COUPLED TRUSS WALL WITH DAMPING ELEMENTS 2004 NOVA Award Nomination 16

To build a 750ft tower (the tallest in Mexico) of First Class office space that is sustainable through Mex-ico's frequent seismic events, inventive design solutions were a prerequisite. The team of Cantor Seinuk Group and Enrique Martinez Romero Structural Engineers provided a vision of a 21st Century Structure for the design and construction of the Torre Mayor project. This vision was shaped around the concept of "Performance Based Design" which provides not only an additional level of reliability, but also predefined criteria for how the building should and would perform during significant seismic events. As part of the criteria it was established that the building had to be operational immediately, even after a large-scale seismic event. With such high standards, it was realized early on, that non-traditional design approaches were going to be a necessity if this vision was to be achieved.

The building's superstructure is primarily a steel structure. The columns at the interior and perimeter of the tower are encased in reinforced concrete for the lower half of the tower for added stiffness, strength, and economy. The selected structural system is based on a highly redundant system, which is a further en-hancement of the "Dual" concept recommended by seismic codes worldwide. This is accomplished by in-troducing a "Dual" conventional (deflection sensitive) lateral force resisting system in combination with a supplemental damping system (velocity sensitive). In effect, a "Trio" system is provided to respond to the seismic energy from an earthquake.

Research and experimental studies during the past decade clearly demonstrated that in order to control the violent nature of earthquakes (or any kind of dynamic impact) it was necessary to understand and ad-dress the energy that is transmitted to structures. In this particular case, we sharpened our focus on utili-zation of supplementary energy absorption devices as a means of enhancing the performance of the structure. Our research and design process was aided by the fact that in late 80's and early 90's the U.S. government declassified a select group of technologies, facilitating the transfer of information from de-fense industries into the civil sector.

The fact that this would be the first new commercial building to be designed utilizing viscous dampers is only part of the story. In-house research on the optimum utilization of dampers resulted in a unique appli-cation that is equally, if not more, significant. This innovative solution in utilizing the damping device was recognized by the US Patent Office [US Patent no. 6,397,528 BI]. The distinctive approach recognizes the strategic values of the arrangement, location, and integration of the dampers with the conventional struc-tural systems.

The objectives that previously were cost prohibitive for tall buildings in high seismic zones become possi-ble with this advancement in technology. In such environments as Mexico City, it is a fact of life that a building will eventually experience a large-scale seismic event. Therefore, under more conventional design approaches, it is a forgone conclusion that the building will have to be significantly repaired if not rebuilt at some point in its lifetime. From a planning, a functional and an economic point of view, it would be cost prohibitive if not impossible to meet the high standard of the performance based criteria for a building of this scale using only conventional construction techniques. Building such an office building to remain operational after a large-scale earthquake would cost tens of millions of dollars more without the use of supplemental damping.

Additional benefits that result from the innovations that make the performance design criteria possible in-clude drastic reductions in maintenance costs by creating a more durable structure that does not require repair after major earthquakes. By maximizing the protection of property, occupant safety is unmatched, as well as occupants' physical and psychological comfort during seismic events. The use of supplemental damping results in a reduction of conventional construction materials. This speeds up construction time, while reducing pollution and the depletion of natural resources.

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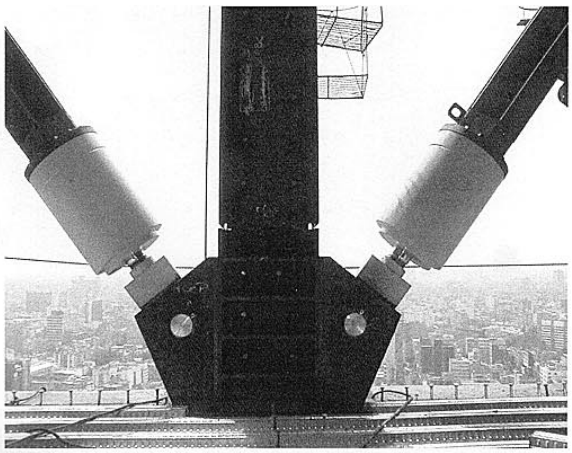
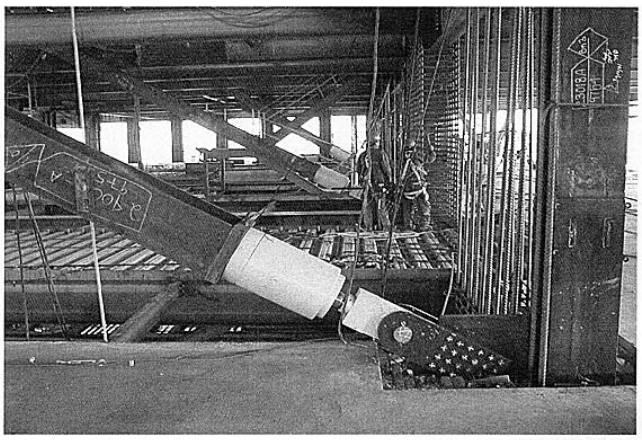
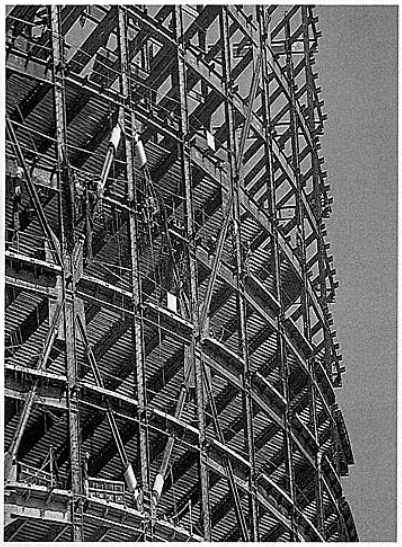
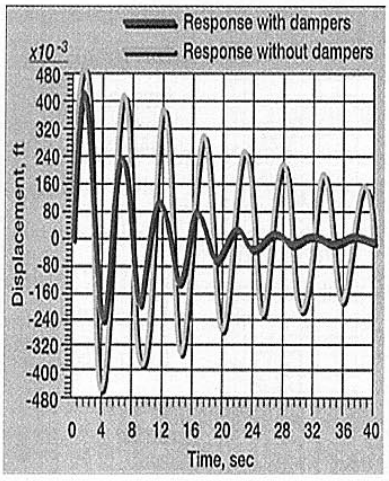
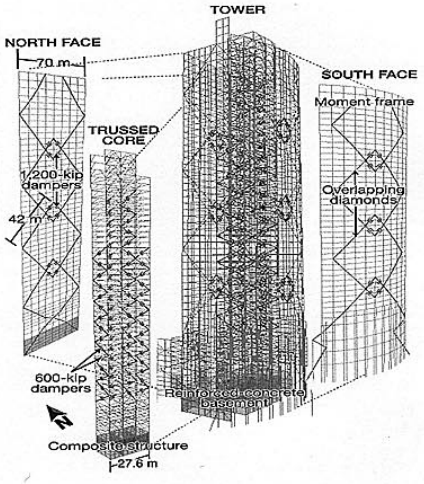




TORRE MAYOR




Response with dampers
Response without dampers
x10-3
Displacement, ft
480
400
320
240
160
80
0
-80
-160
-240
-320
-400
-480
0 4 8 12 16 20 24 28 32 36 40
Time, sec


TOWER
NORTH FACE
70 m
SOUTH FACE
Moment frame
TRUSSED CORE
1,200-kip dampers
Overlapping diamonds
42 m
600-kip dampers
Reinforced concrete basement
Composite structure
27.6 m