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## STAAD.Pro 2007: DIRECT ANALYSIS FOR AISC 360-05

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Hello, and welcome to the **Bentley Structural Team** screencast. I'm *Jason Coleman*; a *Senior Technical Writer* with Bentley Systems.

Today, I'm going to show you a preview of how to use the new direct analysis feature in the upcoming release of **STAAD.Pro 2007**. This is a new feature, which will be available soon to users.

The Direct Analysis Method for steel lateral resisting systems is found in Appendix 7 of the 2005 edition of ANSI/AISC 360, which is the *Specifications for Structural Steel Buildings*. This document is freely available for [download from the AISC](#) [.pdf] and is also printed in the *13th Edition of the AISC Steel Construction Manual*. This specification states that the required strengths of members shall be computed using a second-order elastic analysis. Any general method is allowed for, so long as both P- $\Delta$  and P- $\delta$  effects are considered. Second order analysis in STAAD.Pro is handled by a  $K + K_g$  matrix, with the  $K_g$  matrix contain both P- $\Delta$  and P- $\delta$  effects. The direct analysis method employs a concept called notional loads, as well as reduced stiffnesses, for stability effects.

Let's briefly review P-D and P-d second order effects. P-D is the moment due to story load multiplied by story drift. P-d is the moment due a column's axial load multiplied by the column deflection. Both of these effects are accounted for in **STAAD.Pro 2007's** non-linear analysis.

Geometric imperfections and inelasticity are accounted for in the Direct Analysis Method. Construction tolerances in the specifications allow for columns to be out of plumb by as much as  $L/500$ . Member out-of-straightness resulting from fabrication tolerances can also result in internal column moments. Lastly, residual stresses from the hot-rolling process also results in additional inelastic behavior which must be accounted for.

Notional loads are small ratios of the gravity load at each level. These are applied laterally – at the level of the gravity load – and in both the X and Z plan directions. The notional loads are then added in to the load combinations.

Reduced flexural and axial stiffnesses are used for members contributing to the lateral stiffness of the structure to account for member inelastic effects, such as out-of-straightness and residual stresses. Note that  $\tau_b$  is a function of the axial load in the column, and therefore must be determined by iteration, as will be the loads and deflections for the second order analysis.

We'll use this simple steel portal frame to demonstrate how to use the Direct Analysis Method in **STAAD.Pro 2007**.

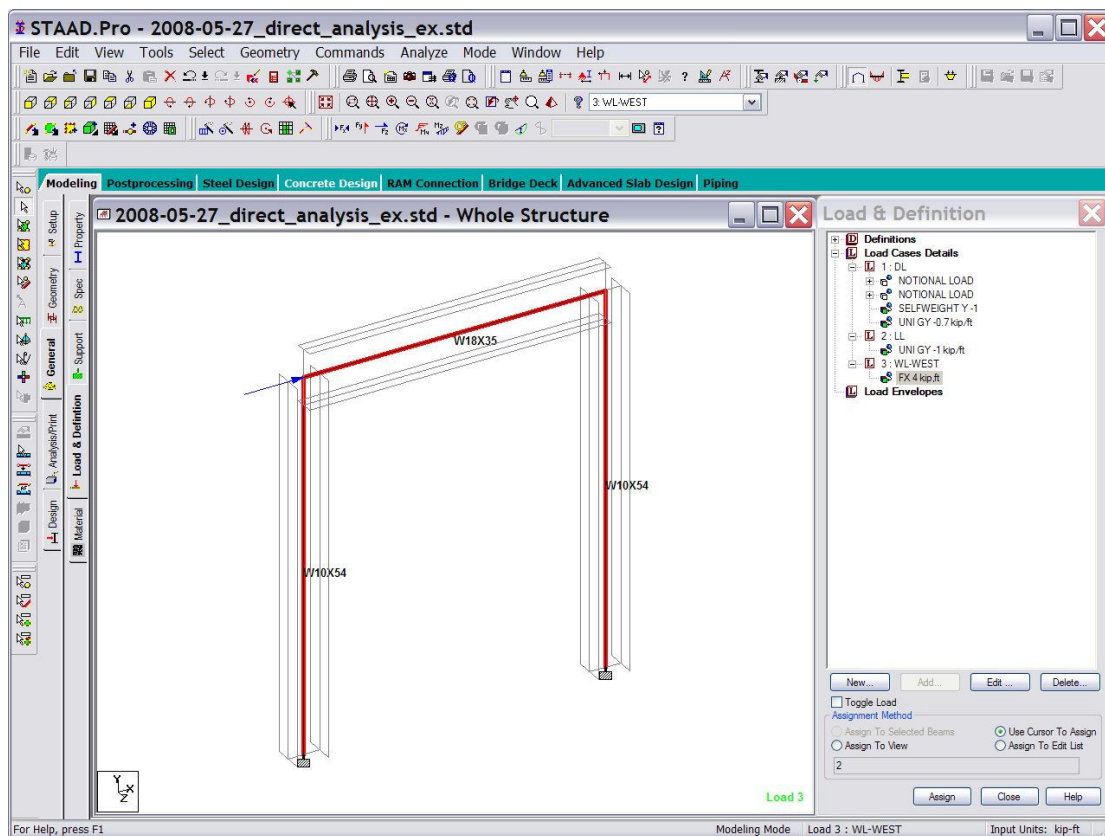


Figure 1: Demonstration **STAAD.Pro 2007** model of a steel portal frame.

Before initiating the direct analysis, we need to have some load cases which we can use to generate notional loads. Notional loads can be generated from either Primary Load Cases or Reference Load Cases in STAAD.Pro. The advantage of using a Reference Load Case is that the information can be easily modified in one place for updates. In this example, we'll use a reference load case with the same values as our Dead Load and Roof Live Load.

Next, we'll add load items to the reference load cases and assign them to the appropriate members. Now, we'll create two new load cases which will be used for notional loads.

The Notional Loads are factored copies of either Primary or Reference Load Cases and they can be found under Repeat Loads command. With the appropriate Load Case highlighted, we select Add... Now, Under the Repeat Load we can see that Notional Load has been added in the new version. Simply select the load case to be used and then the arrow button to move it into the included list.

Now we must specify the Add Direct Analysis parameters for **STAAD.Pro**. The four parameters are FLEX, AXIAL, FYLD, and Notional Load Factor. The FLEX parameter identifies the members that contribute to the structure's lateral stiffness, along with the initial value of  $\tau_b$  to be used. The default value for  $\tau_b$  is unity, and we'll use that for this example. FYLD is used to indicate to the program a value of yield stress to be used to calculate  $\tau_b$ . The AXIAL parameter identifies the members whose axial stiffness contributes to the structure's lateral stiffness. Lastly, the Notional Load Factor is ratio between notional loads and gravity loads, which defaults to 2 tenths of a percent.

Now, we will assign the direct analysis definition parameters to each of the members they apply to: FLEX parameter to the beams, yield strength [FYLD] to all steel members, and the AXIAL parameter to columns.

Next, we will initiate the new Perform Direct Analysis command in the **STAAD.Pro 2007** model. The Direct Analysis is an iterative process based on user assigned thresholds. The  $\alpha$  parameter is based on the method of design being used: 1.0 for ultimate strength and 1.6 for working stress. The tolerances for the maximum difference between values of  $\tau_b$  and displacement may be specified, as well as the maximum number of iterations. If the tolerances are exceeded, then another iteration will be run up to the maximum number provided. We also have the option of including a print specification for this analysis.

Now we are ready to perform the analysis by clicking Run Analysis from the menu bar.

Once the analysis has been performed, we can review the output file. Here we can see the results from each iteration.

This has been a screencast for performing a direct analysis in **STAAD.Pro 2007**. If you'd like to get additional information, sign up for training courses, or learn more about our licensing programs, please visit [Bentley.com](http://Bentley.com). Thank you for watching.

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