Problem

The Church of Jesus Christ of Latter-day Saints has decided to build a temple in an area with high seismic activity. Temples must be designed to endure horizontal loads caused by earthquake ground motions while maintaining an aesthetic architecture.

The steeple of one of these temples is to be designed to meet seismic performance criteria, fit within the current architectural constraints, and provide for a sustainable structure.

Budget

Cost Evaluation

Design Work (15, 6hr weeks @ 100/hr)	$	9,000.00
Bracing	$	4,000.00
Steel ($700/ton)	$	8,750.00
Labor (2 week construction)	$	4,000.00
Total	**$**	**25,750.00**

Savings

Damaged Cladding (Avoided)	$	1,050.00
Replacement of Steel (Avoided)	$	1,750.00
Replacement of Braces (Avoided)	$	1,000.00
Labor Repair (Avoided)	$	1,000.00
Total	**$**	**4,800.00**

Engineering Tools

Mathcad, SAP2000, Revit, Excel

Mathcad Prime 1.0 · SAP2000 · R · Excel

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THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS

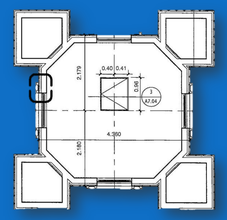
BRIGHAM YOUNG UNIVERSITY FOUNDED 1875 BYU PROVO, UTAH

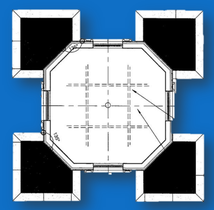
Constraints

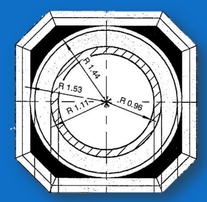
Architectural- No shadows were to be seen through the windows when lighted at night.

Sustainability- Temple cannot be closed for extended amounts of time to repair earthquake damage.

Constructability- Use steel shape sizes locally available near the site.

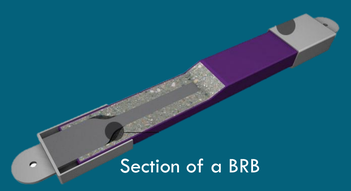






Design

Buckling Restrained Braces (BRB) consist of a small steel core encased in concrete. The concrete prevents the steel core from buckling in compression, facilitating both tension and compression yielding. The cyclic yielding dissipates the energy supplied by the earthquake. The rest of the structure is designed so that the failures will occur in the braces themselves making post-earthquake repair minimal.



Section of a BRB

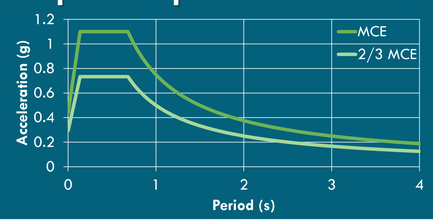
Deflection under Design Earthquake

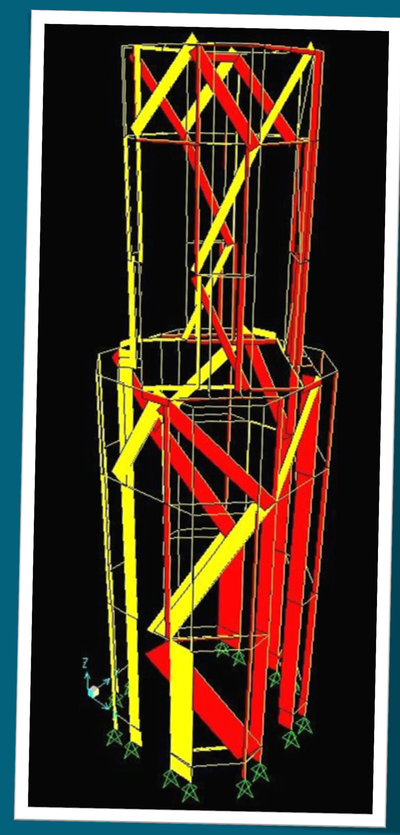
Shape	Deflection (in)
HSS 4x4x5/16	0.358
HSS 3x3x1/4	0.936
Combination of Both Shapes	0.413

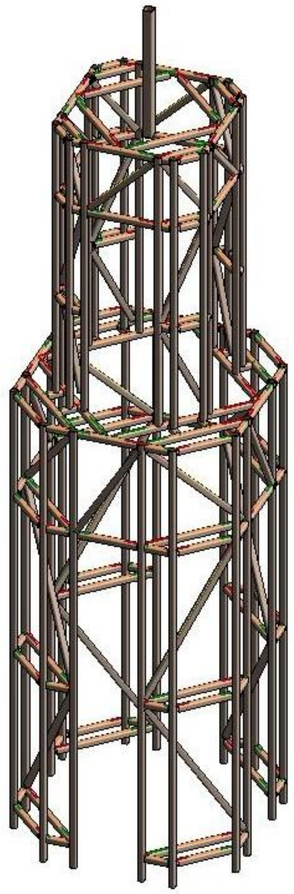
Lateral Forces and Base Shear

System	Level	w(kip)	h(ft)	Fx	V_{base} (kip)
MF (R=8)	1	49.4	26	5.45	14.85
	2	49.4	42	9.41	
SCBF (R=6)	1	49.4	26	8.66	22.64
	2	49.4	42	13.98	
BRBF (R=8)	1	49.4	26	6.31	16.98
	2	49.4	42	10.67	

Response Spectrum For the Site







Temple Steeple Design

R.V.H.B. Engineering

Rasmussen Vidmar Hall Bustamante