under review for fair use: (Figure 5.5. Reinforcement detail for one set of flange walls. Source: Personal Communication with Mavros, 2013)

Report generated on: 01-23-2014 at : 23:00:51

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

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Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams

Description of item under review for fair use: (Figure 5.7. Photograph of experimental wall after completion of tests. Source: Personal Communication with Mavros, 2013)

Report generated on: 01-23-2014 at 23:03:44

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Scott Williams

Description of item under review for fair use: (Figure 6.1. Plan view of the one story masonry shear wall archetype. Source: Evaluation of the FEMA P-695 Methodology for Quantification of Building Seismic Performance Factors, 2010)

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

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Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
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Name: Scott Williams

Description of item under review for fair use: (Figure 6.6. Plan view of 2 story masonry shear wall archetype. Source: Evaluation of the FEMA P-695 Methodology for Quantification of Building Seismic Performance Factors, 2010)

Report generated on: 01-23-2014 at 23:10:14

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use