# Introduction

Twenty-six example problems have been prepared to demonstrate how to use the various SAP2000 commands and features. The problems may help improve your understanding of the sequence for using the commands and how the commands relate to one another during the modeling process. The following table identifies the problem name and structure type being modeled, the features involved in the model, and some of the key commands used to complete the model. The list of commands is intended to help you locate an example(s) that demonstrates use of a command. The listed commands are not the only commands used.

| Problem Name and Structure Type | Features Demonstrated | Command Usage Demonstrated |
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| **A**<br>Concrete Wall and Steel Frame | ▪ Grid lines<br>▪ Divide frames<br>▪ Frame releases<br>▪ Steel Design | Assign > Area > Automatic Area Mesh<br>Assign > Frame Loads > Point<br>Assign > Frame/Cable/Tendon > Releases/Partial Fixity<br>Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Frame/Cable/Tendon Loads > Distributed<br>Assign > Joint Loads > Forces<br>Define > Area Sections<br>Define > Combinations<br>Define > Coordinate Systems/Grids<br>Define > Load Cases<br>Define > Materials<br>Design > Steel Frame Design > View/Revise Overwrites<br>Display > Show Forces/Stresses > Joint<br>Draw > Quick Draw Area<br>File > New Model > 2D Frame Template<br>Options > Preferences > Steel Frame Design |
| **B**<br>Concrete Wall | ▪ Groups<br>▪ Section Cuts<br>▪ Load Combinations<br>▪ Linear Replication | Assign > Assign to Groups<br>Assign > Joint Loads > Forces<br>Define > Area Sections<br>Define > Combinations<br>Define > Load Cases<br>Define > Materials<br>Display > Analysis Results Tables<br>Edit > Replicate - Linear<br>File > New Model - Wall Template |
| **C**<br>Truss Frame | ▪ Diaphragm Constraint<br>▪ Design Optimization<br>▪ Automatic Area Mesh<br>▪ Mode Shapes<br>▪ New Model (not from template, started from scratch) | Assign > Area > Automatic Area Mesh<br>Assign > Area Loads > Uniform (Shell)<br>Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Joint > Constraints<br>Assign > Joint > Restraints<br>Define > Analysis Cases - Modal<br>Define > Area Sections<br>Define > Coordinate Systems/Grids<br>Define > Frame Sections<br>Define > Load Cases |

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| | ▪ Linear Replication<br>▪ Mirror Replication<br>▪ Radial Replication<br>▪ Steel Design | Define > Materials<br>Draw > Draw Frame/Cable/Tendon<br>Draw > Draw Rectangular Area<br>Edit > Divide Frames<br>Edit > Replicate - Linear<br>Edit > Replicate - Mirror<br>Edit > Replicate - Radial<br>File > New Model > Grid Only<br>Options > Preferences > Dimensions/Tolerances<br>Options > Preferences > Steel Frame Design<br>Start Animation |
| **D**<br>Inclined Support | ▪ Radial Replication<br>▪ Rotated Support | Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Joint > Local Axes<br>Assign > Joint > Restraints<br>Assign > Joint Loads > Forces<br>Define > Materials<br>Design > Steel Frame Design > Display Design Info<br>Design > Steel Frame Design > Start Design/Check of Structure<br>Design > Steel Frame Design > Verify All Members Passed<br>Design > Steel Frame Design > Verify Analysis vs Design Sections<br>Display > Show Forces/Stresses > Joint<br>Edit > Replicate - Radial<br>File > New Model - Beam Template |
| **E**<br>Cables in Tension | ▪ Draw Special Joint<br>▪ Geometric Nonlinear P-Delta<br>▪ Move | Assign > Joint > Restraints<br>Assign > Joint Loads > Forces<br>Define > Analysis Cases - Nonlinear, P-Delta<br>Define > Frame Sections<br>Define > Load Cases<br>Define > Materials<br>Draw > Draw Frame/Cable/Tendon<br>Draw > Draw Special Joint<br>Edit > Move<br>File > New Model - Grid Only template<br>View > Show Grid, None |
| **F**<br>Wall Resisting Hydrostatic Pressure | ▪ Hydrostatic Loading<br>▪ Joint Patterns | Assign > Area Loads > Surface Pressure (All)<br>Assign > Joint > Restraints<br>Assign > Joint Patterns<br>Define > Coordinate Systems/Grids<br>Define > Joint Patterns<br>Define > Materials<br>File > New Model - Wall Template |
| **G**<br>Frame with Support Displacement | ▪ New Model from Template<br>▪ Support Displacement | Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Joint Loads > Displacements<br>Define > Materials<br>Display > Show Forces/Stresses > Joint |

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| | | File > New Model - Portal Frame Template<br>Options > Preferences > Dimensions/Tolerances |
| **H**<br>Reinforced Concrete Beam | ▪ Concrete Design<br>▪ New Model From Template | Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Frame/Cable/Tendon Loads > Distributed<br>Define > Frame Sections<br>Define > Load Cases<br>Define > Materials<br>Design > Concrete Frame Design > Display Design Info<br>Design > Concrete Frame Design > Select Design Combos<br>Design > Concrete Frame Design > Start Design/ Check of Structure<br>File > New Model - Beam Template |
| **I**<br>Prestressed Concrete Beam | ▪ Response Combinations<br>▪ Output Stations<br>▪ Prestressing | Assign > Frame/Cable/Tendon > Output Stations<br>Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Frame/Cable/Tendon Loads > Distributed<br>Assign > Joint > Springs<br>Define > Combinations<br>Define > Frame Sections<br>Define > Load Cases<br>Define > Materials<br>Display > Show Forces/Stresses > Frame/Cable/Tendon<br>Draw > Frame/Cable/Tendons - Tendon |
| **J**<br>Beam on Elastic Foundation | ▪ Divide Frames<br>▪ Response Combinations<br>▪ Springs | Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Frame/Cable/Tendon Loads > Temperature<br>Assign > Joint > Masses<br>Assign > Joint Loads > Forces<br>Define > Frame Sections<br>Define > Load Cases<br>Define > Materials<br>Display > Show Forces/Stresses> Frame/Cable/Tendon<br>Edit > Divide Frames<br>File > New Model - Beam Template<br>Options > Preferences > Dimensions/Tolerances |
| **K**<br>Steel Moment Frame | ▪ New Model From Template<br>▪ Steel Design<br>▪ Unbraced Length Ratio | Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Frame/Cable/Tendon Loads > Distributed<br>Assign > Joint Loads > Forces<br>Define > Load Cases<br>Define > Materials<br>Design > Steel Frame Design > Start |

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| | | Design/Check of Structure<br>Design > Steel Frame Design > View/Revise Overwrites<br>Display > Show Tables<br>File > New Model - 2D Frames Template |
| **L**<br>Periodic Loading | ▪ Mode Shapes<br>▪ Modal Time History Analysis (Periodic) | Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Joint Loads > Forces<br>Define > Analysis Cases - Time History, Periodic<br>Define > Frame Sections<br>Define > Functions > Time History<br>Define > Materials<br>Display > Show Plot Functions<br>File > New Model - 2D Frames Template |
| **M**<br>Flat Plate in the X-Y Plane with a Twist | ▪ Mesh Area Objects<br>▪ Trick Problem | Assign > Joint Restraints<br>Assign > Joint Loads > Forces<br>Define > Area Sections<br>Define > Coordinate Systems/Grids<br>Define > Materials<br>Display > Show Forces/Stresses > Joint<br>Draw > Draw Rectangular Area<br>Edit > Mesh Areas<br>File > New Model - Grid Only |
| **N**<br>Frame Shear Wall Intersection | ▪ Diaphragm Constraint<br>▪ Groups<br>▪ Section Cuts | Assign > Area Loads > Uniform (Shell)<br>Assign > Assign to Groups<br>Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Joint > Constraints<br>Assign > Joint > Restraints<br>Assign > Joint Loads > Forces<br>Define > Analysis Cases - Modal, Nonlinear, Time History<br>Define > Area Sections<br>Define > Frame Sections<br>Define > Materials<br>Define > Section Cuts<br>Display > Show Tables<br>Draw > Quick Draw Area<br>File > New Model - 2D Frames Template<br>Options > Preferences > Dimensions/Tolerances |
| **O**<br>Isolated Building Nonlinear Time History Analysis | ▪ Base (Seismic) Isolation<br>▪ Diaphragm Constraint<br>▪ Ritz Vectors<br>▪ Dynamic Analysis<br>▪ Mode Shapes<br>▪ Link Elements<br>▪ Modal Nonlinear Time History Analysis | Assign > Area > Sections<br>Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Joint > Constraints<br>Define > Analysis Cases - Buckling<br>Define > Area Sections<br>Define > Functions > Time History<br>Define > Link/Support Properties<br>Define > Load Cases<br>Define > Materials<br>Display > Show Tables<br>Display > Show Plot Functions<br>Draw > Draw 1 Joint Link |

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| | | Draw > Draw Frame/Cable/Tendon<br>Draw > Quick Draw Area<br>Edit > Replicate - Linear<br>File > New Model - 3D Frame |
| **P**<br>Critical Buckling Load | ▪ Buckling Analysis<br>▪ P-Delta | Assign > Frame/Cable/Tendon Loads > Points<br>Assign > Frame/Cable/Tendon > Automatic Frame Subdivide<br>Assign > Joint > Restraints<br>Assign > Joint Loads > Forces<br>Define > Analysis Cases - Nonlinear, P-Delta<br>Define > Frame Sections<br>Define > Load Cases<br>Define > Materials<br>File > New Model - Grid Only Template |
| **Q**<br>Three Frames | ▪ Concrete Moment Frame<br>▪ Create Time History Video<br>▪ Dynamic Analysis<br>▪ Mode Shapes<br>▪ New Model From Template<br>▪ Link Elements<br>▪ Nonlinear Time History Analysis | Assign > Joint > Masses<br>Assign > Joint > Restraints<br>Assign > Joint Loads > Forces<br>Define > Analysis Cases - Modal, Nonlinear, Time History<br>Define > Frame Sections<br>Define > Functions > Time History<br>Define > Link/Support Properties - Damper<br>Define > Link/Support Properties - Rubber Isolator<br>Define > Materials<br>Draw > Draw 1 Joint Link<br>Draw > Draw 2 Joint Link Element<br>Draw > Quick Draw Frame/Cable/Tendon<br>File > Create Video > Multi-Step Animation Video<br>File > New Model - 2D Frames Template<br>Start Animation |
| **R**<br>Bridge with Moving Load | ▪ Divide Frames<br>▪ Bridge Loads<br>▪ Output Stations | Assign > Frame/Cable/Tendon > Output Stations<br>Assign > Joint > Restraints<br>Define > Analysis Cases - Moving Load<br>Define > Bridge Loads > Bridge Responses<br>Define > Bridge Loads > Lanes<br>Define > Bridge Loads > Vehicle Classes<br>Define > Bridge Loads > Vehicles<br>Define > Frame Sections<br>Define > Materials<br>Display > Show Forces/Stresses > Frame/Cable/Tendon<br>Display > Show Influence Lines<br>Edit > Divide Frames<br>Edit > Move<br>File > New Model - 2D Frames |
| **S**<br>Finite Element Model of Steel | ▪ Change Labels<br>▪ Section Cuts<br>▪ Mesh Areas | Assign > Assign to Groups<br>Assign > Joint > Restraints<br>Assign > Joint Loads > Forces |

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| Beam with Web Opening | ▪ New Model (From Scratch, Not From Template)<br>▪ Stress Contours For Shells | Define > Area Sections<br>Define > Materials<br>Define > Section Cuts<br>Display > Show Tables<br>Display > Show Forces/Stresses > Shell<br>Draw > Draw Rectangular Area<br>Edit > Change Labels<br>Edit > Mesh Areas<br>Edit > Replicate - Linear<br>File > New Model - Grid Only Template<br>View > Set 2D View<br>View > Set Limits |
| **T**<br>Domed Cylindrical Structure | ▪ New Model From Template<br>▪ Add To Model from Template | Edit > Add to Model from Template<br>File > New Model - Cylinder Template<br>File > New Model - Dome Template |
| **U**<br>Barrel Vaulted Structure | ▪ Add To Model From Template<br>▪ Response Combinations<br>▪ New Model From Template | Assign > Area Loads > Uniform (Shell)<br>Assign > Joint > Restraints<br>Assign > Area Sections<br>Define > Combinations<br>Define > Load Cases<br>Define > Materials<br>Draw > Draw Quad Area<br>Edit > Add to Model from Template<br>Edit > Mesh Areas<br>Edit > Move<br>Edit > Replicate - Mirror<br>File > New Model - Barrel Shell<br>File > New Model - Wall Template<br>View > Set 2D View<br>View > Set Limits<br>View > Show All<br>View > Show Grid<br>View > Show Selection Only |
| **V**<br>Temperature Loading | ▪ Grid Lines<br>▪ Temperature Loading | Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Frame/Cable/Tendon Loads > Temperature<br>Assign > Joint > Restraints<br>Define > Coordinate Systems/Grids<br>Define > Load Cases<br>Define > Materials<br>Display > Show Forces/Stresses > Joint<br>File > New Model - 2D Frames Template |
| **W**<br>Simple Beam with Trapezoidal Loads | ▪ Divide Frames<br>▪ Trapezoidal Loads (Distributed Loads) | Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Frame/Cable/Tendon Loads > Point<br>Assign > Frame/Cable/Tendon Loads > Distributed<br>Define > Load Cases<br>Define > Materials<br>Edit > Divide Frames<br>File > New Model - Beam Template |
| **X** | ▪ Divide Frames | Assign > Area Loads > Uniform (Shell) |

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| Through Truss Bridge | ▪ Grid Lines<br>▪ Linear Replication<br>▪ Steel Design | Assign > Frame/Cable/Tendon > Frame Sections<br>Define > Area Sections<br>Define > Coordinate Systems/Grids<br>Define > Frame Sections<br>Define > Load Cases<br>Define > Materials<br>Design > Steel Frame Design > Start Design/Check of Structures<br>Draw > Quick Draw Area Element<br>Draw > Quick Draw Braces<br>Draw > Quick Draw Frame/Cable/Tendon<br>Edit > Divide Frames<br>Edit > Move<br>Edit > Replicate - Linear<br>File > New Model - Vertical Truss<br>Options > Preferences > Steel Frame Design |
| **Y**<br>Response Spectrum Analysis for Single Degree of Freedom System | ▪ Draw Special Joint<br>▪ Dynamic Analysis<br>▪ Mode Shapes<br>▪ Response Spectrum Analysis | Assign > Joint > Masses<br>Assign > Joint > Springs<br>Define > Analysis Cases - Response Spectrum<br>Define > Functions > Response Spectrum<br>Display > Show Forces/Stresses > Joints<br>Draw > Draw Special Joint<br>File > New Model - Grid Only Template<br>File > New Model - Vertical Truss |
| **Z**<br>Response Spectrum Analysis | ▪ Diaphragm Constraint<br>▪ Dynamic Analysis<br>▪ Grid Lines<br>▪ Mesh Areas<br>▪ Mode Shapes<br>▪ New Model From Template<br>▪ Linear Replication<br>▪ Response Spectrum Analysis | Assign > Frame/Cable/Tendon > Frame Sections<br>Assign > Joint > Constraints<br>Assign > Joint > Masses<br>Assign > Joint > Restraints<br>Define > Analysis Cases - Response Spectrum<br>Define > Area Sections<br>Define > Coordinate Systems/Grids<br>Define > Frame Sections<br>Define > Functions > Response Spectrum<br>Define > Materials<br>Draw > Draw Rectangular Area<br>Draw > Quick Draw Area Element<br>Draw > Quick Draw Frame/Cable/Tendon<br>Edit > Mesh Areas<br>Edit > Replicate - Linear<br>File > New Model - 3D Frame |