Case Study
Designing Rooftop Tower Structure for Reduced Damage due to Seismic Ground Motions
Implementation of a Parametric Study

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Tuesday, June 26 – Friday, June 29
Acknowledgements

Brent Maxfield, Civil/Structural Engineer, The Church of Jesus Christ of Latter-day Saints

Degenkolb Engineers
Cedar City LDS Temple
Parametric Seismic Studies

Background

Washington DC Temple

- Small to moderate earthquakes have damaged multiple steeples on LDS temples

Los Angeles Temple Seismic Retrofit

- Demands on towers may exceed the calculated demand from ASCE 7
Spire Damage
Washington D.C. Temple
Degenkolb Study – Phase I

Considered the following:

- Steel structure designed with ASCE 7 forces
- BRB frames
- Rocking mechanism
- Steeple seismically isolated above roof
- Effects of bearing walls v. transfer girders below

Findings:

To minimize seismic demand, the steeples need to have a period difference of a factor of 3 or greater: $1/3$ or $3$
Building Section
Cedar City Temple

- Gap provided in precast cladding to allow for rocking mechanism
- Tower rests on transfer girders
- Dampers mounted below transfer girders
Implementation of Phase II Study

Steel reductions offset damper costs:
- Transfer girders
- Tower braced frames
Rocking Mechanism

Dampers mounted below transfer girders in large ceiling space to control rocking
Implementation of Rocking Mechanism

Two sets of threaded rods:

- One set to engage dampers
- One set to prevent rocking in wind and designed to yield in seismic event
Implementation of Rocking Mechanism

Shear key resists sliding but allows for tower uplift
Conclusions

Design for better performance can be achieved in a cost effective way in new construction.

Keys to success:
- Owner interested in long term building use
- Collaborative design team
- Investment in studying alternate systems