

THE TUBED MEGA FRAME

EN INNOVATIV BETONGSTOMME FÖR MYCKET HÖGA HUS

Mikael Hallgren

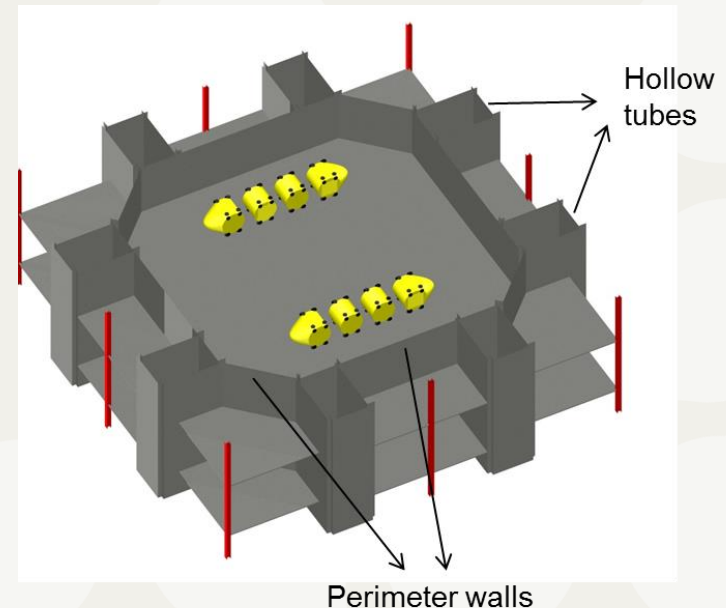
Konstruktör, Tekn.Dr

Adj. Professor KTH

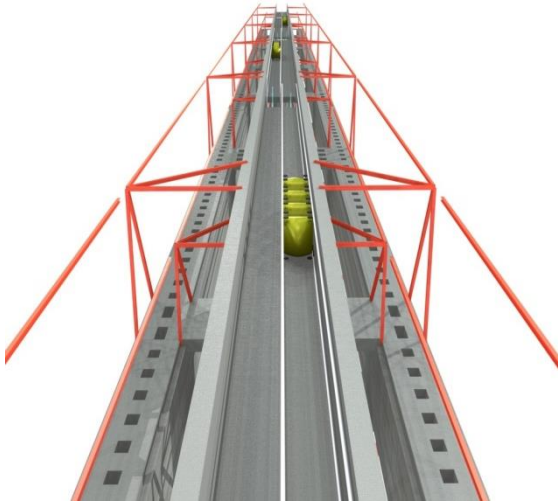
Utvecklingsprojekt 2014 - 2017

Elva examensarbeten (MSc) på KTH
handledda av **Fritz King** och Mikael Hallgren

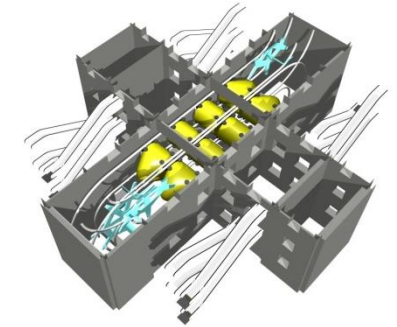
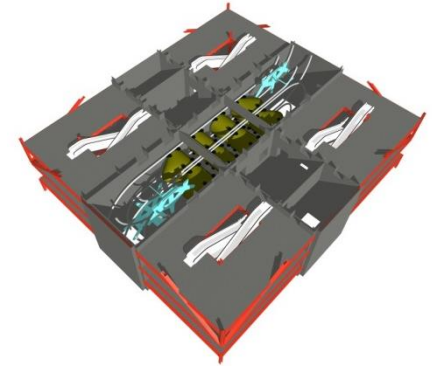
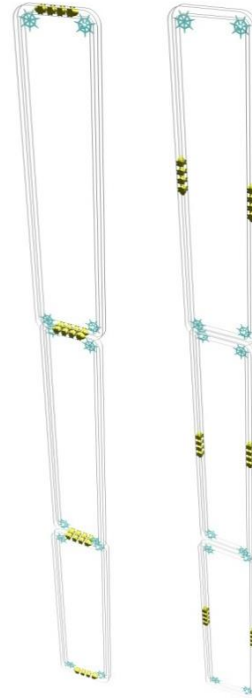
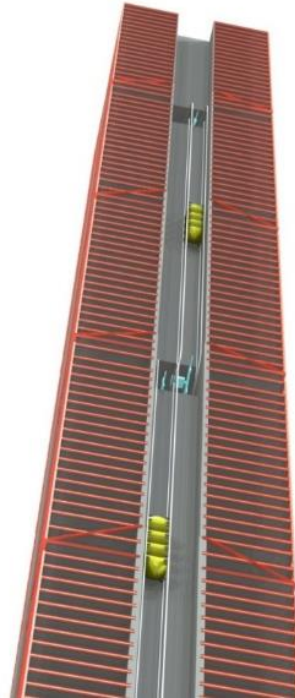
CIR-dagen 2023-01-31, Göteborg



Vertical Trains – the *Articulated Funiculator*



Vertical Shafts

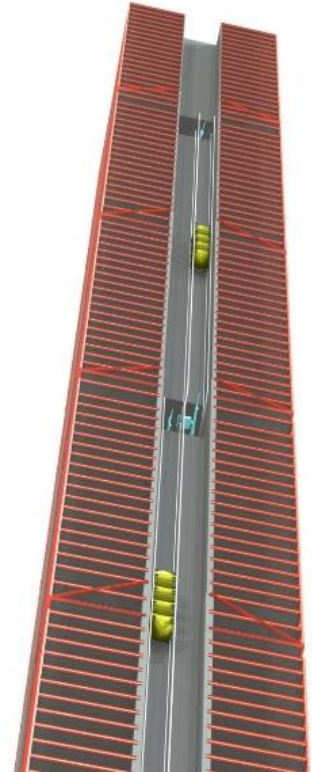
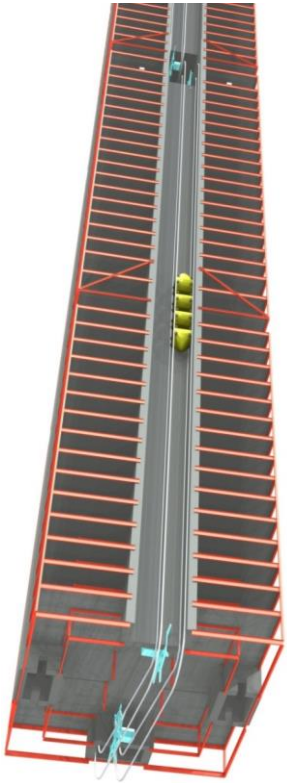


Horizontal Stations

The Tubed Mega Frame



- New vertical transport systems.
- No central core.
- Essentially all loads at building perimeter.
-
- Increased building stance
-
- Efficient super structure.



- No central core.



- Open floor plates



- New and exciting architectural programs in high-rise buildings



- True vertical cities



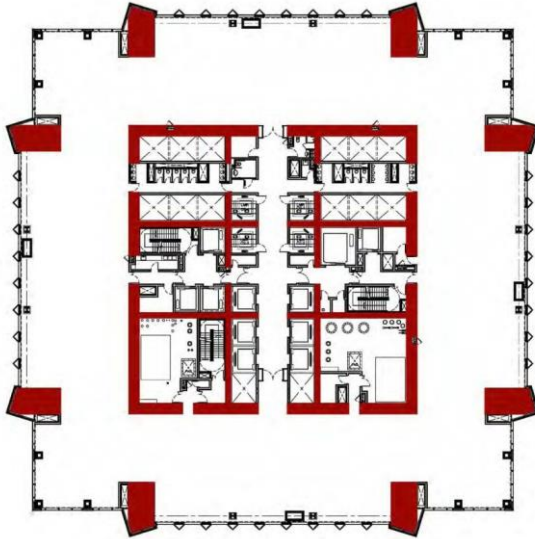


Ping An (600 m)

- Central core
- 8 Super Columns
- Outriggers
- Belt trusses
- Perimeter diagonal braces
- Horizontal floor bracing

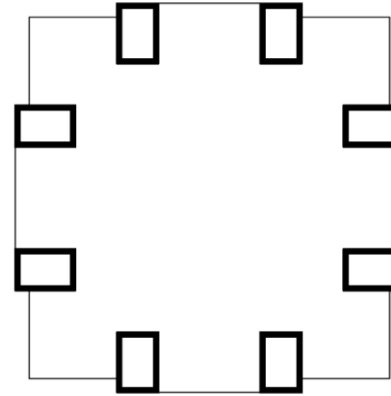
**Case study –
800 meter Prototype**
8 Tubed super columns
Belt walls





Ping An

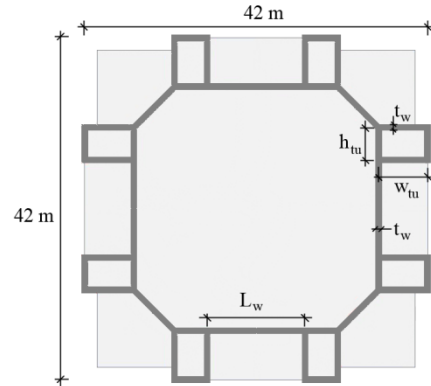
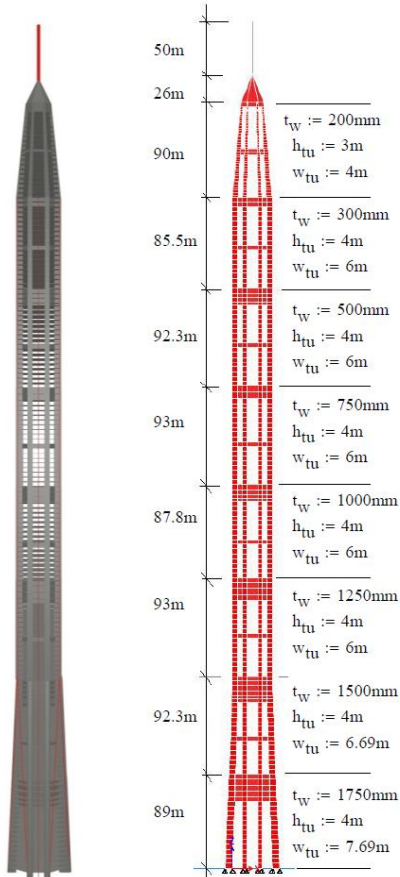
56 m x 56 m (~3,136 m² gross)
 Central core (30 m x 30 m, 900 m²)
 8 super columns
 Floor utilization (single floor snapshot): ~ 0.70



800 meter Prototype

42 m x 42 m (~1,764 m² gross)
 No central core
 8 tubed super columns
 Outrigger walls
 Floor utilization ratio: ~ 0.89

Case study — a 800 m prototype building



Substudies:

1. Global Analysis and Structural Performance
2. Hollow Reinforced Concrete Columns
3. Perimeter Walls
4. Construction Methodology
5. Foundation

High Performance Concrete: $f_c = 100\text{ MPa}$ $E_c = 50\text{ GPa}$

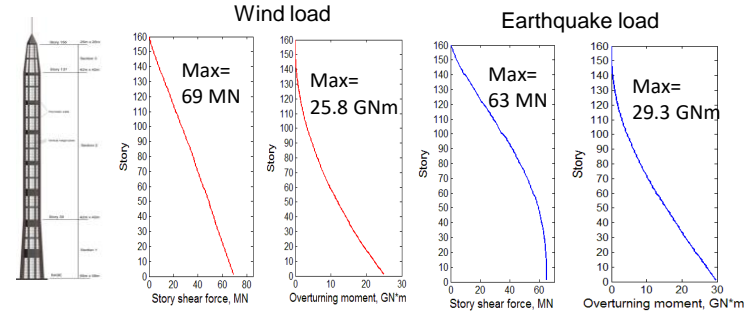
Site location: Southern Cina

Conclusions from the case study

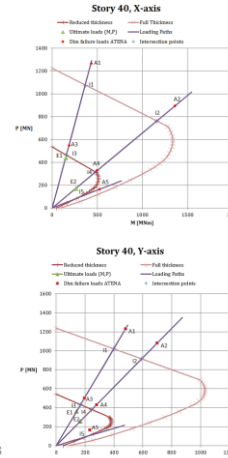


- Favourable structural performances for the TMF
- TMF has high stiffness comparing to similar existing high-rise buildings
- TMF has a sufficient structural stability
- Cross-sectional dimensions could be reduced
- High Performance Concrete utilised for TMF
- TMF is still a concept under development but seems feasible

Global analyses



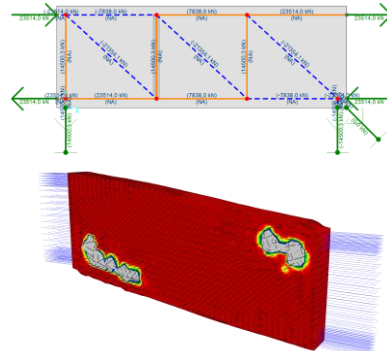
Design of Columns



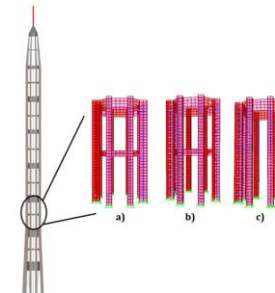
Construction Methodology



Design of Walls

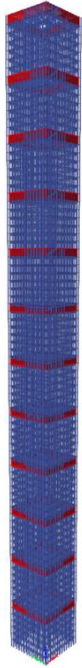


Buckling analyses



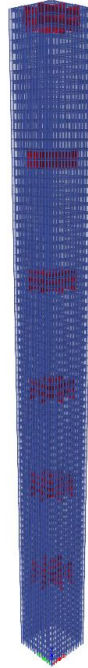
Analysis Model	Mode	Buckling Factor
All columns without openings	A-A	33.51
All columns with openings	A-A	31.18
All columns with openings and without intermediate perimeter walls	A-A	18.57

MODIFIED TUBED MEGA FRAME TYPES



- a. 2-story belts walls every 57 meters
- b. 1-story belt walls every 28.5 meters

Perimeter
Frame
Belt Walls



- a. 2-story interior cross walls every 57 meters
- b. 1-story interior cross walls every 28.5 meters

Perimeter
Frame
Cross Walls



- a. 2-story belts walls every 57 meters
- b. 1-story belt walls every 28.5 meters

Mega Hollow
Columns
Belt Walls



- a. 2-story interior cross walls every 57 meters
- b. 1-story interior cross walls every 28.5 meters

Mega Hollow
Columns
Cross Walls

432 PARK AVENUE – TUBED MEGA FRAME COMPARISON

432 Park: Perimeter moment frame – core – outrigger. H = 426 m

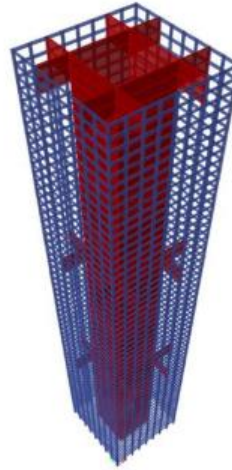
Tubed Mega Frame types:

- Cross walls
- Belt walls
- Perimeter frame
- Hollow mega columns

All models have a 28.5m x 28.5m footprint and results in a slenderness ratio of 1:15 (original)

Four different heights were analyzed, nine models per height

All nine models have the same amount of concrete

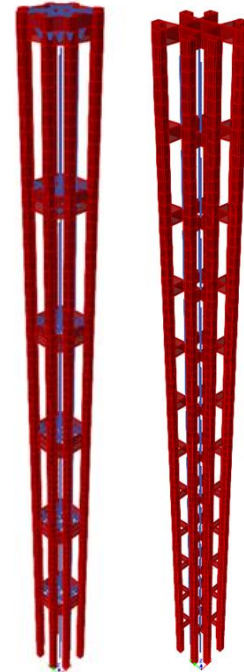
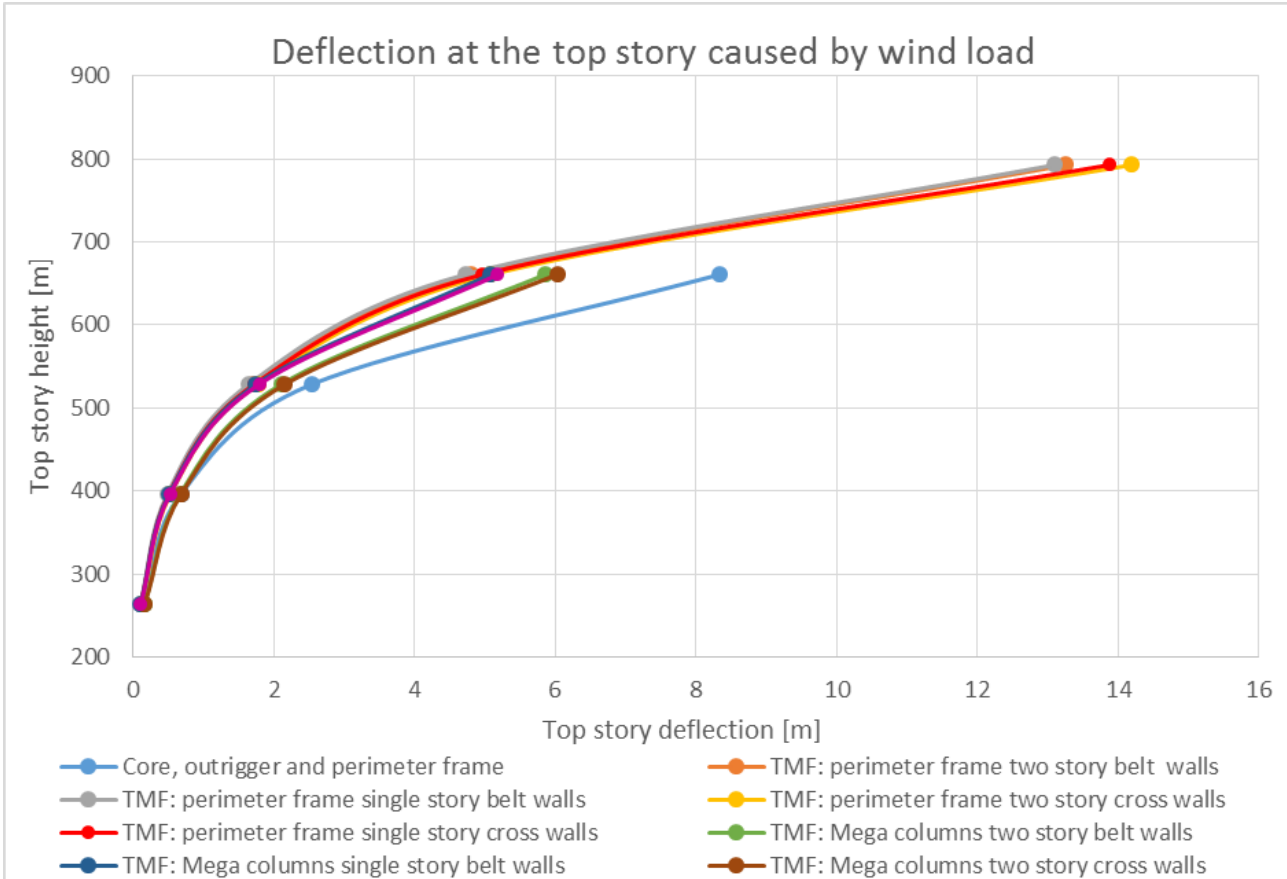
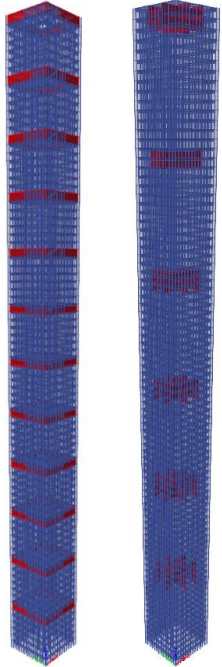


frame – core – outrigger

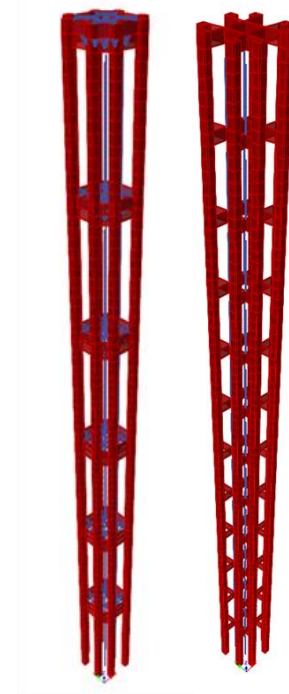
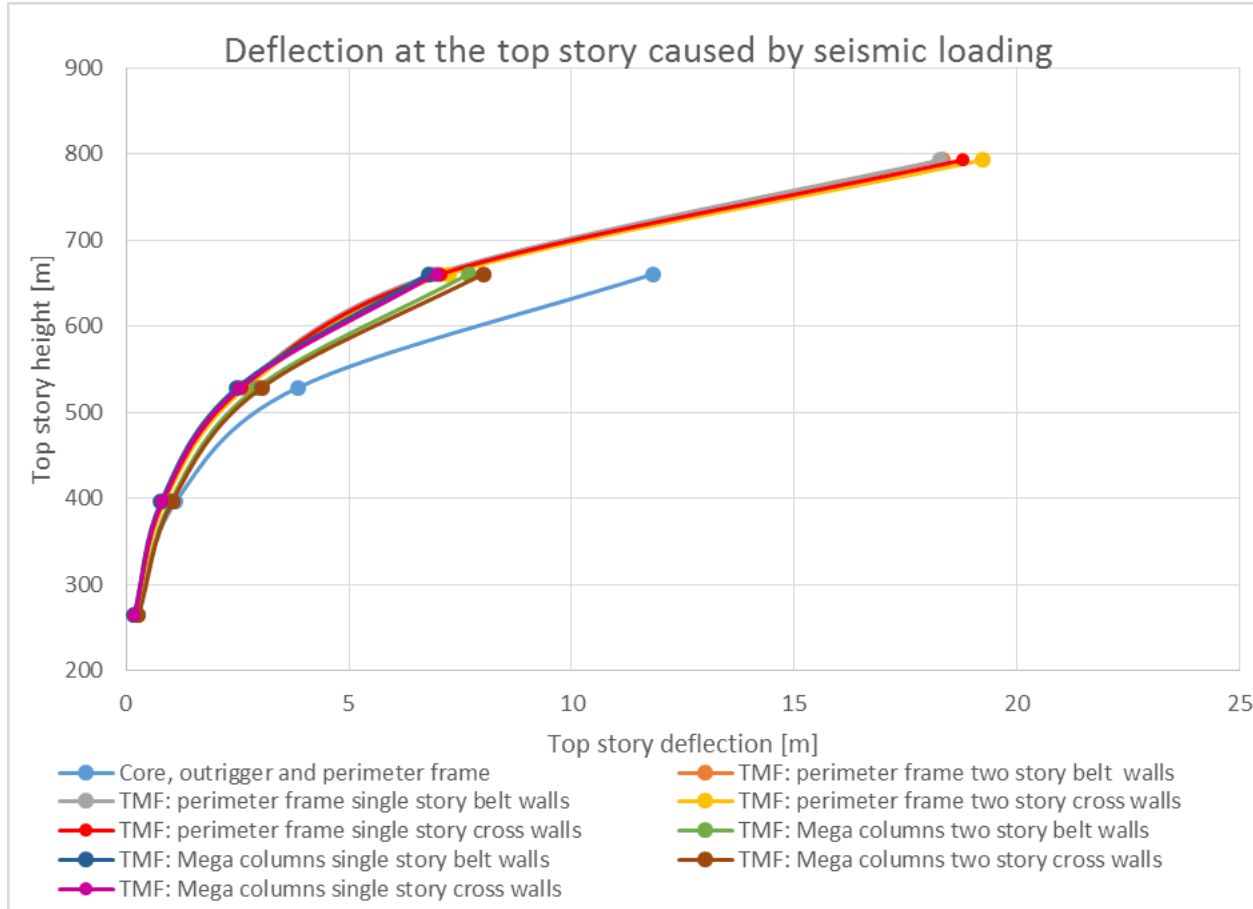
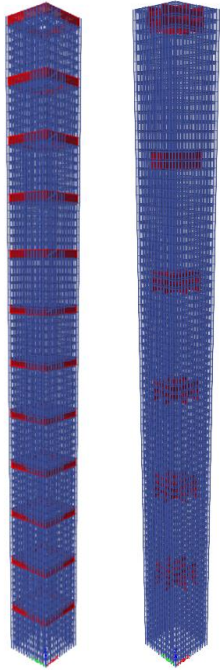


432 Park Avenue

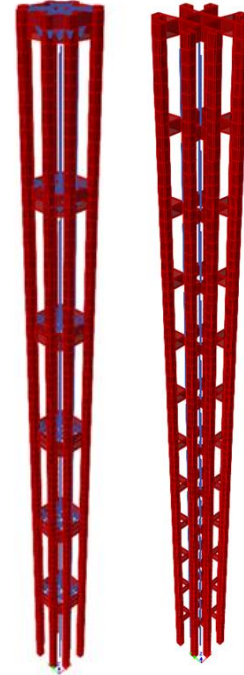
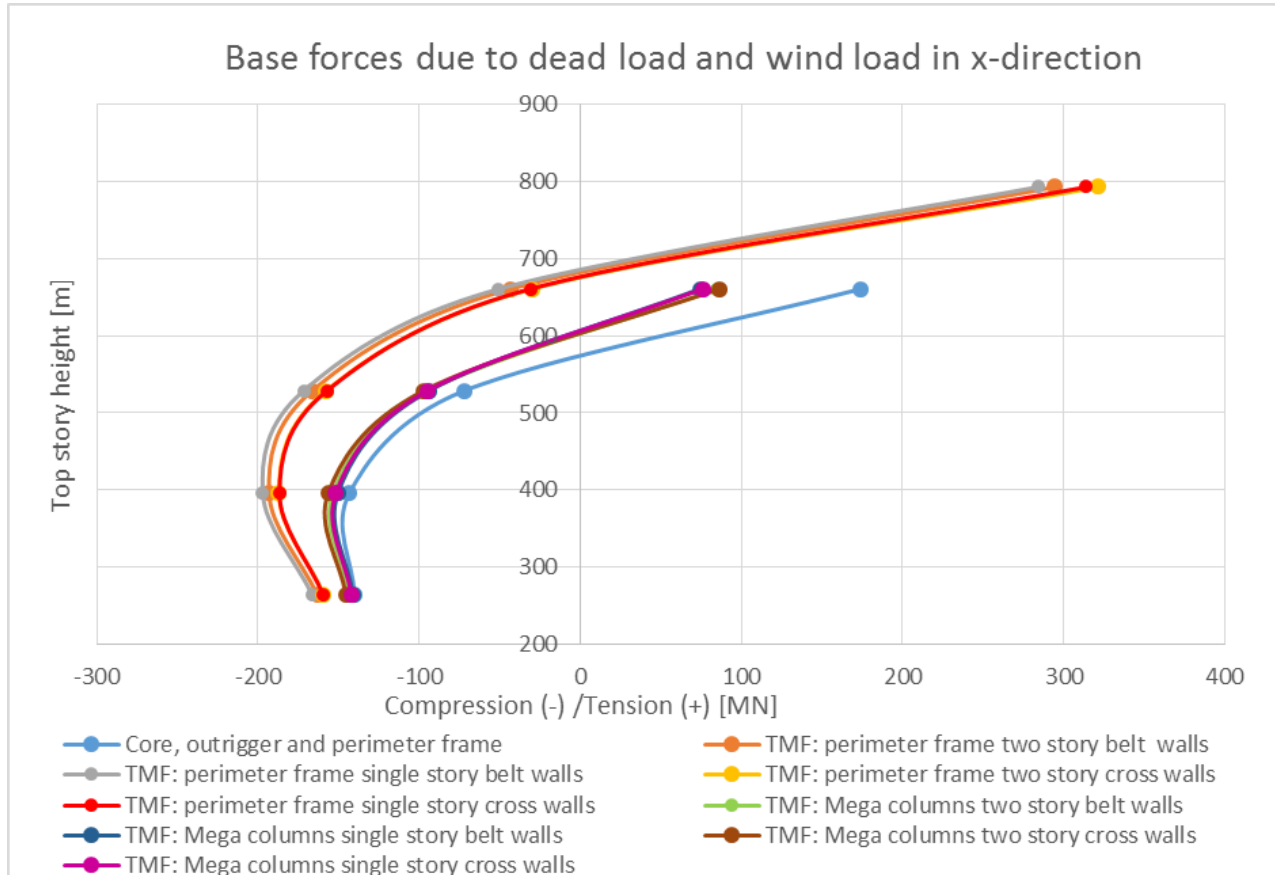
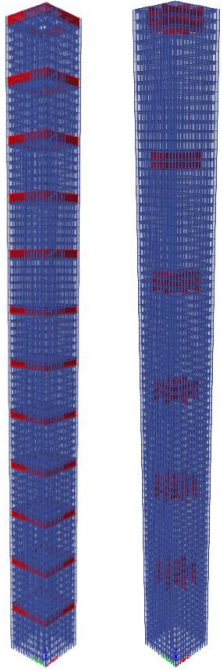
432 PARK AVENUE – TUBED MEGA FRAME COMPARISON



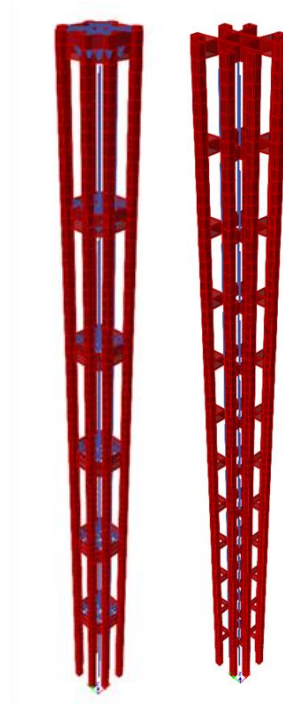
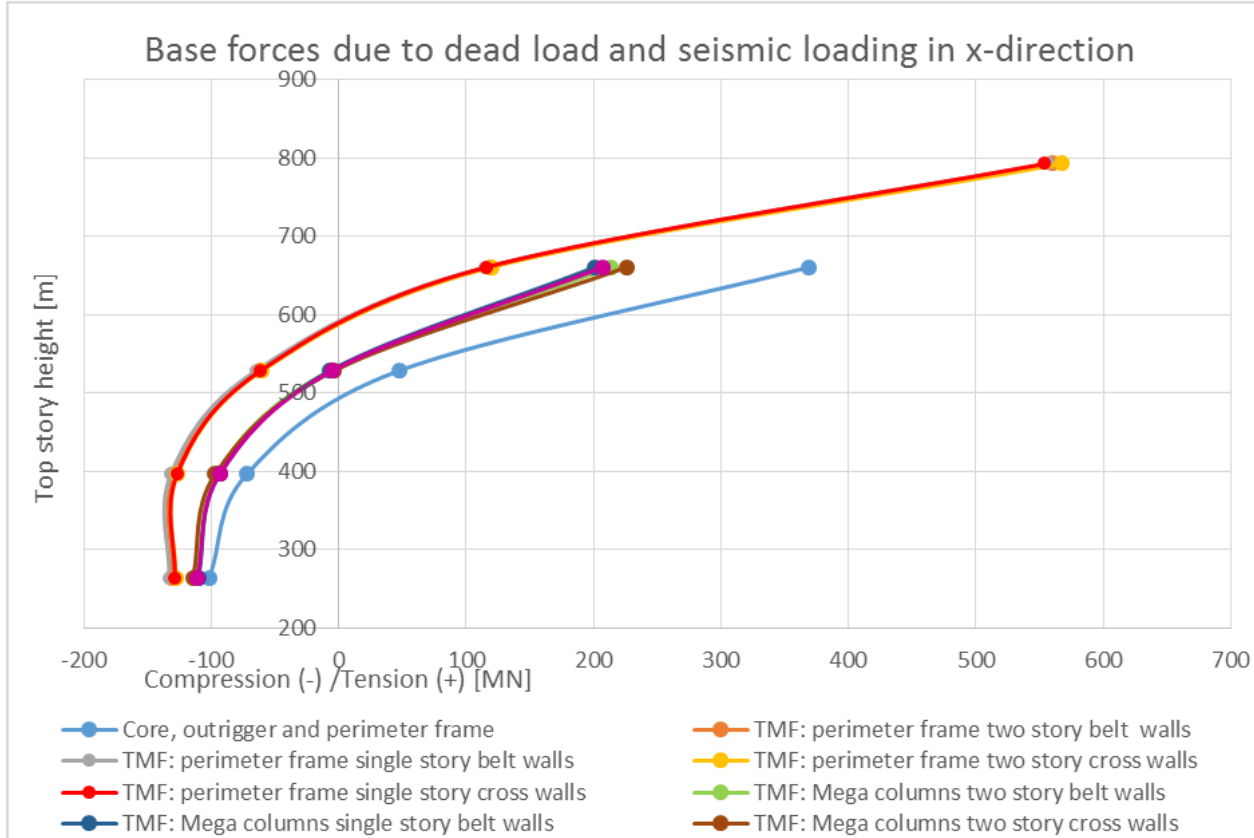
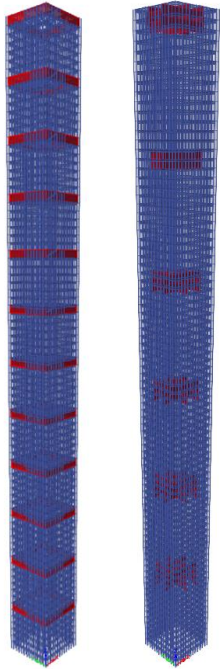
432 PARK AVENUE – TUBED MEGA FRAME COMPARISON



432 PARK AVENUE – TUBED MEGA FRAME COMPARISON



432 PARK AVENUE – TUBED MEGA FRAME COMPARISON



MAIN CONCLUSION



- The Tubed Mega Frame types appear to perform equally or even better than current high-rise “core – outrigger” systems.



STORT TACK TILL EXAMENSARBETARNA!



- Tobias Dahlin och Magnus Yngvesson
Construction Methodology of Tubed Mega Frame Structures in High-Rise Buildings, MSc thesis 2014
- Niklas Fall och Viktor Hammar
Design of Perimeter Walls in Tubed Mega Frame Structures, MSc thesis 2014
- David Tönseth och Kristian Welchermill
Design of Hollow Reinforced Concrete Columns in the Tubed Mega Frame, MSc thesis 2014
- Han Zhang
Global Analysis and Structural Performance of the Tubed Mega Frame, MSc thesis 2014
- Sulton Azamov
Comparative analysis of Tubed Mega Frame and Core-outrigger system Foundations, MSc thesis 2014
- Arezo Partovi och Jenny Svärd
Global Analysis of Tall Buildings with Tubed Mega Frame Structures, MSc thesis 2016
- Hamzah Al-Nassrawi and Grigorios Tsamis
Global Analysis and design of a complex slanted High-Rise Building with Tube Mega Frame, MSc thesis 2017
- Sujan Kumar Rimal och Levi Grennvall
Analysis of Tripod shaped high rise building using Tubed Mega Frame Structures, MSc thesis 2017
- Paulina Chojnicka and Lydia-Foteini Marantou
Global analysis of a tubed structural system for an inclined slender tall building, MSc thesis 2017
- Matea Bradaric and David Desimons
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- Matiss Sakne
Structural design and performance of tube mega frame in arch-shaped high-rise buildings, MSc thesis 2017