Post-Northridge Special Moment Frame Testing

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Introduction

The design of Special Moment Frames (SMF) and in particular, their connections has undergone a significant overhaul in the Post-Northridge era. This poster focuses on the critical aspects of SMF systems and their connections and reports the results of a full-scale experimental test on a post-Northridge SMF connection.

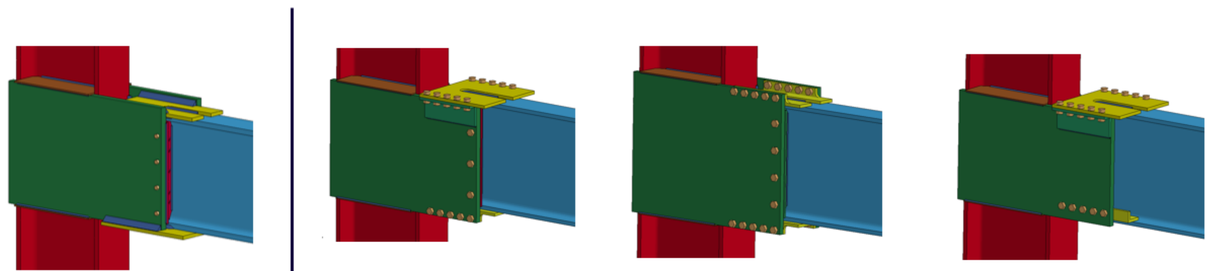
Seven full-scale Special Moment Frame connection specimens with wide-flange, HSS and BU-Box columns and beam ranging from **W21x73** to **W40x397** were designed, fabricated using SidePlate Technology and tested at the University of California, San Diego between 2015 and 2017.

The tests were conducted in accordance with AISC-341 Seismic Provisions and all tests achieved AISC and OSHPD's requirements. The average performance of the connection was **6.6%** story drift ratio which is **65%** larger than the required limit of the code (i.e. **4%).**

Special Moment Frame Testing

Special Moment Frame designed in accordance with AISC-341 provisions are expected to provide significant inelastic deformation capacity through flexural yielding of the SMF beams. The following figure shows Test U2 with W40x211 beam sustaining **6% story drift**.

Connection Various Configurations

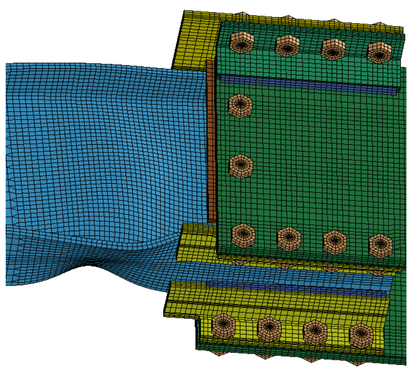


Test Matrix and the Results

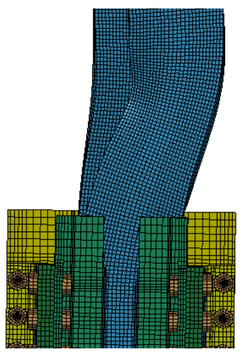
SidePlate Field-Bolted SMF Testing Matrix
(Phase 1 and Phase 2)

Test ID	Beam	Column	Config	Story Height	Span	Bolt Diameter	Bolt Rows	Final Performance
H1	W21x73	HSS14x14x7/8	A	14’	18’	1-1/8” TC	4	1 full cycle @ X%
H2	W24x84	HSS18x18x3/4	A	14’	18’	1-1/8” TC	4	2 full cycles @ 6%
U1	W40x211	W36x282	A	16’	30’	1-1/4” TC	8	2 full cycles @ 7%
U2	W40x211	W36x282	B	16’	30’	1-1/4” TC	8	2 full cycles @ 6%
U3	W36x150	W36x231	B	16’	26’	1-1/4” HX	6	1 full cycle @ 7%
U4	W44x290	W36x395	B	16’	34'	1-1/2” HX	8	1.5 cycles @ 6%
U5	W40x397	BU-Box30x30x2	A	16’	38’	1-1/2” HX	10	

Finite Element Simulation



Physical Test



FEA Simulation

R&D Remarks

The following techniques have been used to develop the connection:

1. The Column panel zone region has been substantially strengthened to minimize column deformations and force plastic hinging into the beam.
2. The additional SidePlate extensions on the beam actually brace it and cause the hinge to be pushed further out from the column face, effectively dissipating more energy without increasing the beam size.
3. By design, only fillet welds are used in the configuration, ensuring that there is no notch effect in the root of the welds.
4. The unique connection configuration allows for maximum weld ductility by keeping all of its fillet welds mostly parallel to the direction of load.
5. Substantial Finite Element Analyses (FEA) were conducted to optimize each and every component of the connection, including but not limited to: welds, hold-backs, profiles, plate geometry, thicknesses, etc. All in an effort to reduce stress concentration and to eliminate notch effects and to remove any triaxial stress states.

Conclusions

Properly designing any SMF connection takes years of research, practice and industry feedback. It can be as much of an art as it is an engineering science. And using proven fabricated details supported by full-scale testing will help to ensure safe, buildable, economic, and effective connections.

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