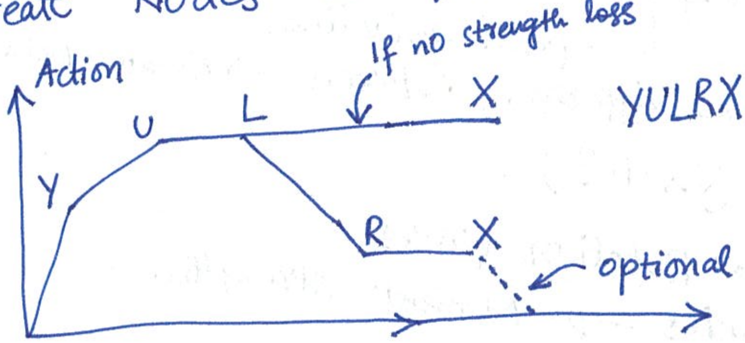
Engr. Shabbir

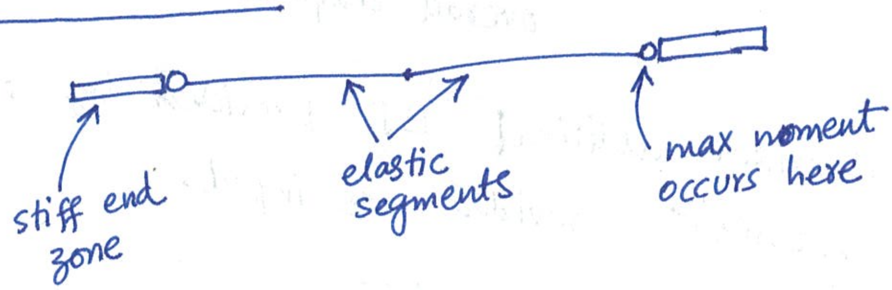
NL Modeling Perform 3D

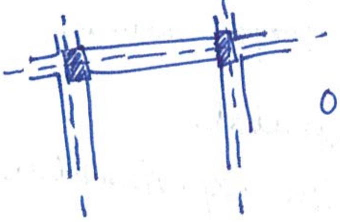
- PBD Guidelines
  - TBI 2010
  - ASCE 41
  - LATBDC 2014
- Create Nodes → Make their groups
- 

  YULRX → for every component

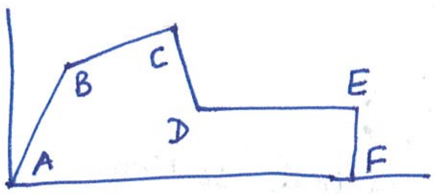
We can avoid U as well as R.

- Beam NL Modeling





overlap of beam and column due to centre point modeling so "Stiff end zone"

- 

  ASCE 41

- We model rigid PH.
  Program uses the elastic stiffness of beam and calculate M_{cap}. When $M > M_{cap}$, the

hinge activates.

For beams M − θ.

For My determination → no φ factor.
and use "expected" material properties.
└ from guidelines

ATC 72 → the difference between Ultimate point and yield point (× 1.3)

ASCE 41 → Rotation values

Basic Mechanics → Moment strengths.

- Avoid  → convergence issues

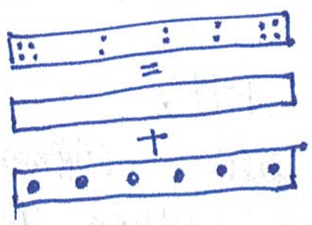
overall compound behavior.

- Consider additional ED provided by NL hysteretic behaviors provided as input.

- Perform → ED factors
  What will be the area of loop when
  = completely degraded / undegraded.

Can determine from calibration with experimental results. Or follow research

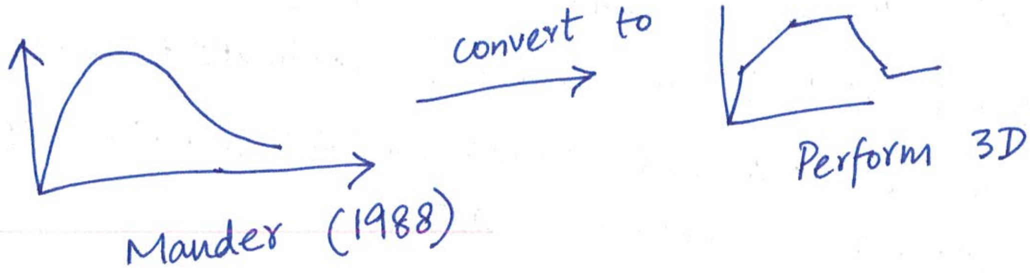
- <u>NL Modeling of SW</u> :–

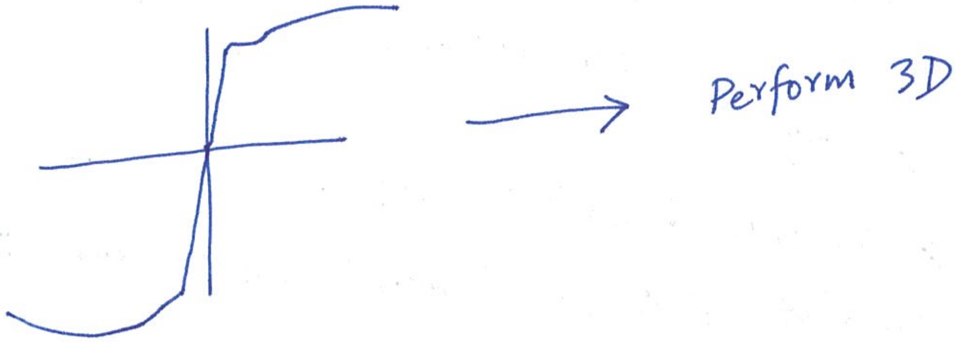


Actual section
=
Concrete fibers
+
Steel fibers

So no need of overall FD of wall, just give material FD.

Material σ ε models. eg Mander (1988) model





- Strength Sections :
  for Linear actions (e.g shear usually), we should not ignore them so we check them through a strength section. eg put beam shear st in beam component section.
  it will give D/C for shear.
  During TH the axial load in col is not constant.
  Shear st is always axial load dependent.
  so V2-V3 strength section. (Axial load-dependent shear capacity)

- Limit States
  Put a number in Performance levels and define in "Limit states".
  we can get D/C for all types of actions.

PERFORM 3D

- Text file from ETABS (.TPE)

  Each row is an element. Coordinates of each node.
- Open in excel and observe the row number. help in importing elements in Perform.

  For line element $x_1, y_1, z_1, x_2, y_2, z_2$

  For area " 12 columns.
- Elements → groups

  Bar → uniaxial behavior only

  Without making group, we cannot import elements.
- Import/Export

  ☑ uncheck it Orientation data because our text file have only coordinate geometry.
- Make a group of Columns first → to import all frame elements in that. Then change group of beams.
- PH → Inelastic → Moment Hinge, Rotation Type (in which FD is Mθ)

  You need to have the moment capacities and rotation capacities. (basic mechanics)

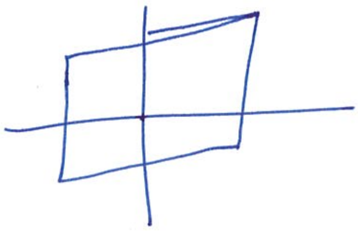
  Use the cross-section → If select, then automatically it calculate from cross-section

  No φ, expected material properties.

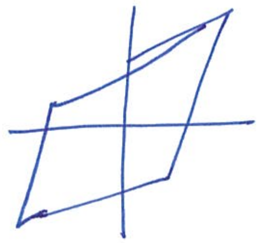
  upper bound/lower bond → for sensitivity analysis it will use both bounds and give result.

  Def cap → to put capacities → Program knows the compount → gives D/C ratio.

If you dont put capacity, Analysis will still run.
Cyclic degradation Factors → Models in literature or fy to map Perform with test results or literature (ED factors).
Unloading behavior factor → the shape of unloading.
Go to plot loops and check the cyclic behavior.



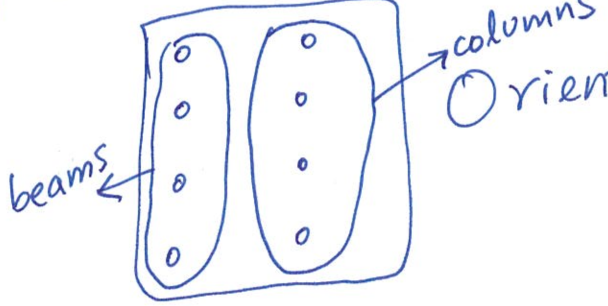
No cyclic degradation option



With cyclic degradation option.

→ Compound
(no need to define stiffend zones)
(It is already available in compound)

→ When you define a cross-section
axis 2 → along the depth
You have to remember these local axis.
and then assign this in the elements.
There use the basic direction of axis 2. So for beams "Axis 2 should be vertically up". Check arrows after assigning.



Orientations

→ Generally shear material = Linear

→ For Shear walls, the generally used orientation is "Axis 2 is parallel to IK"
The fibers generally move along axis 3.
Orientation is Axis 2 should be towards upwards.

→ Group → Axial Strain and Rotation gauges. (Shear walls)

→ Ch 10 of ASCE 41 → Rotation capacities

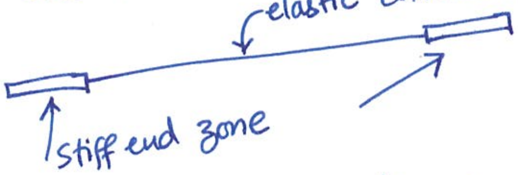
→ For shear walls shear → linear
Strength sections = Section cut

→ In moment hinge we defined "Rotation capacity" in "Performance level 1".

→ Different beams → diff Def capacities → so different compounds for them.

→ Define limit states. Component type → Performance level 1.

→ If columns are to remain linear elastic



→ Column hinges —— PMM hinge (Rotation type) — P M2 M3 hinge
—— Fiber type

In beams, you only require Mθ.
Because column is biaxial bending + Axial load → moment capacity is not constant.
So you have to define

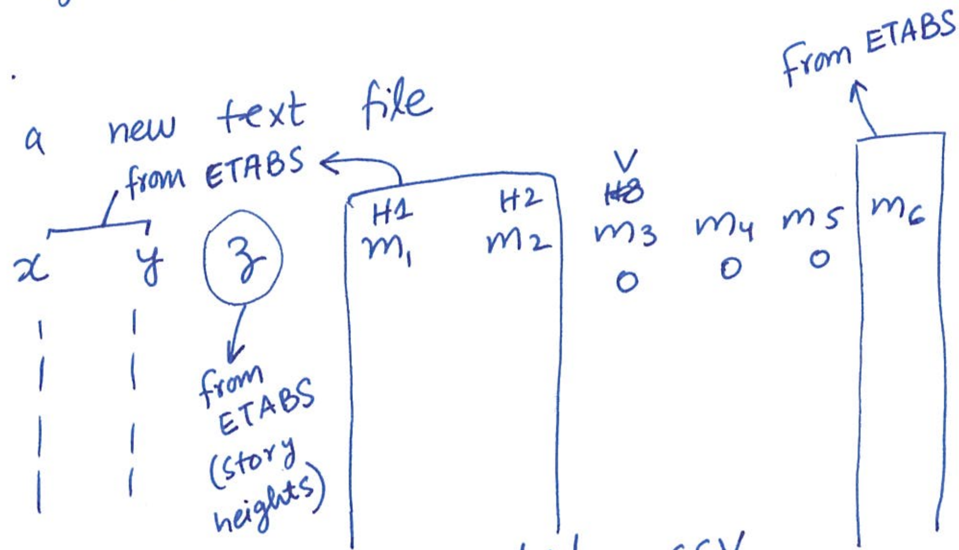
→ No automatic definition of mass and loads.

→ If Rigid diaphram ⟶ then rotational mass is necessary to define. If distributed then no need of rotational mass.

→ If geometry is imported from ETABS, it is easy to assign masses.

→ Assign Rigid frame diaphragms to all floors in ETABS.

Make a new text file



make this file as comma separated .csv

Go to import / export ⟶ ⊙ Only nodes

Check mass options and then OK.

Then include those lumped mass nodes in to rigid diaphrams.

→ Loads
- Node
- Element
- Self Weight

Mr. Aung Lecture

→ Modal amplitude units should be consistent with forces you extract for modal load combinations.

→ ~~V & 0.85~~ $V_{RSA, reduced} \nless 0.85 V_{ELF}$

→ Energy error in results.

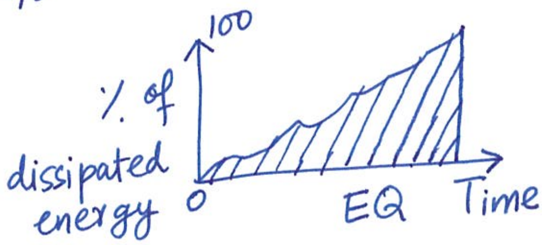
→ "Energy Balance" in Analysis Phase

Energy error percentage = 1.19 %.

if > 5% recheck the model and rerun

= difference between input and output energy

Go to element group → select a groop → Plot



Check the participation of ED by different element groups.

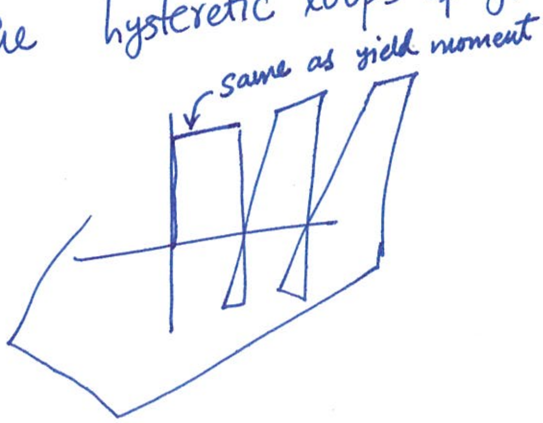
This give Qualitative Analysis

e.g "girders yielding or not" → without checking the strain values.

→ In BMD of a line of columns → double curvature because of the yielding of girders.

→ Base Shear history → like jerking a rope from one end (base).

→ Plot the hysteretic loops of girder hinges



→ Extract
rebar strains
Axial strains
PH rotations → check limits based on ASCE 41
Residual → last step drifts.

→ In ETABS → local axis is automatically defined
In Perform 3D → " " we have to manually defined.

Similarly, mass, loads etc. NO area load in Perform (manually calculate)

For Podium (in Perform) → usually distributed mass
" " " " → no rigid diaphram to account for back stay effects.

→ 10,000 steps GM → 3,4 days + cannot extract the text file of results.
Reduce the steps of GM without spoiling it. The spectras of both should match.

→ It is not good to model 2ndry beams in Perform because then we have to divide the girders.
So better to just put loads on girders directly.