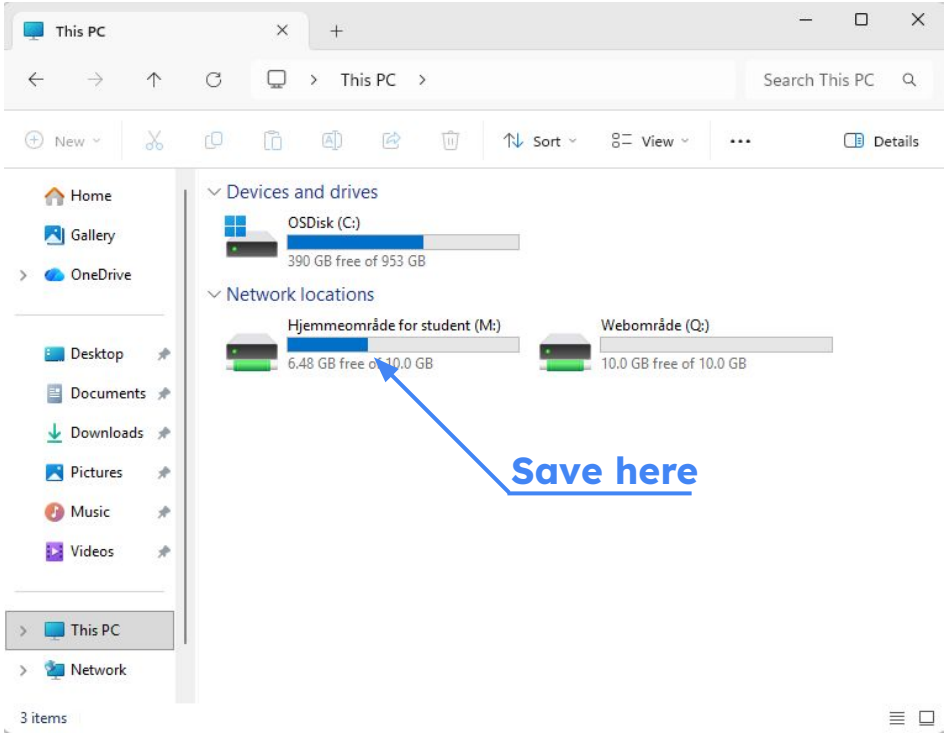
NTNU SEISMIC DESIGN TEAM

SAP2000®

# Introduction

# Save file




**Or:**

Google Drive

OneDrive

# Structure/Geometry

**Workflow**

*0. General*

1. Grid
2. Materials
3. Frame Sections
4. Frame objects
5. Connections

# General

## Cursor

- Pan: middle mouse
- Rotate: shift - middle mouse

## Display options

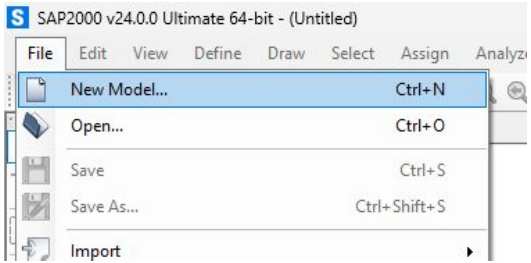
- Edit => Display options
  - 3D view:
    => View options=>Extrude

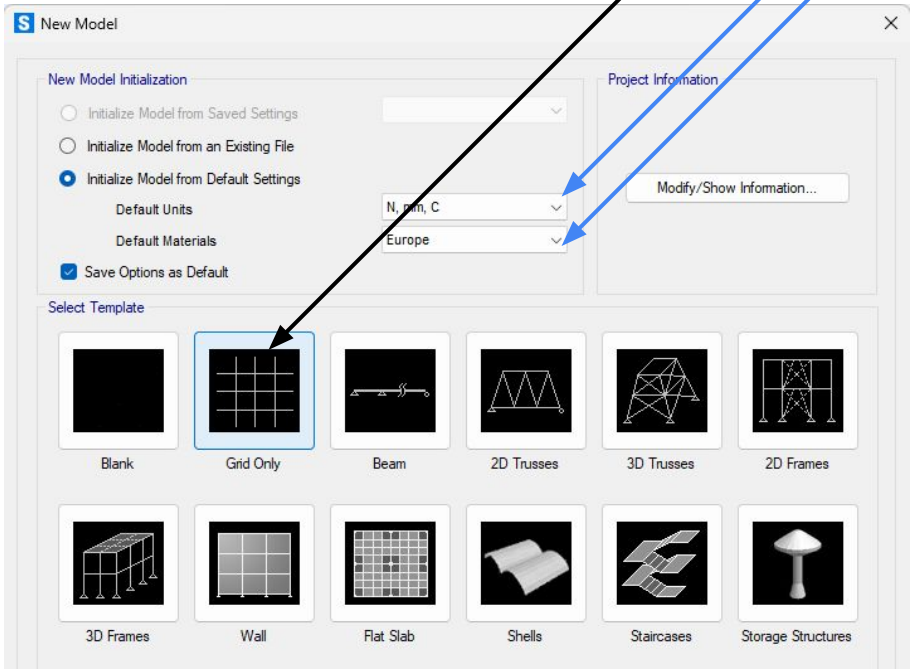
# New model

Click Grid Last

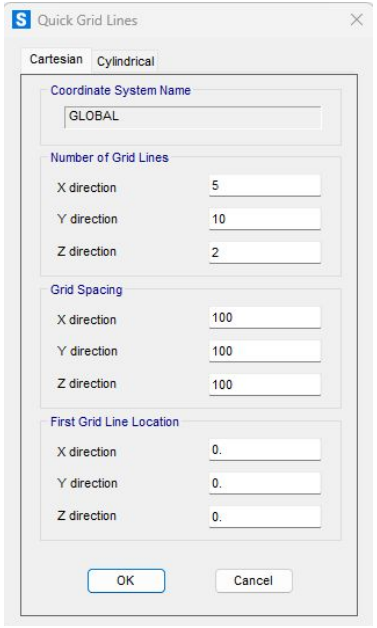
N/kN

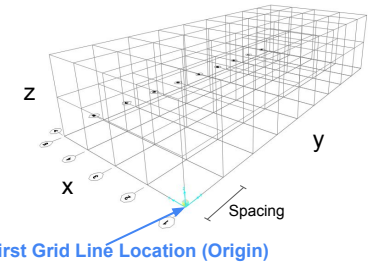
Europe



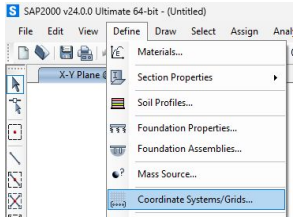
# Grid Setup



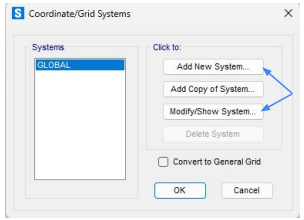




## Modify grid later:

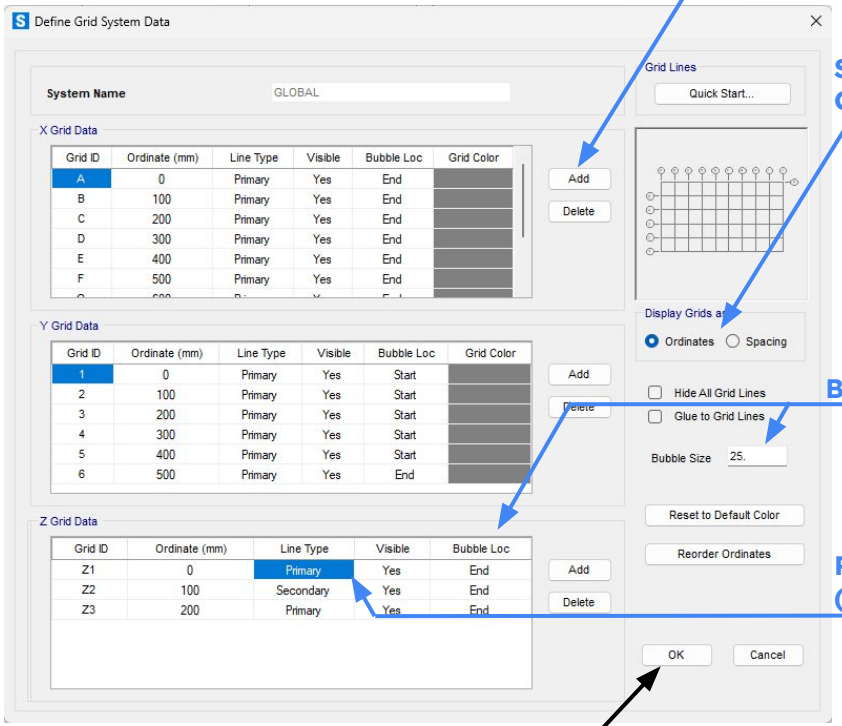
**1.**




**2.**




**3.**




Add Line (same spacing)

Switch Coordinates/Spacing

Bubble

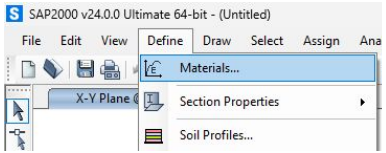
Primary (w/ Bubble)

Secondary (No Bubble)

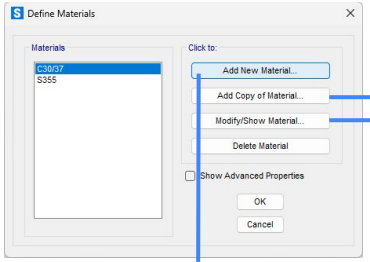
**Last: OK**

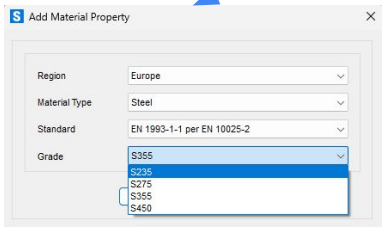
# Materials

1.

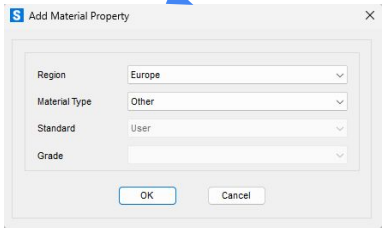



2.




Eurocode Materials




Timber and other materials

3.

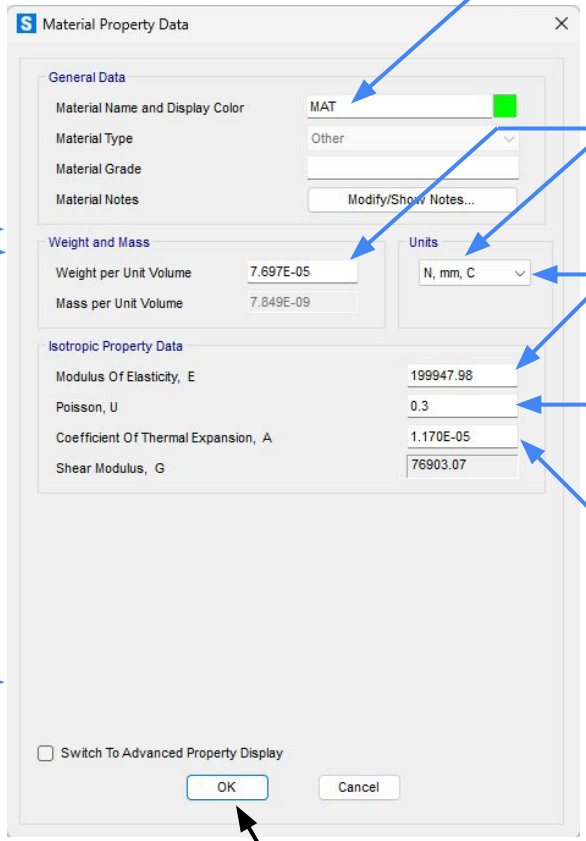
Material Name: GL24h, C24 etc.

Density (NEWTONS)

Watch units

$$\nu = \frac{\varepsilon_{\perp}}{\varepsilon_{\parallel}}$$

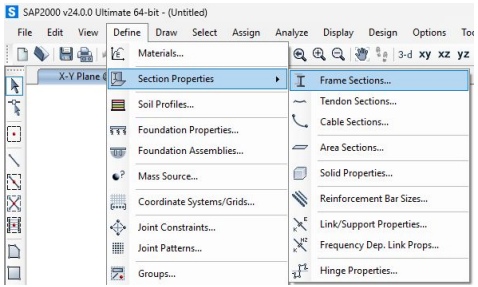
$$\alpha \cdot \Delta T = \varepsilon$$



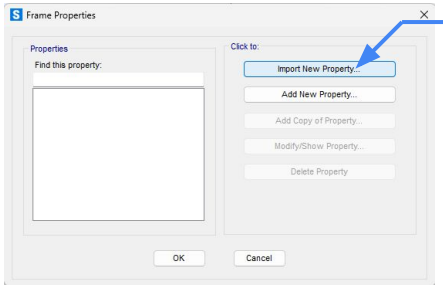
# Frame sections (Cross section/tverrsnitt)

## Complex sections (I, H, C)

**1.**

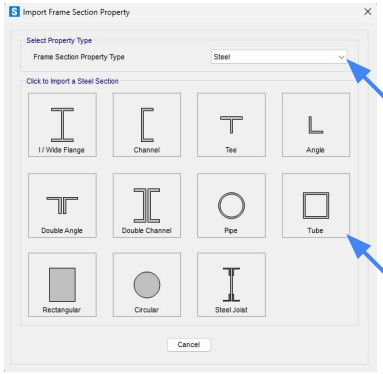



**2.**




Import New

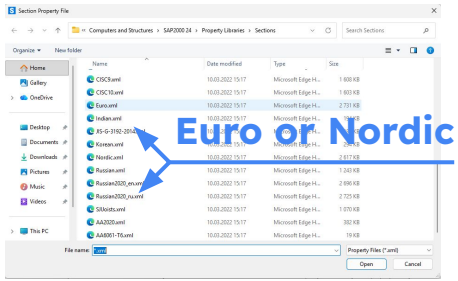
**3.**




Material

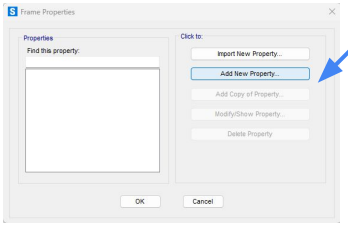
Section

**4.**



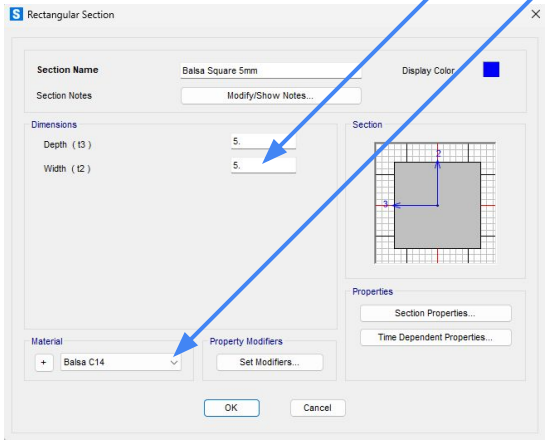

Euro or Nordic

## Simple Sections (or non standard)




Add New

Fill out



# Frame objects

**Select object**
Select frame or node to edit

**Element drawing options**

**Draw frame element**
Draw a frame or brace element (Ramme-element/stav).

**Draw 2D surface or square**
Use to draw walls/shear walls

**Node snapping options: Choose after element selected**

**Snap to Grid (intersections)**
Snaps to defined grid

**Snap to perpendicular**
Snaps to a point perpendicular to the frame element of the first point

**Snap to ends and midpoints**
Useful for Bracing/fagverk

**Snap to closest (Dont use)**
Snaps to closest element/mode. Only use for ideas or tests.

**Snap to element intersections**
Intersections between frame elements

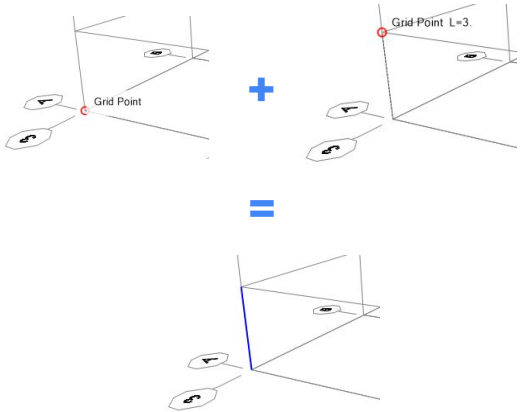
**Snap to increment**
Snaps to every 0.1cm etc.



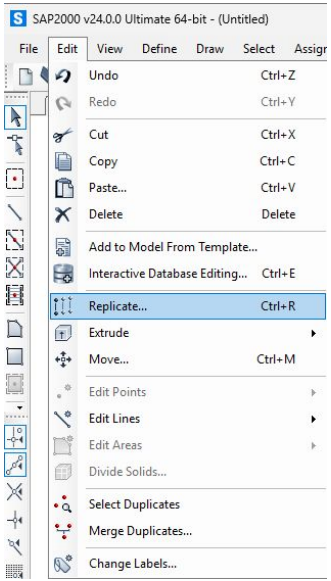
**1. Choose object**

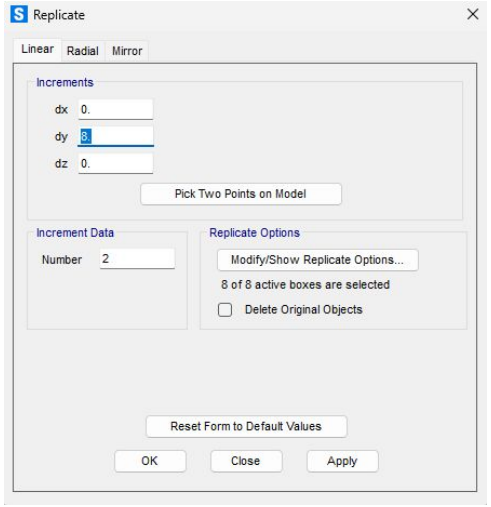
**2. Choose snapping**

**3. Click on 2 points**



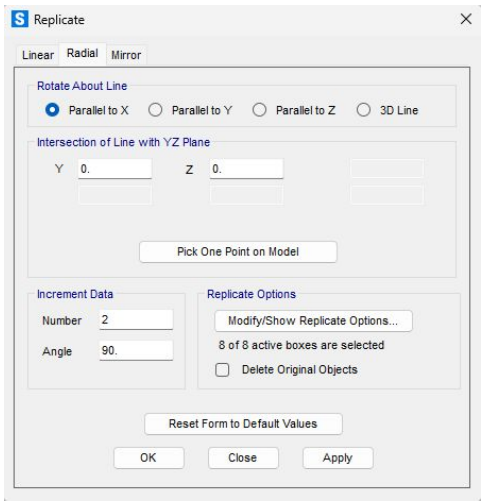
# Mirror/rotate/duplicate



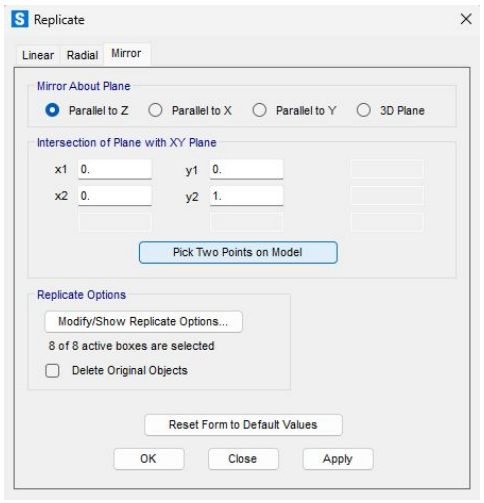

## Duplicate

**Increment**: Choose distance between duplicates
**Increment Data:** Choose number of copies




## Rotate

**About axis**: Choose axis to rotate around
**Intersection:** Choose where the axis is
**Increment Data:** Choose number of copies
**Angle:** Choose angle to rotate
**Options: Delete original objects** if you want to move the selection, instead of making a copy



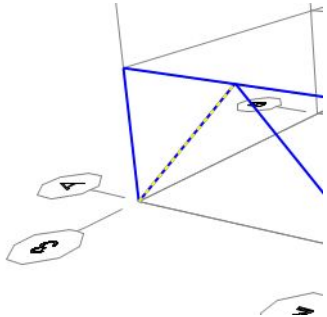

## Mirror

**About axis**: Choose axis to mirror about
**Intersection:** Choose where the plane is

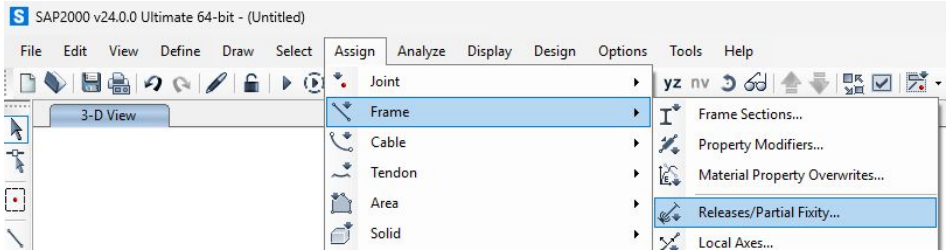
**Delete original objects** if you want to move the selection, instead of making a copy

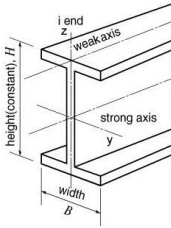
# Connections

## 1. Choose drawn element (Turns Blue/Yellow)



## 2. Assign => Frame => Releases/Partial Fixity



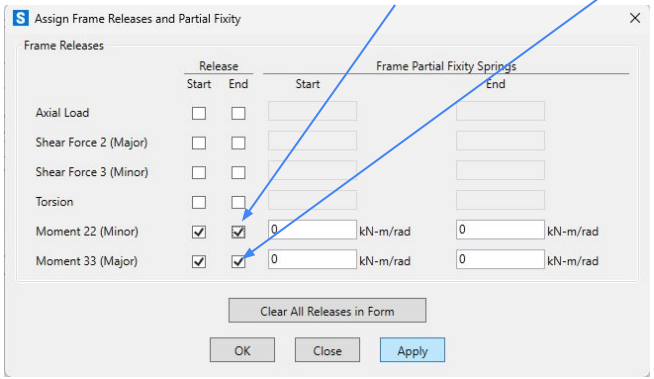




## 3.

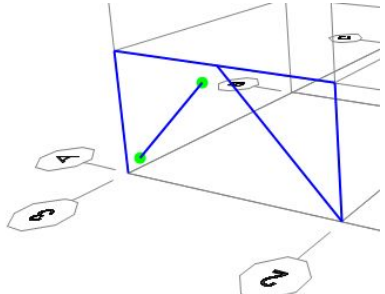
### a) Pinned-Pinned

#### => Release Moment,

- **Major = y axis, Minor= z axis**

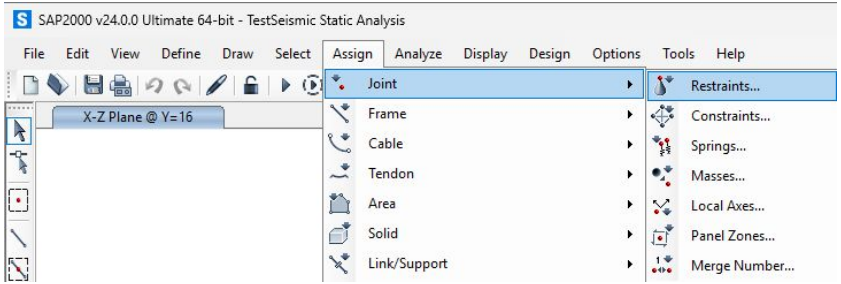



## 4.

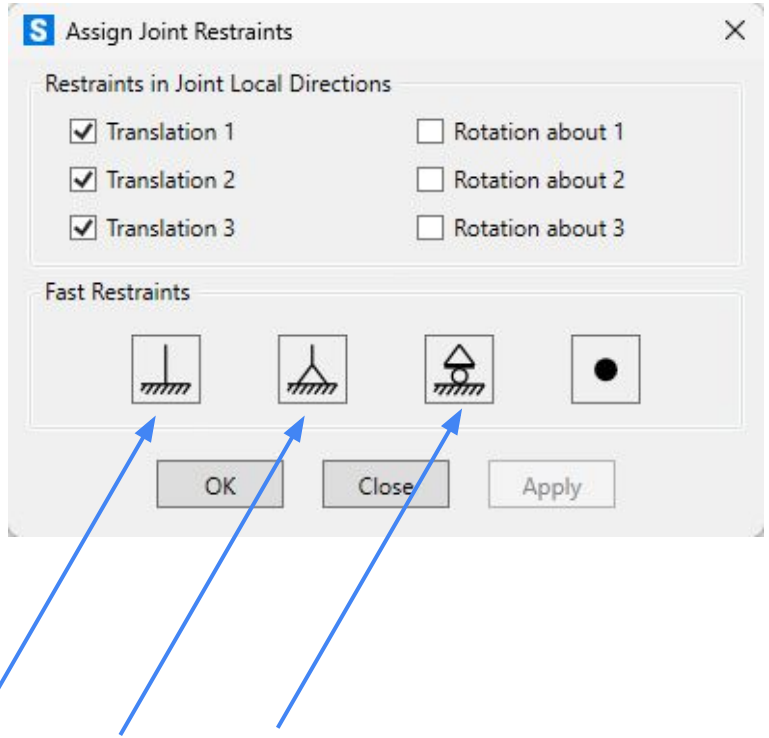


# Boundary Conditions

## 1. Choose drawn element (Turns Blue/Yellow)




## 2. Choose Restraint



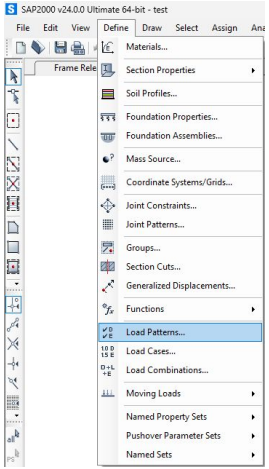
# Static Analysis

**Workflow**

1. Loads
2. Load Combinations
3.

# Loads

1.



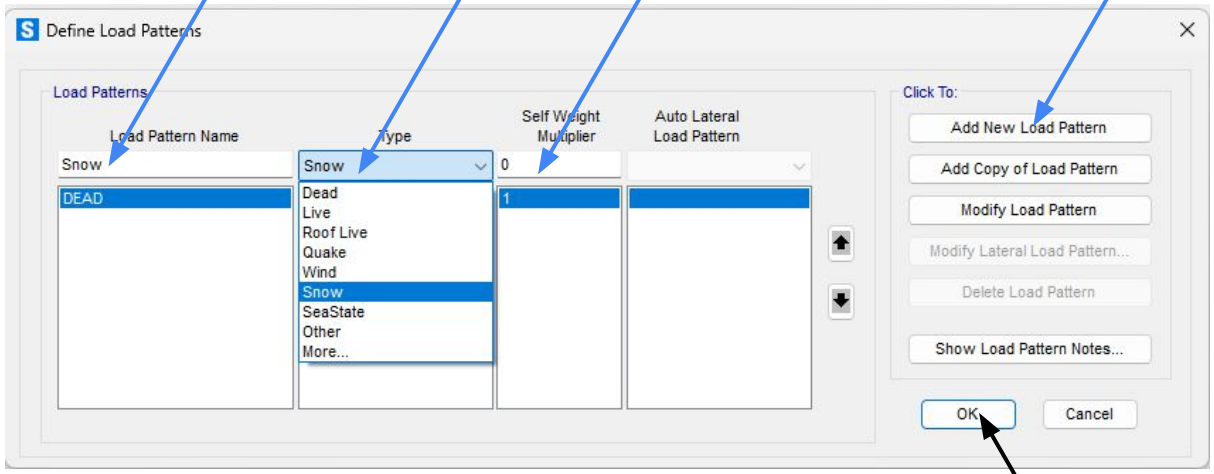

2.

Name

Type

If Dead => 1: Auto adds weight

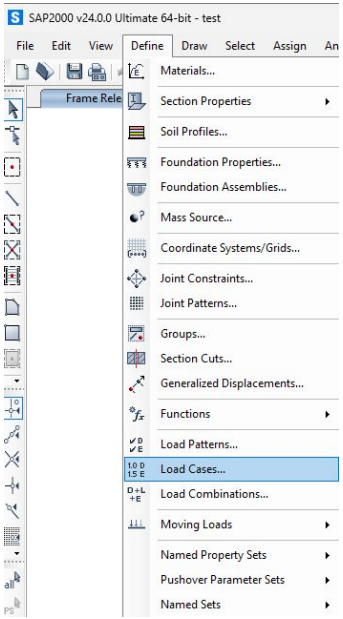
Last: Click add



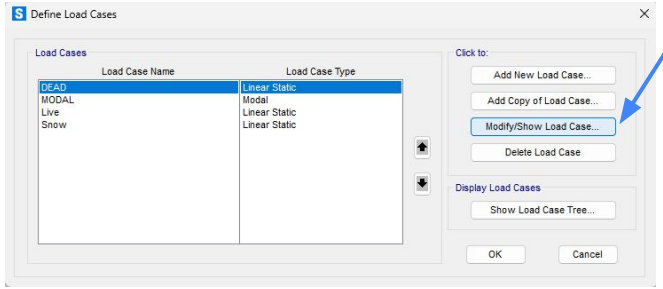

OK

# Non-linear analysis

**1.**

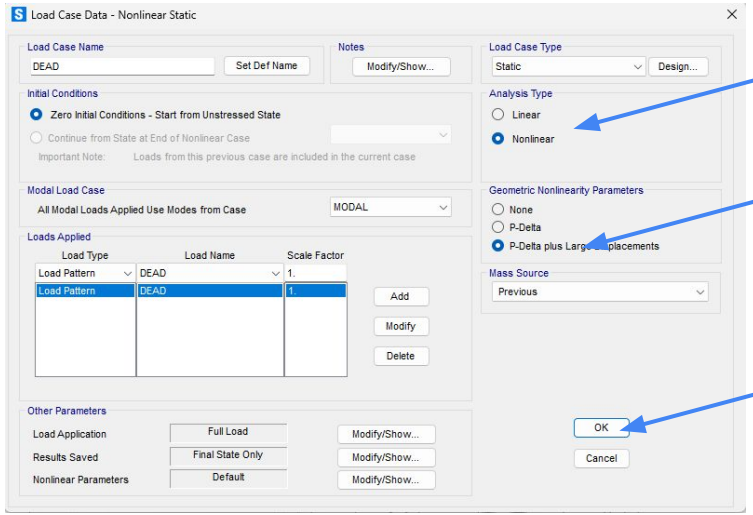



**2.**




Click Modify

**3.**



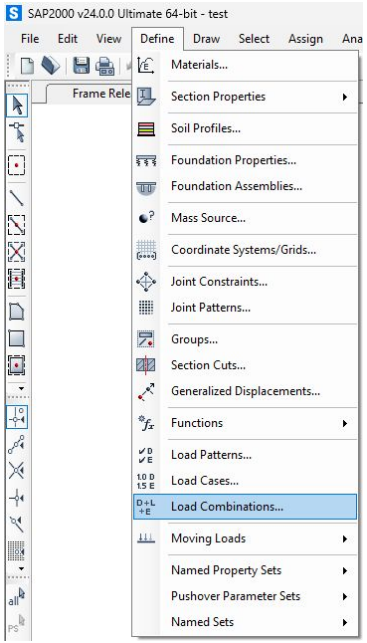

Non-linear

P-Delta

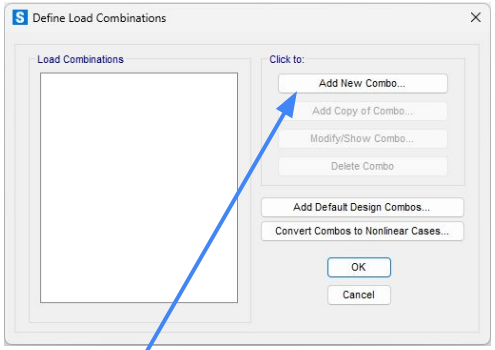
OK

# Load combinations

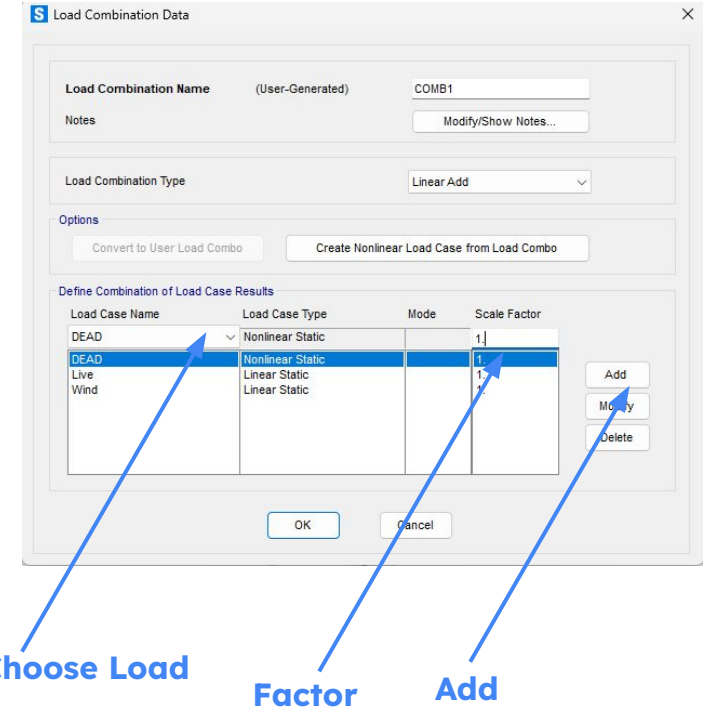
1.



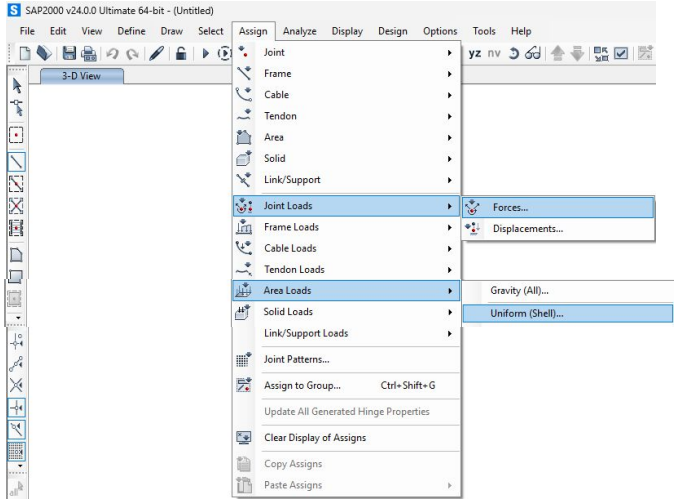

2.



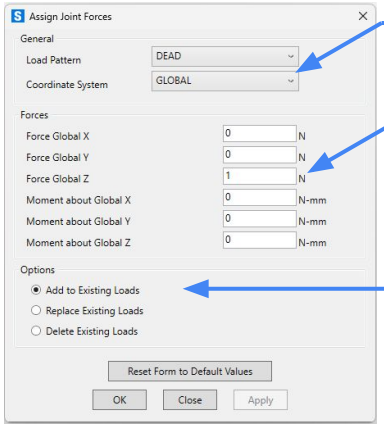

3.



# Assign loads




## Point Load



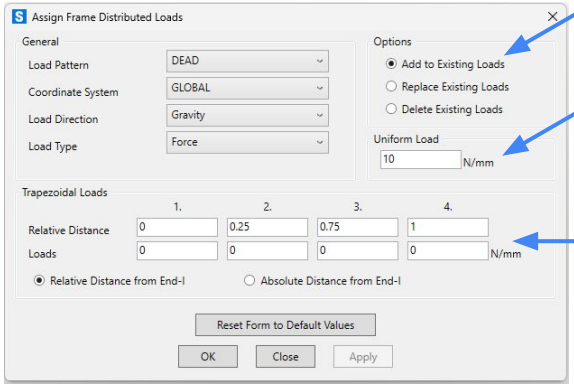

Choose load type

Add Force (Usually Z)

Make sure this is Add

=> Click on all points where you want the load
=> OK

## Distributed Load




Make sure this is Add

Add distributed load

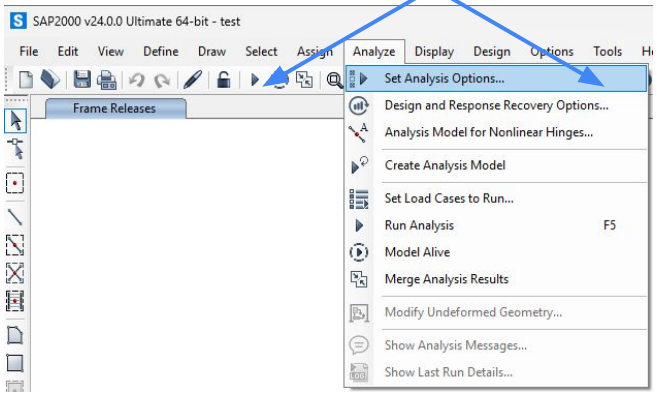
Only for non-uniform (Don't need to touch)

=> Click on all elements where you want the load
=> OK

# Analysis

1.

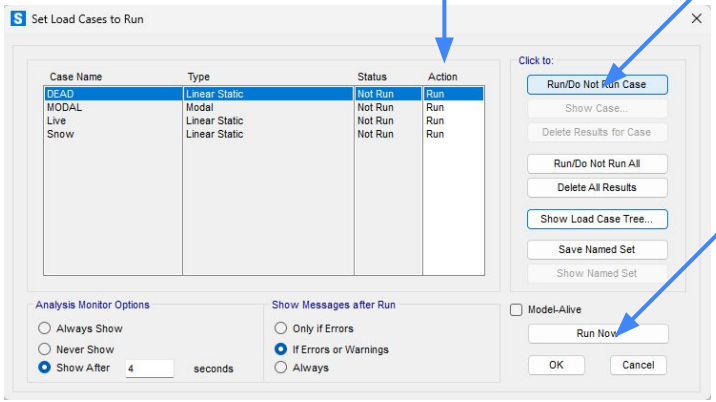
Either




The ones that say "Run" will run

Click Run for all cases you want to see the results of

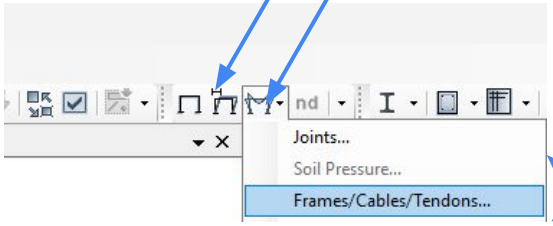
Click Run Now



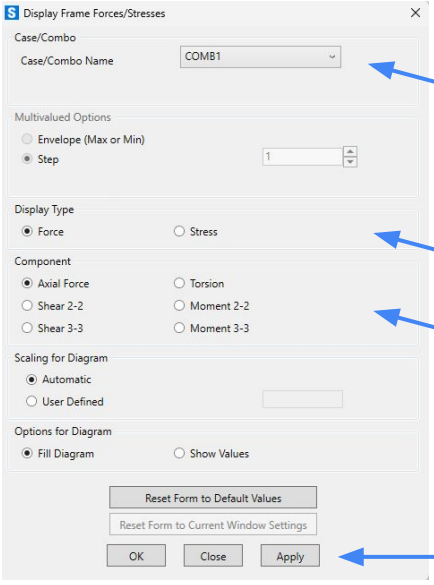
# View

Show Deformed shape

Show Internal Forces




Forces at Joint or Frame




Choose load/loadcombo

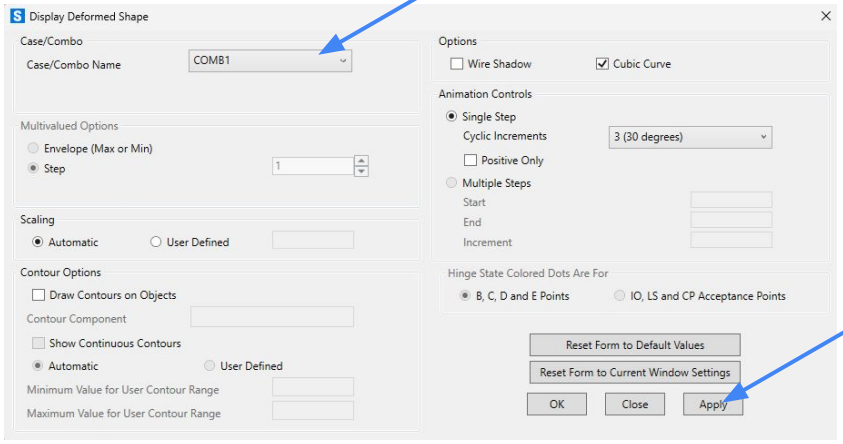
Force/Stress

Choose Force/Moment type

Apply

## Deformed shape

Choose load/loadcombo




Apply

# Dynamic Analysis

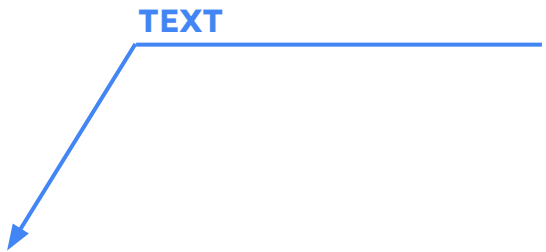
**Workflow RHA**

1. Mass
2. Time history
3. Load Case

Video on Response Time History (RHA) analysis
https://www.youtube.com/watch?v=VjkqA4_hlMk

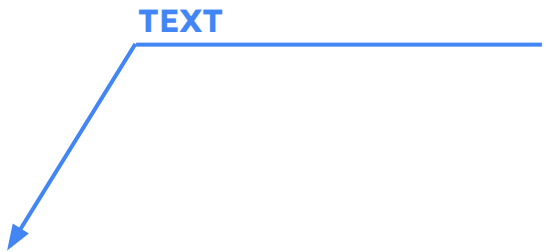
# Define Mass Source

1.



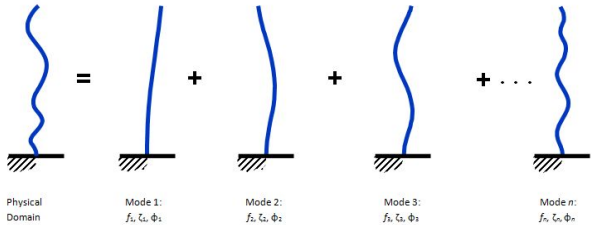
# Time History

1. TEXT



# Modal Load Case

**Recall:**




Modes refer to the structures oscillating behaviour.

1. TEXT