

REFERENCES

ABAQUS (1994). *User's Manual*, Vol. I & II, Version 5.4, Hibbitt, Karlsson & Sorensen, Inc.

ABAQUS (1994). *Theory Manual*, Version 5.4, Hibbitt, Karlsson & Sorensen, Inc.

American Institute of Steel Construction (1994). *Manual of Steel Construction - Load & Resistance Factor Design (2nd Ed.)*, Vols. I & II, Chicago, Illinois.

American Institute of Steel Construction (1989). *Manual of Steel Construction - Allowable Stress Design*, Chicago, Illinois.

Ang, K. M., and Morris, G. A. (1984). "Analysis of Three-Dimensional Frames with Flexible Beam-Column Connections." *Canadian Journal of Civil Engineering*, Vol. 11, 245-254.

Astaneh, A., and Ho, I. (1993). "Behavior and Design of Angle Connections Subjected to Cyclic Axial Force and Shear." *Proceedings of the Symposium on Structural Engineering in Natural Hazards Mitigation*, ASCE, New York, 1232-1235.

Astaneh, A., Nader, M. N., and Malik, L. (1989). "Cyclic Behavior of Double Angle
Journal of Structural Engineering, 115(5), 1101-1118.

Beaufoy, L. A., and Moharram, A. (1948). "Derived Moment-Angle Curves for Web-Cleat Connections." *Preliminary Publication, Third Congress, International Association for Bridge and Structural Engineering*.

Bursi, O. S., and Leonelli, L. (1994). "A Finite Element Model for the Rotational Behavior of End Plate Steel Connections." Structural Stability Research Council, Proceedings, 1994 Annual Task Group Technical Session, Lehigh University, Bethlehem, Pennsylvania.

Frye, M. J., and Morris, G. A. (1975). "Analysis of Flexibly Connected Steel Frames." Canadian Journal of Civil Engineering, 2, 280-291.

Goverdhan, A. V. (1983). "A Collection of Experimental Moment-Rotation Curves and Evaluation of Prediction Equations for Semi-Rigid Connections." MS thesis, Vanderbilt University, Nashville, Tennessee.

Jones, S. W., Kirby, P. A., and Nethercot, D. A. (1980). "Effect of Semi-Rigid Connections on Steel Column Strength." Journal of Constructional Steel Research, 1(1), 38-46.

Jones, S. W., Kirby, P. A., and Nethercot, D. A. (1983). "The Analysis of Frames with Semi-Rigid Connections - A State-of-the-Art Report." Journal of Constructional Steel Research, 3(2), 2-13.

Kishi, N., and Chen, W. F. (1986). "Data Base of Steel Beam-to-Column Connections." Report No. CE-STR-86-26, School of Civil Engineering, Purdue University, West Lafayette, Indiana.

Kishi, N., and Chen, W. F. (1986). "Steel Connection Data Bank Program." Report No. CE-STR-86-18, School of Civil Engineering, Purdue University, West Lafayette, Indiana.

Kishi, N., and Chen, W. F. (1986). "The Collection of Tests on Steel Beam-to-Column CE-STR-86-20, School of Civil Engineering, Purdue University, West Lafayette, Indiana.

Kishi, N., and Chen, W. F. (1990). "Moment-Rotation Relation of Semi-Rigid Journal of Structural Engineering, 116(7), 1813-1834.

Krishnamurthy, N., and Graddy, D. E. (1976). "Correlation between 2- and 3-Dimensional Finite Element Analysis of Steel Bolted End-Plate Connections." Computers and Structures, 6(4/5), 381-389.

Kukreti, A. R., Murray, T. M., and Abolmaali, A. (1987). "End-Plate Connection Moment-Rotation Relationship." Journal of Constructional Steel Research, 8, 137-157.

Levy, S. (1971). "3-D Isoparametric Finite Element Program." Report No. 71-C-191, New York, General Electric Company.

Lewitt, C. W., Chesson, E., and Munse, W. H. (1969). "Restraints Characteristics of Flexible Riveted and Bolted Beam-to-Column Connections." Bulletin No. 500, Engineering Experiment Station, University of Illinois.

Lother, L. E. (1960). *Advanced Design in Structural Steel*, Prentice-Hall, Englewood Cliffs, New Jersey.

Lui, E. M., and Chen, W. F. (1986). "Analysis and Behavior of Flexibly-Jointed Frames." Engineering Structures, 8, 107-118.

McMullin, K. M., and Astanteh, A. (1988). "Analytical and Experimental Studies of Double-Angle Framing Connections." Report No. UCB/SEMM-88/14, Department of Civil Engineering, University of California, Berkeley, California.

Munse, W. H., Bell, W. G., and Chesson, E. (1959). "Behavior of Riveted and Bolted Beam-to-Column Connections." *Journal of the Structural Division, ASCE*, 29-50.

Nethercot, D. A. (1985). "Utilization of Experimentally Obtained Connection Data in Assessing the Performance of Steel Frames." *Connection Flexibility and Steel Frames*, W.-F. Chen, ed., American Society of Civil Engineers, New York.

Nethercot, D. A. (1985). "Steel Beam-to-Column Connections - A Review of Test CIRIA, London.

Owens, G. W., and Moore, D. B. (1992). "Steelwork Connections : The Robustness of Simple Connections." *The Structural Engineer*, 70(4), 36-45.

Patel, K. V., and Chen, W. F. (1984). "Nonlinear Analysis of Steel Moment Journal of Structural Engineering, 110(8), 1861-1874.

Ramberg, W., and Osgood, W. R. (1943). "Description of Stress-Strain Curves by Three NACA Technical Report No. 902.

Rathbun, J. C. (1936). "Elastic Properties of Riveted Connections." *Transactions of ASCE*, 101, 524-563.

Richard, R. M., and Abbott, B. J. (1975). "Versatile Elastic-Plastic Stress-Strain Journal of the Engineering Mechanics Division, ASCE, 101(EM4), 511-515.

Richard, R. M., Hsia, W., and Chmielowiec, M. (1988). "Moment-Rotation Curves for Double Framing Angles." *Materials and Member Behavior, Proceeding Sessions at Structures Congress, Orlando, Florida, ASCE, New York*, 107-119.

Richard, R. M., Hsia, W., and Chmielowiec, M. (1988). "Derived Moment Rotation Curves for Double Framing Angles." *Computers and Structures*, 30(3), 485-494.

Salmon, C. G., and Johnston, J. E. (1990). *Steel Structures : Design and Behavior*, 3rd ed., Harper & Row, New York.

Sherbourne, A., and Bahaari, M. R. (1994). "3D Simulation of End-Plate Bolted
Journal of Structural Engineering, 120(11), 3122-3136.

Sommer, W. H. (1960). "Behavior of Welded Header Plate Connections." MS thesis, University of Toronto, Toronto, Ontario.

Steel Structures Research Committee. (1931, 1934, and 1936). First, Second, and Final Reports, Department of Scientific and Industrial Research, HMSO, London.

Stefano, M. D., and Astaneh, A. (1991). "Axial Force- Displacement Behavior of Steel Double Angles." *Journal of Constructional Steel Research*, 20, 161-181.

Thompson, L. E., McKee, R. J., and Visintainer, D. A. (1970). "An Investigation of Rotation Characteristics of Web Shear Framed Connections Using A-36 and A-441 Steels." Department of Civil Engineering, University of Missouri-Rolla, Rolla, Missouri.

Thornton, W. A. (1997). "Strength and Ductility Requirements for Single Shear Connections with Shear and Axial Load." *Proceedings of National Steel Construction*

Conference, American Institute of Steel Construction, Chicago, IL, May 7-9, 38-1 to 38-17.

APPENDIX A

INPUT FILE FOR THE EQUIVALENT SPRING MODEL

INPUT FILE FOR THE EQUIVALENT SPRING MODEL

```
*HEADING
ELASTIC-PERFECTLY PLASTIC ANALYSIS FOR A SIMPLIFIED
DOUBLE ANGLE CONNECTION MODEL (REGWELD3.INP)
CHECK : LOAD-DISPLACEMENT RELATIONSHIP
        MOMENT-ROTATION RELATIONSHIP
CONSIDER : BEAM ELEMENT (TYPE=B33)
          SPRING ELEMENT (TYPE=SPRING2)
          USE SPRING STIFFNESSES FROM THE REGRESSION OF WELD3
DIMENSION : W18x35 BEAM (d=17.7 in., tw=1.104 in., L=240 in.)
PROPERTIES : E=29000 (KSI.), v=0.3
          A50 STEEL FOR BEAM
JAE YANG, 2/1/97
*****
*PREPRINT, ECHO=NO, HISTORY=NO, MODEL=NO
*RESTART, WRITE, FREQ=1
*WAVEFRONT MINIMIZATION
*****
*NODE
1,-24.,0.,0.
2,0.,24.,0.
3,0.,0.,0.
4,12.,0.,0.
5,24.,0.,0.
6,36.,0.,0.
7,48.,0.,0.
8,60.,0.,0.
9,72.,0.,0.
10,84.,0.,0.
11,96.,0.,0.
12,108.,0.,0.
13,120.,0.,0.
14,132.,0.,0.
15,144.,0.,0.
16,156.,0.,0.
17,168.,0.,0.
18,180.,0.,0.
19,192.,0.,0.
20,204.,0.,0.
21,216.,0.,0.
22,228.,0.,0.
23,240.,0.,0.
*NGEN, NSET=NALL
3,23,1
*NSET, NSET=REACT
3,23
*NSET, NSET=BMRHTLDF
23
*NSET, NSET=BMTOPLDF
3,13,23
```



```

*NSET, NSET=DISPLCHK
3
***
*ELEMENT, TYPE=SPRING2, ELSET=TSPRING
1,1,3
*ELEMENT, TYPE=SPRING2, ELSET=RSPRING
2,2,3
*ELEMENT, TYPE=B33, ELSET=BEAM1
3,3,4
*ELGEN, ELSET=BEAM
3,20,1,1
*BEAM SECTION, SECTION=RECT, ELSET=BEAM, MATERIAL=STEEL
0.552,17.7
0.,-1.,0.
*MATERIAL, NAME=STEEL
*ELASTIC
29000.,0.3
*PLASTIC
50.,0.
*SPRING, ELSET=TSPRING, NONLINEAR
1,1
-11.8873,-0.542
-11.4913,-0.486
-11.0875,-0.429
-10.6821,-0.372
-10.2803,-0.316
-9.8611,-0.259
-9.3988,-0.201
-8.9678,-0.158
-8.199,-0.114
-6.3458,-0.0718
-3.8302,-0.0406
-2.1679,-0.0228
0.,0.
2.1679,0.0228
3.8302,0.0406
6.3458,0.0718
8.199,0.114
8.9678,0.158
9.3988,0.201
9.8611,0.259
10.2803,0.316
10.6821,0.372
11.0875,0.429
11.4913,0.486
11.8873,0.542
*SPRING, ELSET=RSPRING, NONLINEAR
5,5
-19.542,-0.00678
-19.023,-0.0066
-18.505,-0.00642
-17.957,-0.00623
-17.381,-0.00603

```

```

-16.689,-0.00579
-15.824,-0.00549
-14.931,-0.00518
-13.806,-0.00479
-10.924,-0.00379
-6.428,-0.00223
-3.257,-0.00113
0.,0.
3.257,0.00113
6.428,0.00223
10.924,0.00379
13.806,0.00479
14.931,0.00518
15.824,0.00549
16.689,0.00579
17.381,0.00603
17.957,0.00623
18.505,0.00642
19.023,0.0066
19.542,0.00678
*BOUNDARY
NALL,YSYMM
1,1
3,3
3,4
3,6
23,3
23,4
23,6
*STEP, NLGEOM, MONOTONIC=YES, INC=50
*STATIC, RIKS
0.1,1.0,,0.2,1.,3,1,0.5
*CLOAD
23,1,20.
NALL,3,-1.904762
*****
*EL PRINT, ELSET=BEAM1, POSITION=NODES, SUMMARY=NO
S
*EL PRINT, ELSET=TSPRING, SUMMARY=NO
S11,E11
*EL PRINT, ELSET=RSPRING, SUMMARY=NO
S11,E11
*NODE PRINT, NSET=DISPLCHK, SUMMARY=NO
U
*NODE PRINT, NSET=BMRHTLDF, SUMMARY=NO
U1,CF1
*NODE PRINT, NSET=BMTOPLDF, SUMMARY=NO
U3,CF3
*NODE PRINT, NSET=REACT, SUMMARY=NO
RF
*MONITOR, NODE=3, DOF=1
*END STEP

```

VITA

Jae-Guen Yang was born on June 25 1962, in Seoul, Korea. He graduated with his Bachelor of Science degree in Architectural Engineering from Yonsei University in Seoul, Korea, in February 1985. He received his Master of Science degree, specializing in Structures, at the same university in February 1987.

He began his graduate studies at Virginia Polytechnic and State University in September 1990. After receiving the Master of Science degree in December 1991, he continued his studies as a Ph. D. student at the same university.