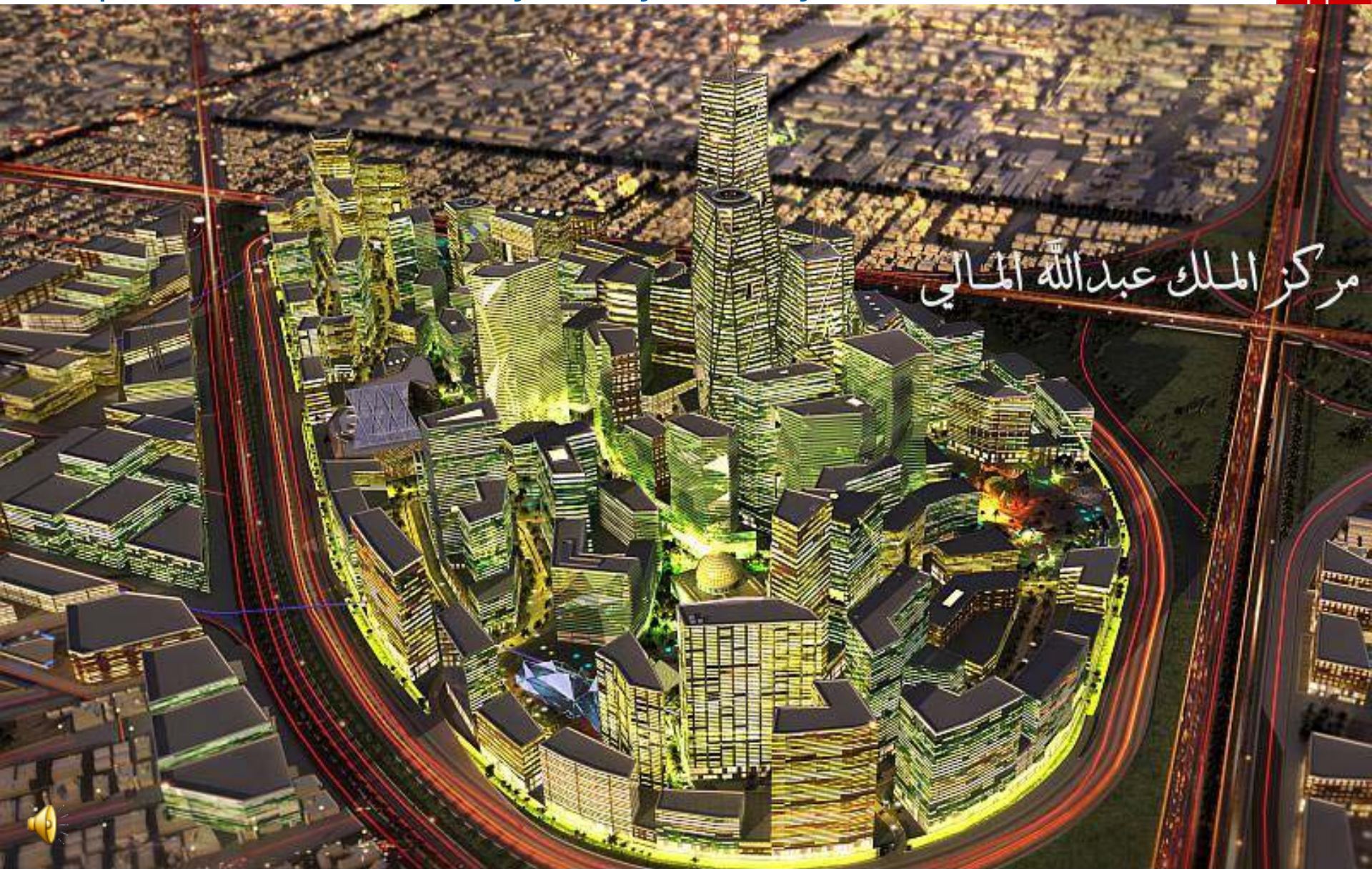
SELF REFERENCE FRAME ENGINEERING BODY APPROACH FOR COMPLEX SETTING OUT OPERATIONS

Joël van Cranenbroeck, Chair WG 6.2 – FIG Commission 6
Director of Technology and Project Development
Leica Geosystems AG, Heerbrugg - Switzerland

Capital Market Authority in Riyadh city



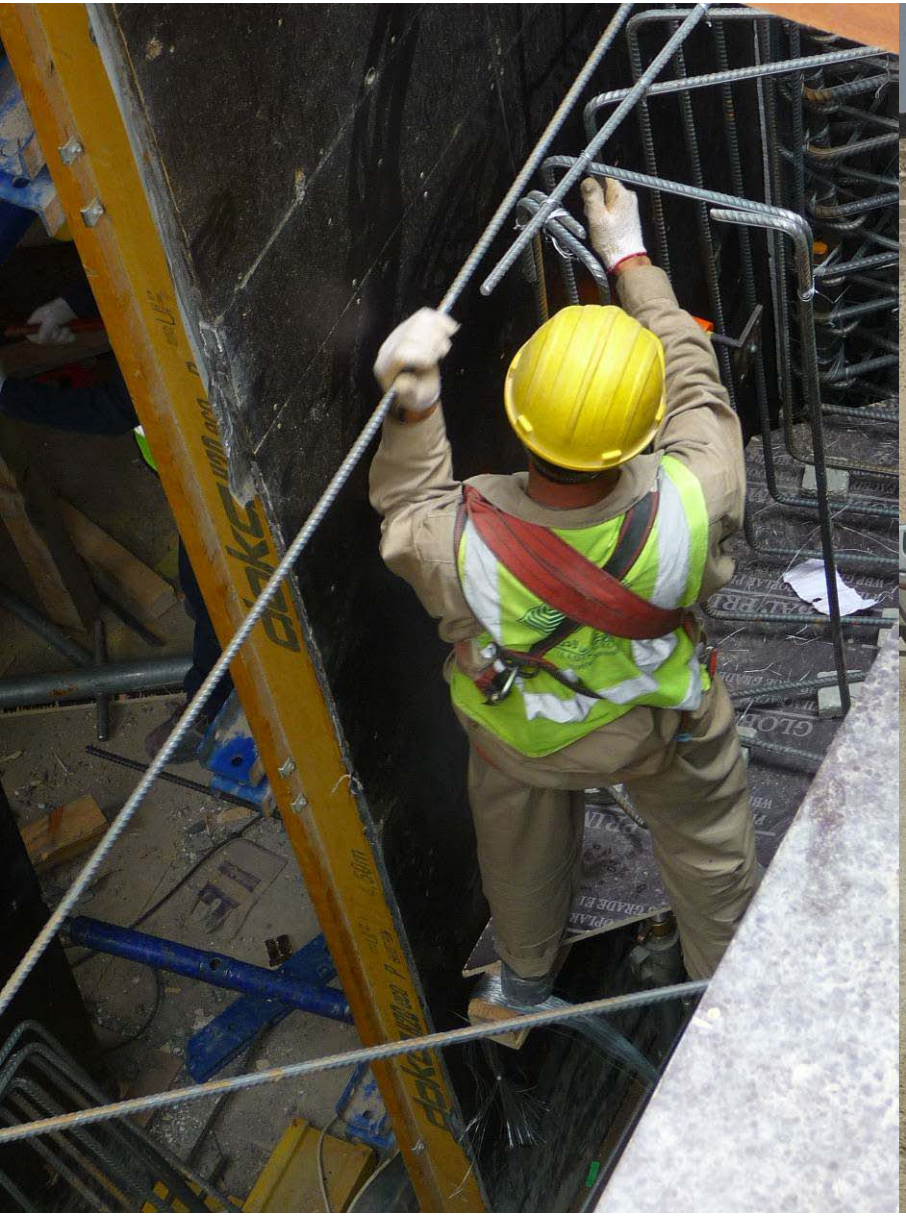
CMA Tower in King Abdullah Financial District

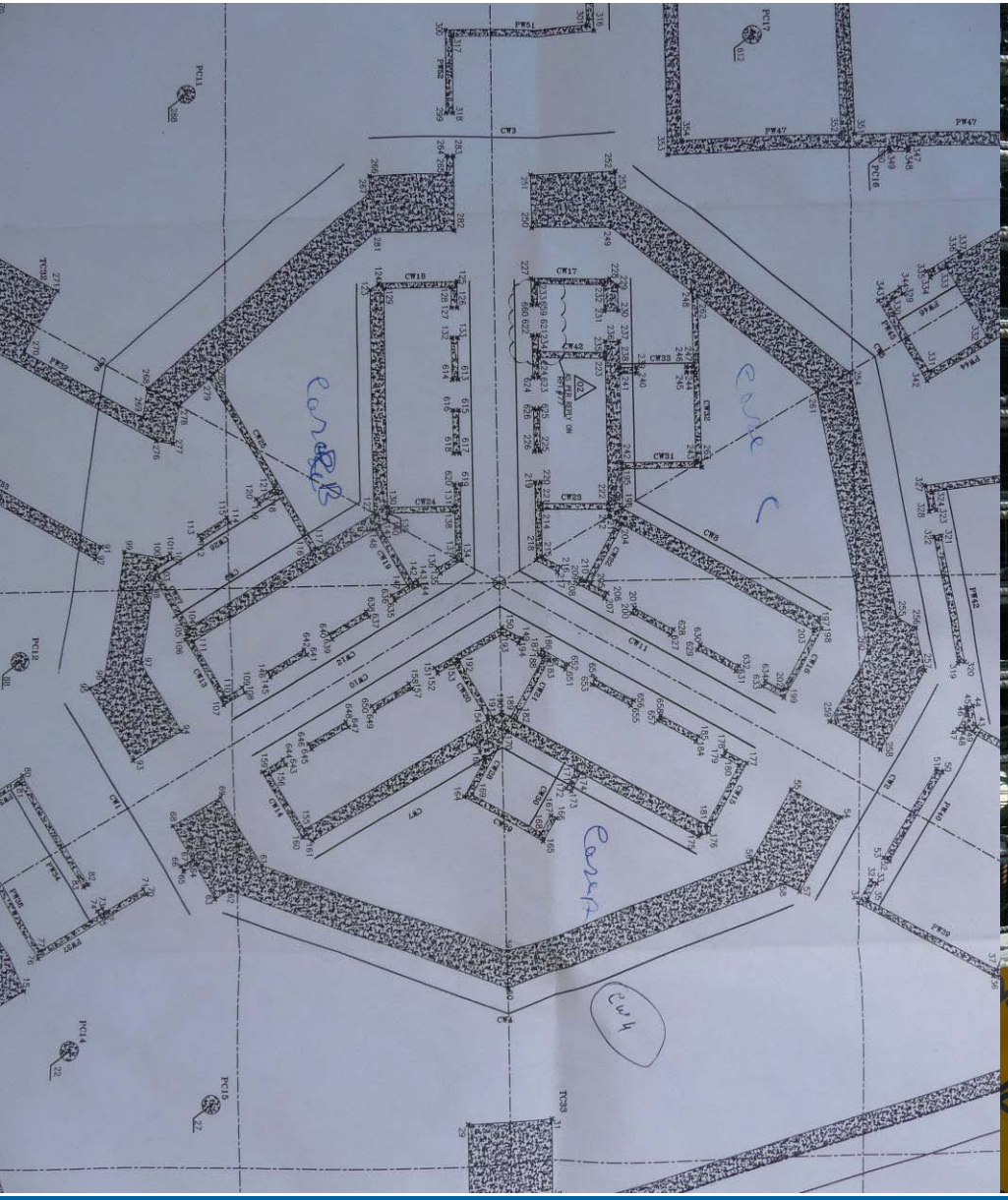
Walter P Moore provided structural engineering design services for this 80-story high-rise office tower in Saudi Arabia. At 400 meters tall and 1,991,000 square feet, this world class office tower is to be the landmark project of the new King Abdullah Financial District in Northern Riyadh.

55 deg. Celsius

55 deg. Celsius

55 deg. Celsius





doka
Frami Xlife

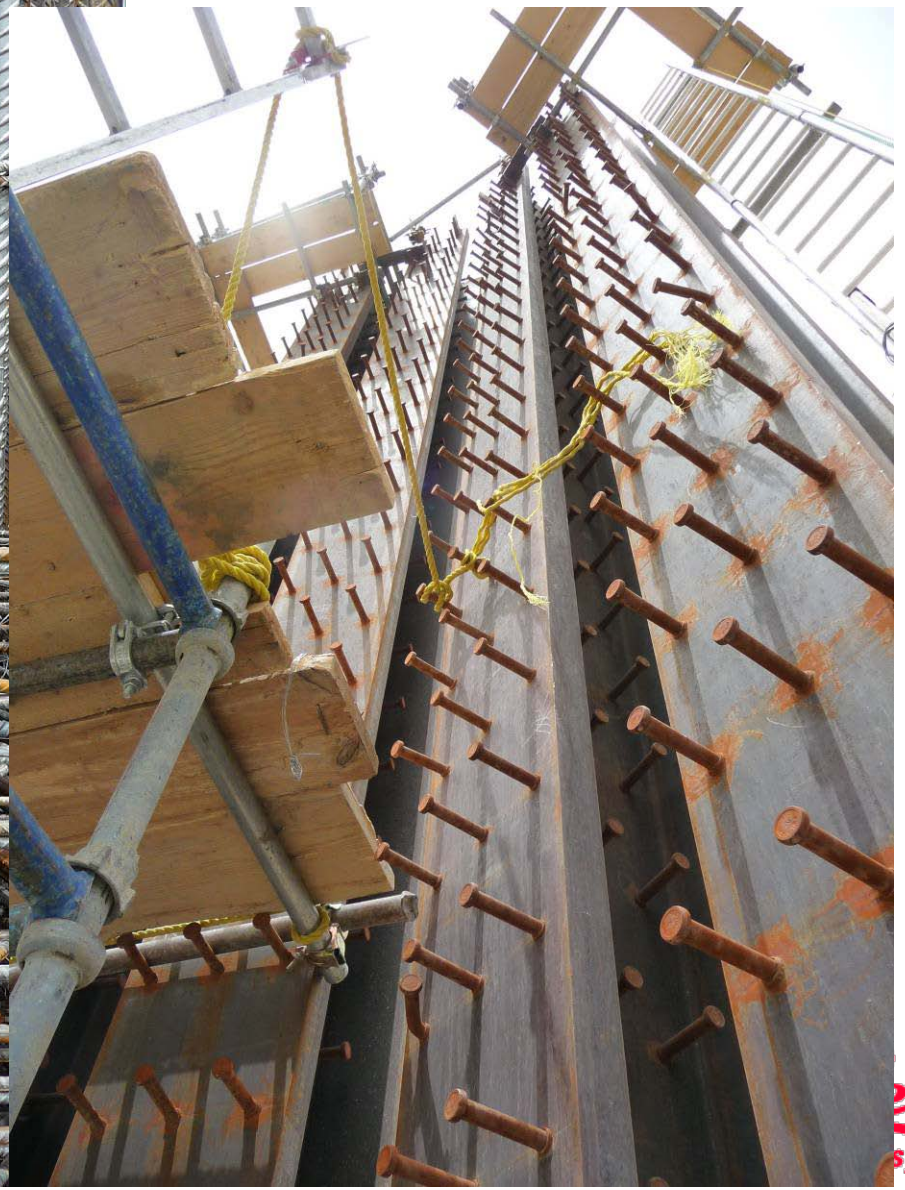
C.R.7
XCMG QY50K

33

flynas.com
nas air
AKE 17888 SV

CMA Tower in King Abdullah Financial District

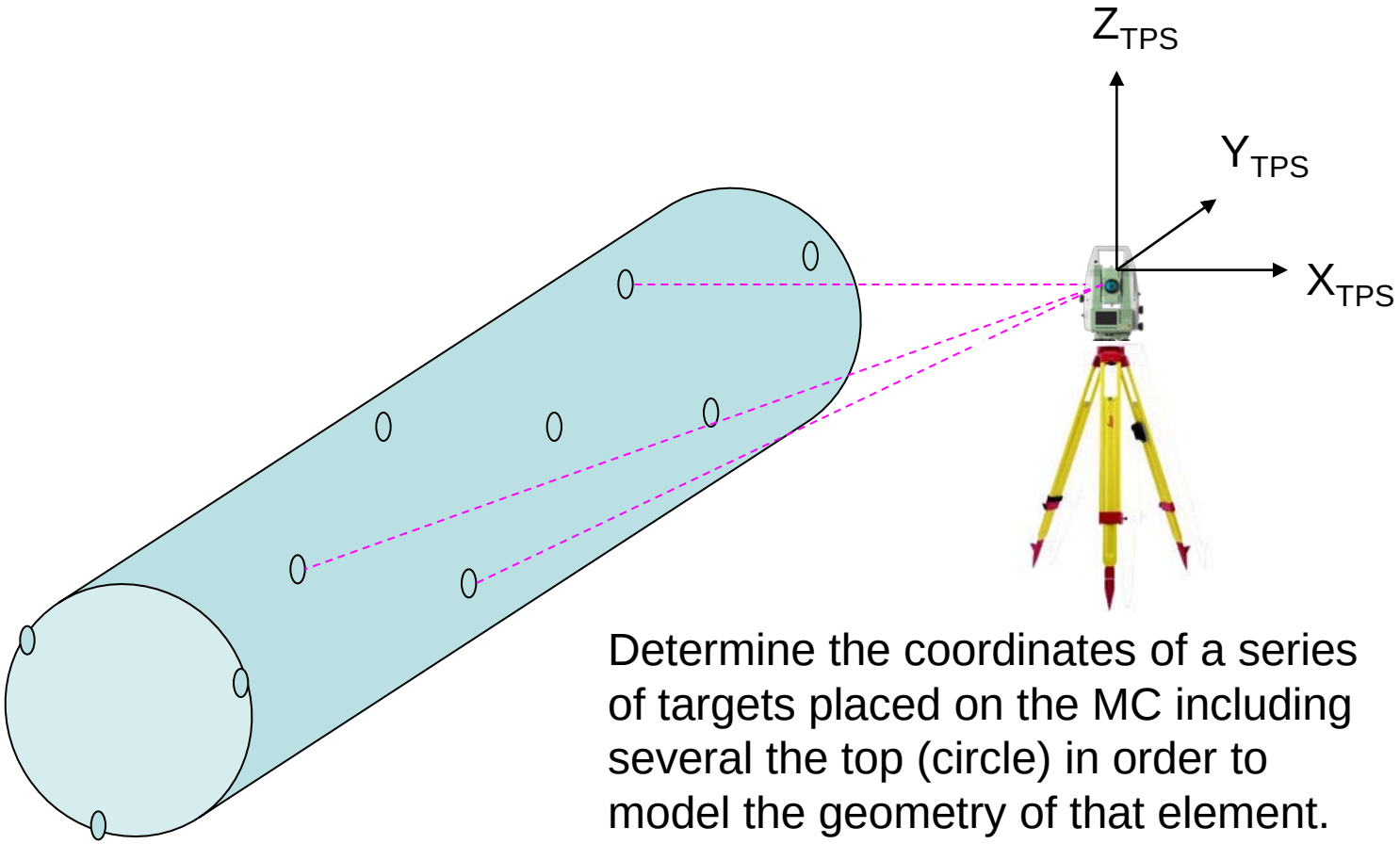
LIEBHERR



SCHWING
SPB30

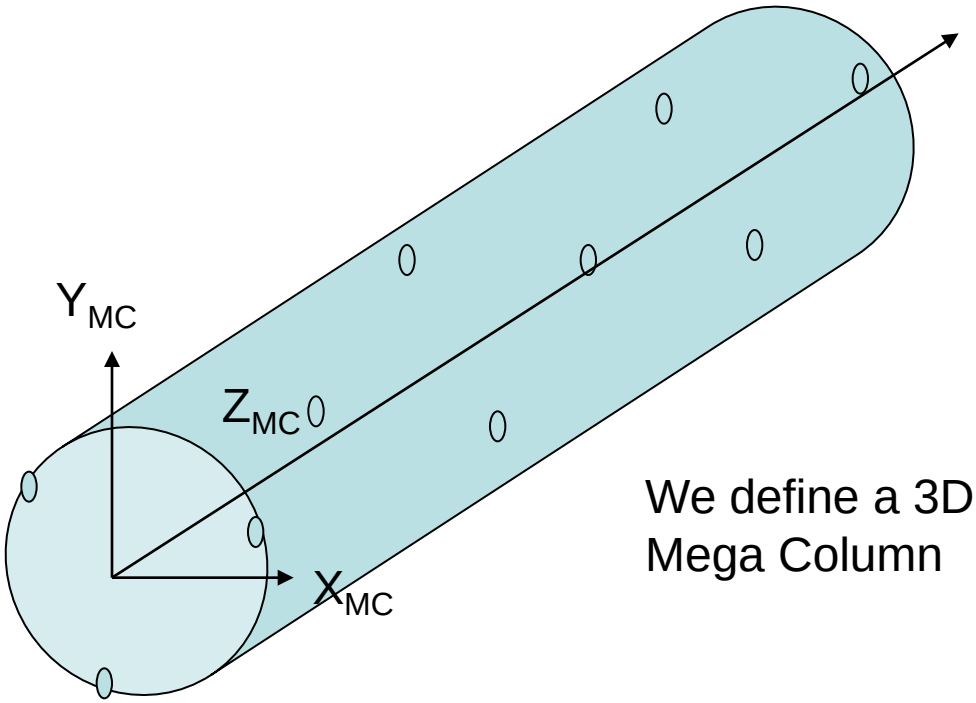
CMA Tower in King Abdullah Financial District

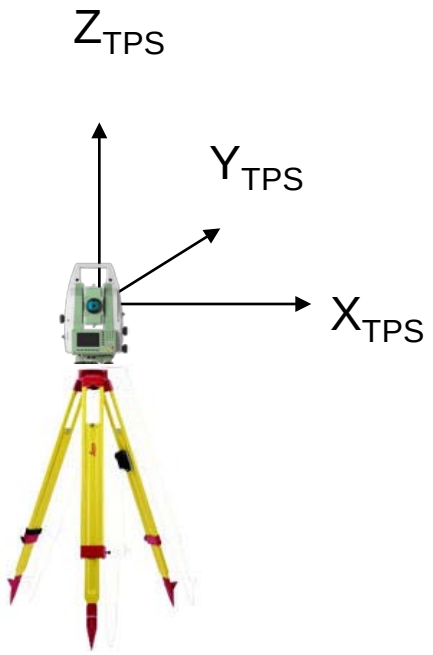
1. Determine the MC (Mega Column) geometry



Determine the coordinates of a series of targets placed on the MC including several the top (circle) in order to model the geometry of that element.

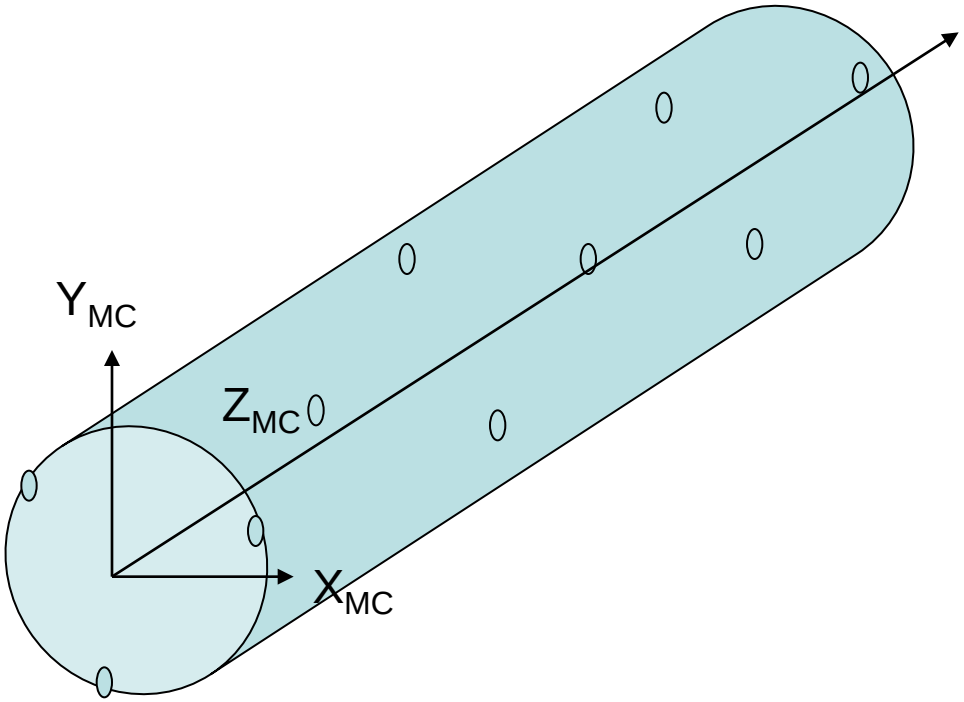
2. To transform the TPS CS into the MC coordinate system.





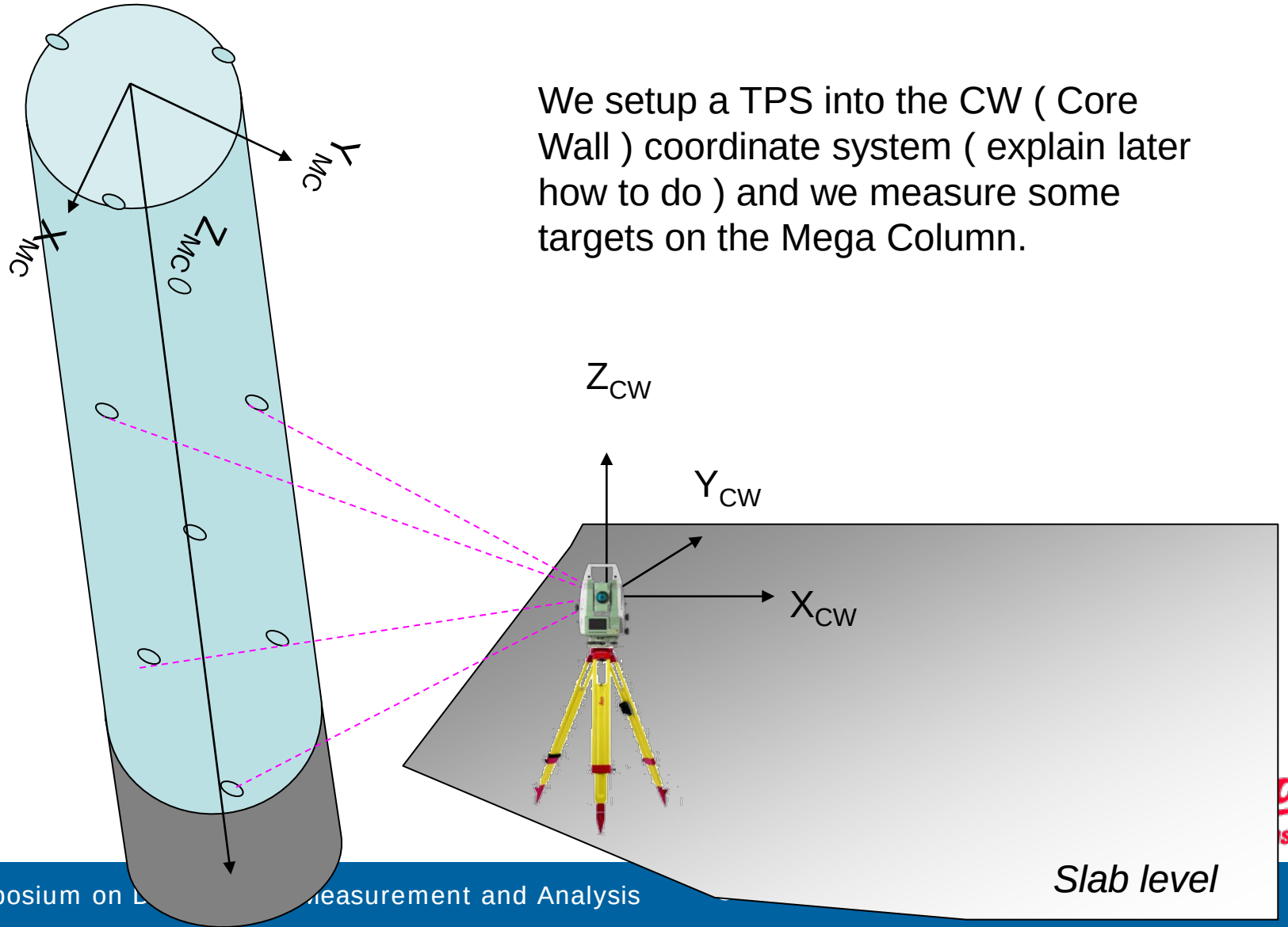
We define a 3D transformation TPS to Mega Column

2. To transform the TPS CS into the MC coord. system.



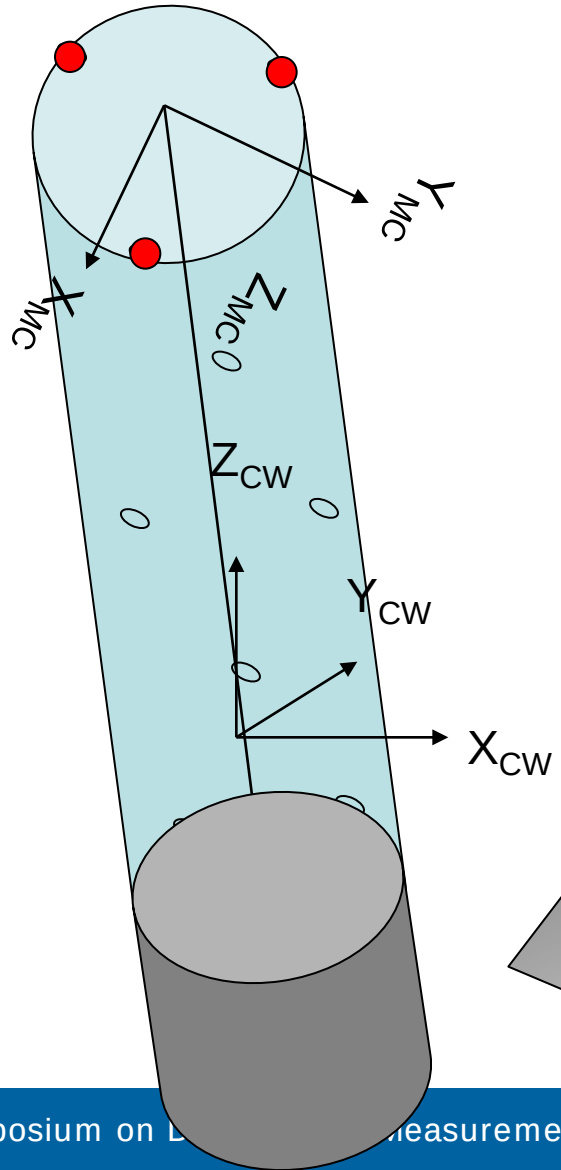
The MC owns its coordinate system.

3. When the MC is on place and request control.

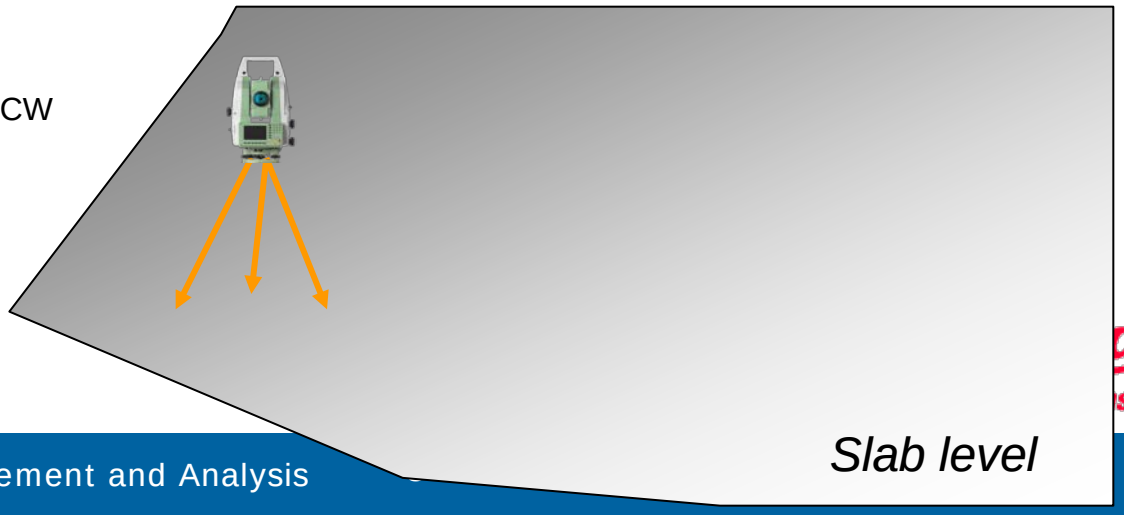


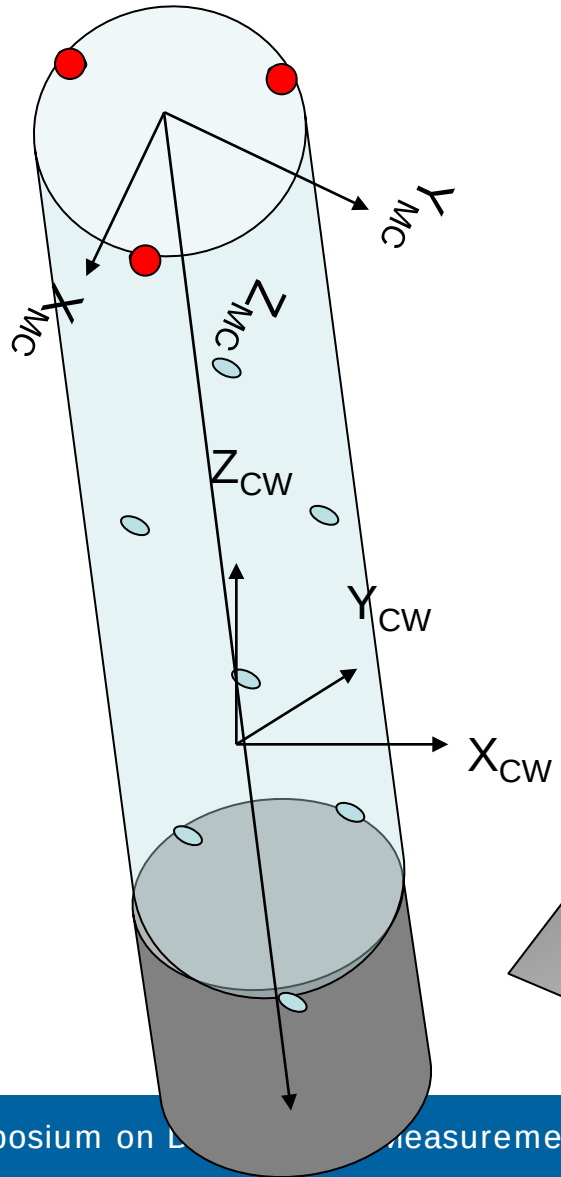
We setup a TPS into the CW (Core Wall) coordinate system (explain later how to do) and we measure some targets on the Mega Column.

4. 3D Transformation from MC coordinates into CW.



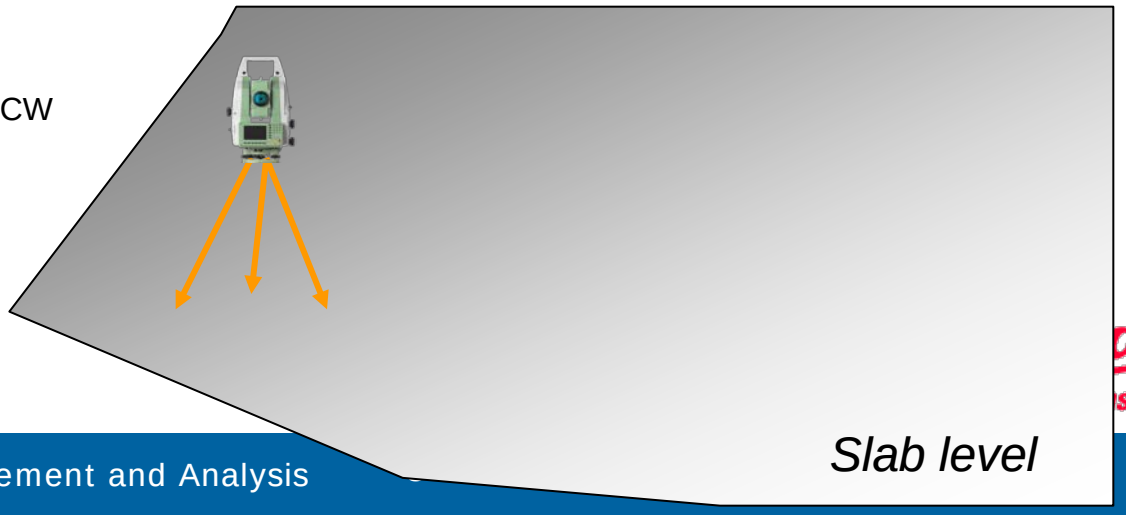
Using common points known in both (CW and MC) coordinate systems, we can derive the 3D transformation parameters and determine the top circle (3 points for instance) targets into the CW coordinate system.





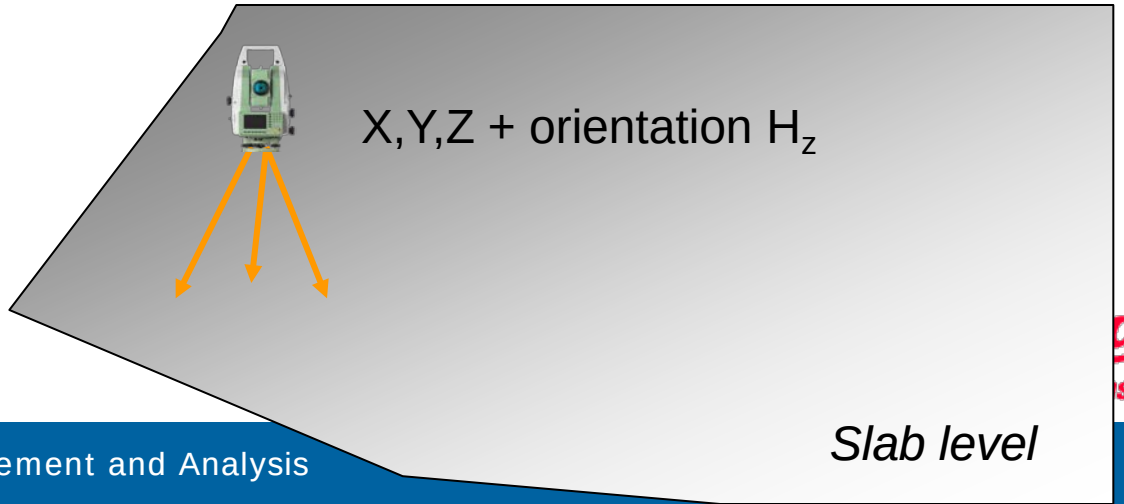
After the 3D transformation we can examine the residuals and evaluate how much the MC could have been distorted.

We do need at least 5 common points in both CW and MC coordinate systems.

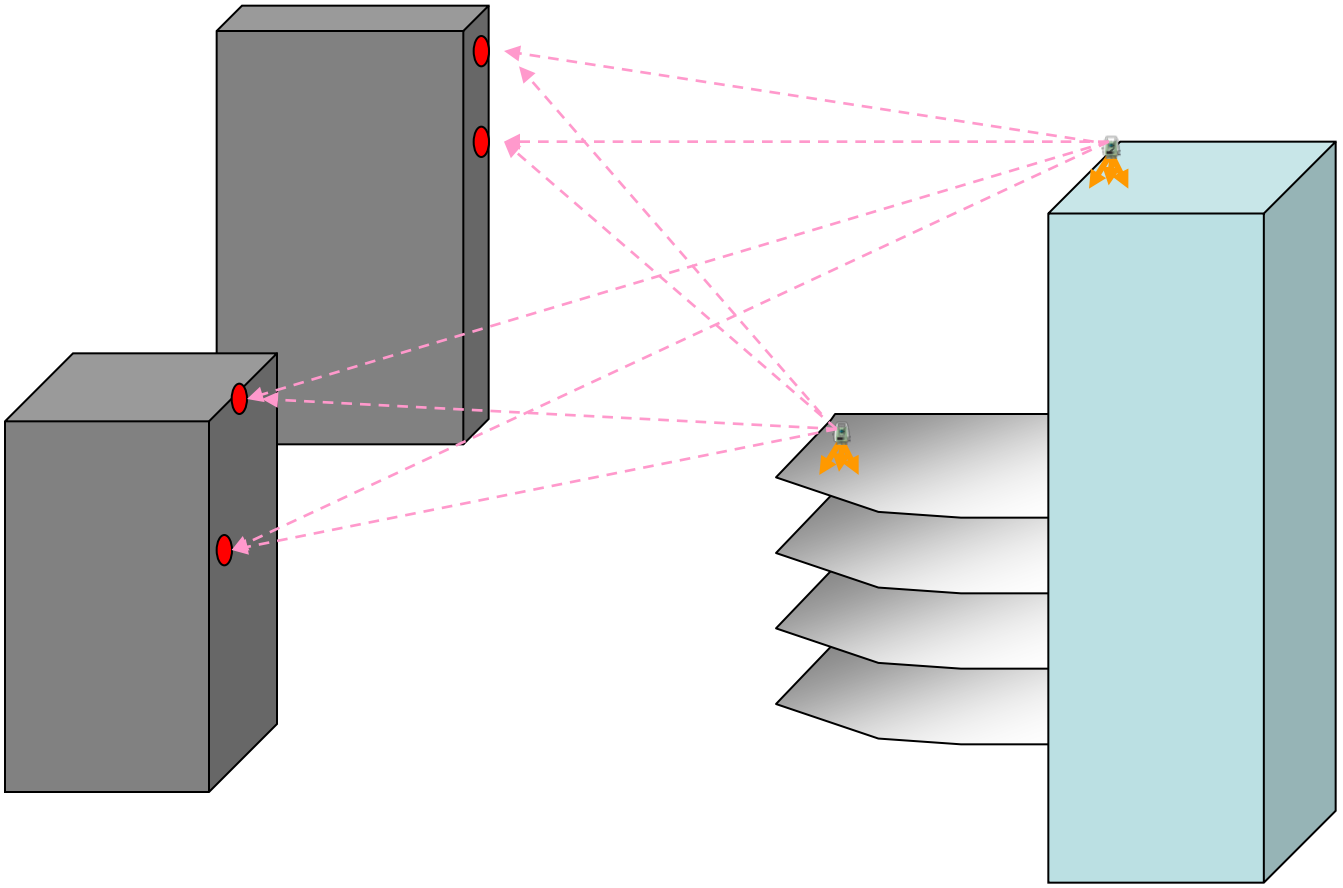


To setup the TPS on CW coordinate system we do need at least 2 points (x,y) for 2D position and orientation and 1 point (z) for 3D.

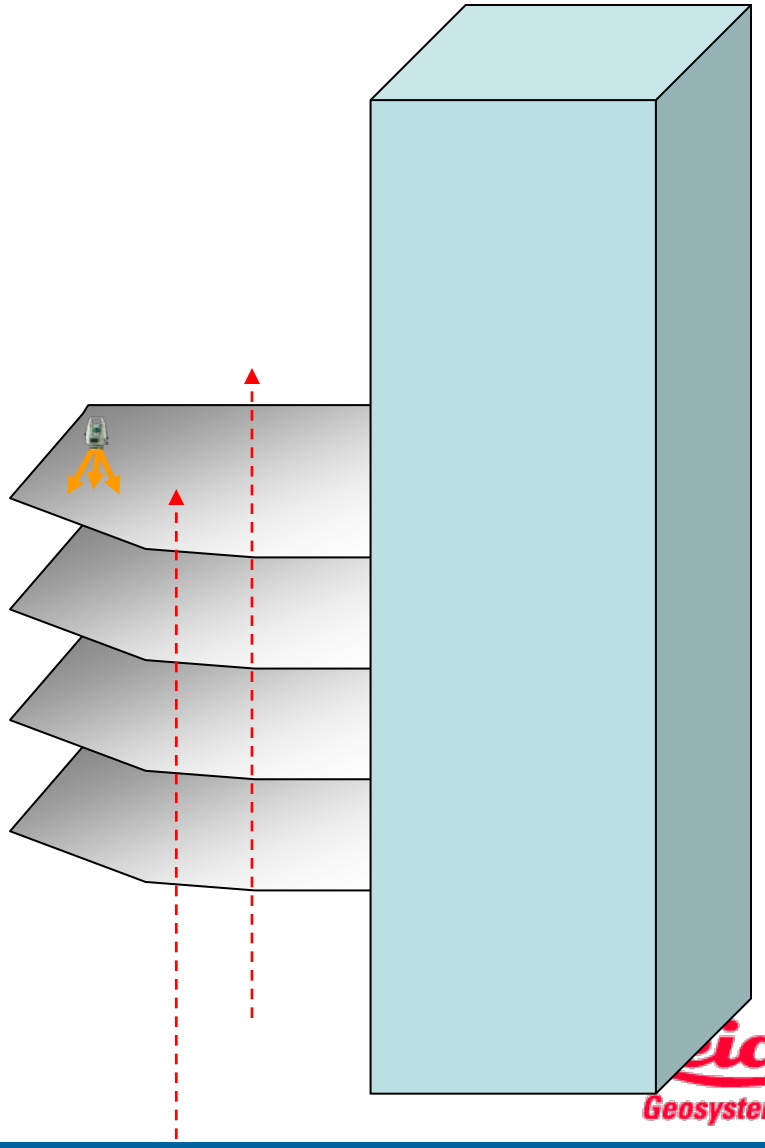
There are 2 possibilities, the first one (1) is to transfer coordinates from the top (using reflectors placed on surrounded buildings) and the second (2) is to transfer coordinates from the ground.



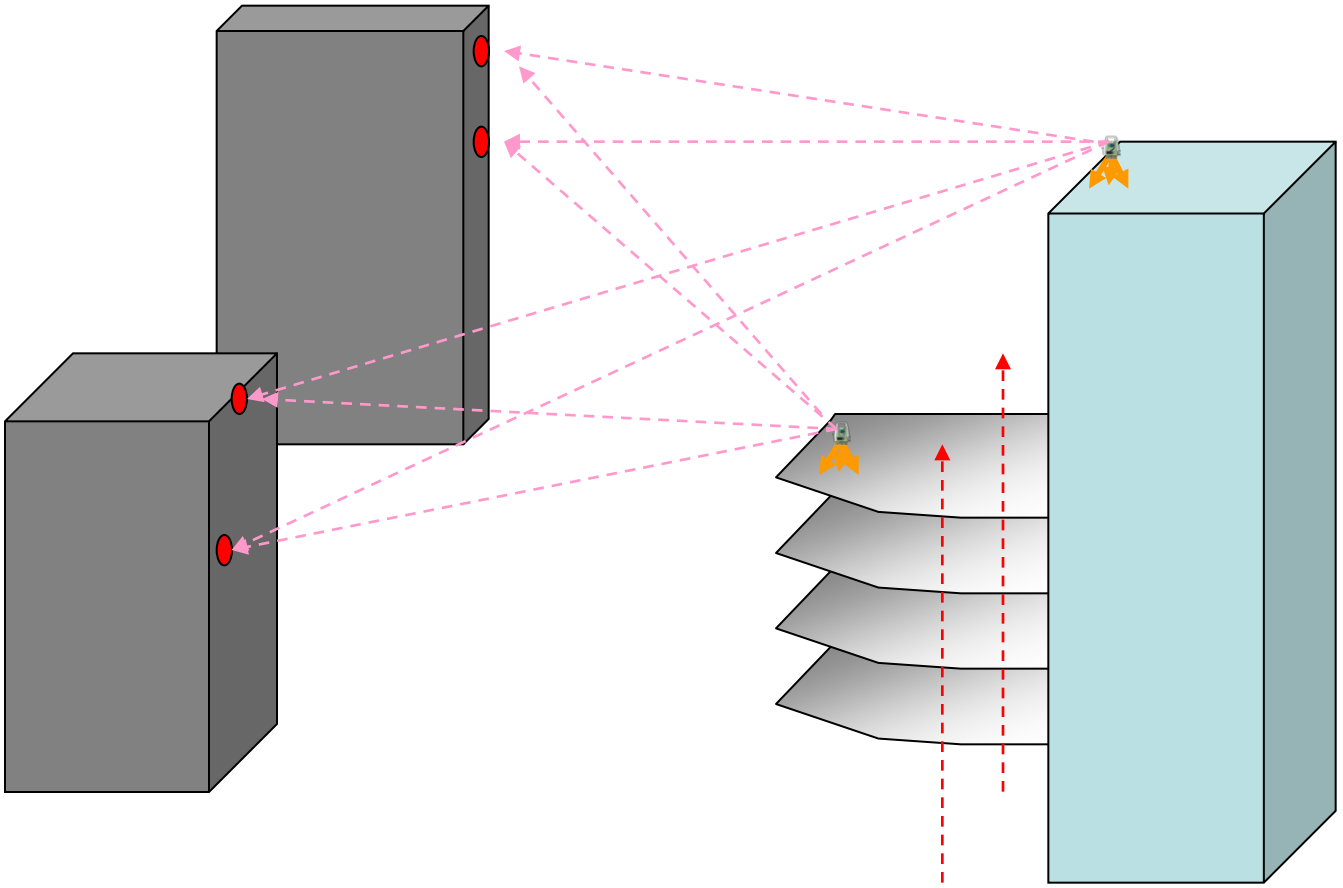
6. Annexe – How to setup the TPS ? From the top (1)



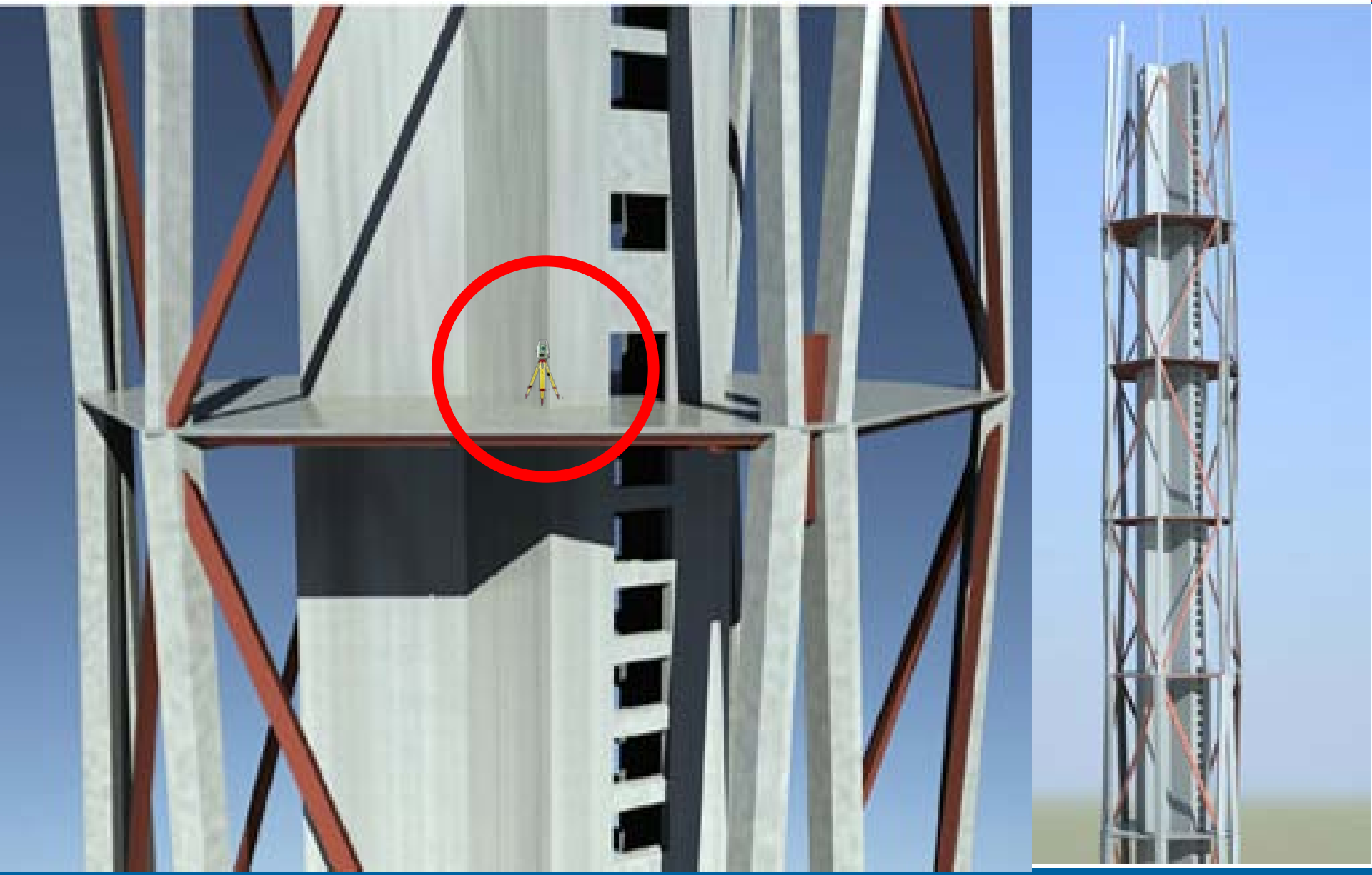
6. Annexe – How to setup the TPS ? From the ground (2)



6. Annexe – How to setup the TPS ?From the top (1) and ground (2)



CMA Tower in King Abdullah Financial District



3D Transformation

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} Tx \\ Ty \\ Tz \end{bmatrix} + s \cdot \begin{bmatrix} \cos\phi \cdot \cos\kappa & -\cos\phi \cdot \sin\kappa & \sin\phi \\ \cos\omega \cdot \sin\kappa + \sin\omega \cdot \sin\phi \cdot \cos\kappa & \cos\omega \cdot \cos\kappa - \sin\omega \cdot \sin\phi \cdot \sin\kappa & -\sin\omega \cdot \cos\phi \\ \sin\omega \cdot \sin\kappa - \cos\omega \cdot \sin\phi \cdot \cos\kappa & \sin\omega \cdot \cos\kappa + \cos\omega \cdot \sin\phi \cdot \sin\kappa & \cos\omega \cdot \cos\phi \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

$$s \cdot R = (1 + ds) \cdot dR = \begin{bmatrix} 1+ds & -d\kappa & d\phi \\ d\kappa & 1+ds & -d\omega \\ -d\phi & d\omega & 1+ds \end{bmatrix} = I + \begin{bmatrix} ds & -d\kappa & d\phi \\ d\kappa & ds & -d\omega \\ -d\phi & d\omega & ds \end{bmatrix}$$

$$X = dX + (1 + ds) \cdot dR \cdot X_0$$

$$\begin{bmatrix} X_i \\ Y_i \\ Z_i \end{bmatrix} = \begin{bmatrix} x_i & 0 & z_i & -y_i & 1 & 0 & 0 \\ y_i & -z_i & 0 & x_i & 0 & 1 & 0 \\ z_i & y_i & -x_i & 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} ds \\ d\omega \\ d\phi \\ d\kappa \\ dT_x \\ dT_y \\ dT_z \end{bmatrix}$$

Many thanks for your consideration

Joel van Cranenbroeck, Director of Technology and Project Development
GEOMOS AG
CH-9435 Heerbrugg, Switzerland
Joel.vancranenbroeck@geomos.ch
Mobile : +32 474 98 61 93