

Developer's Tips

Applying pseudo-static seismic loads in any stage of a sequential excavation using Phase2

In this column I'll be dealing with the new added functionality, enabling users to apply pseudo-static seismic loads in any stage of a sequential excavation using our Phase2 5.0 software. To get this functionality, you must download the latest Phase2 update 5.028, from our website . There is no cost for people that have purchased version 5 of Phase2.

A common question that customers of our Phase2 product have is: How do I apply a seismic load in a particular stage of a sequential excavation? When first released, Phase2 5.0 had the ability to apply a pseudo-static seismic load. However, you could not stage the application of the load. The load was always applied in the first stage and existed throughout the history of the model. This was clearly a severe restriction, since most people want to apply the load on the finished structure to estimate the response to earthquake loading.

To solve this problem, Rocscience has added a new option to enable the customer to apply the pseudo-static seismic load in any stage of a sequential excavation.

Rocscience often uses customer feedback as a way to improve and add to the functionality of its software products. In working closely with industry leaders we are able to provide the functionality that people ask for. All customer requests for functionality are taken seriously with the majority being implemented in future product upgrades. We strongly encourage customers to email us at software@rocscience.com with any suggestions or criticisms they have concerning our software.

Background

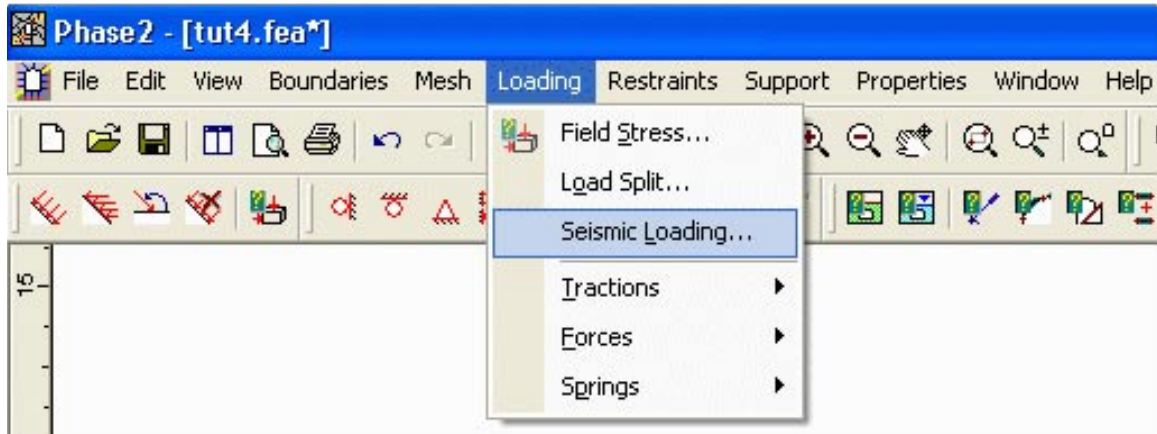
Pseudo-static seismic loads are implemented into Phase2 by applying a body force in the direction of seismic loading. The direction may be either horizontal, vertical, or a combination of both. The seismic force for each finite-element is determined using the equation:

Seismic Force = Seismic Coefficient * area of element * Unit Weight of element material

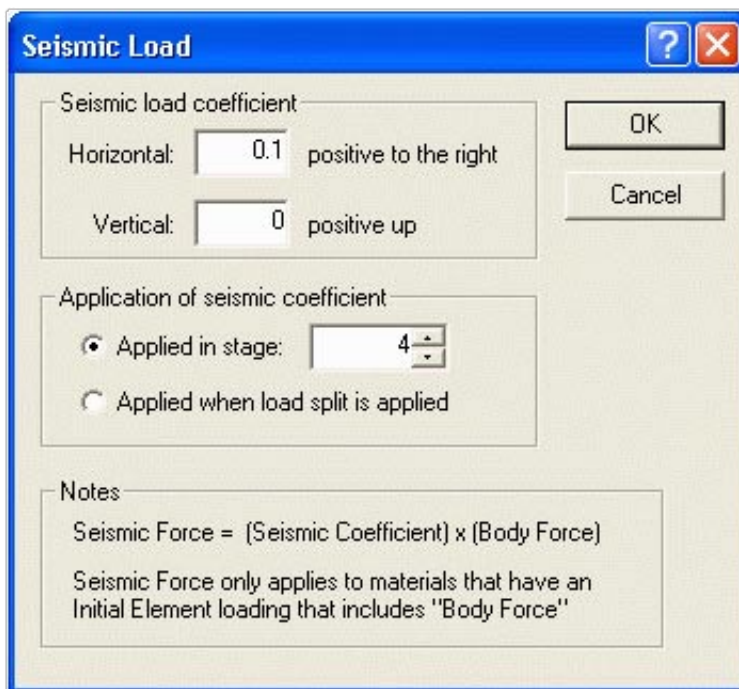
or simply the seismic coefficient times the self weight of the finite-element. The self weight of a finite-element is also referred to as its body force.

Implementation

To add a pseudo-static seismic load in Phase2, simply select the *Seismic Loading* option in the *Loading* menu.



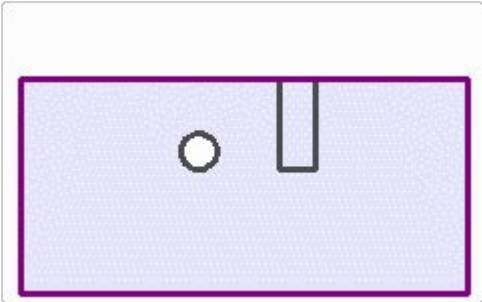
The following dialog is then displayed:



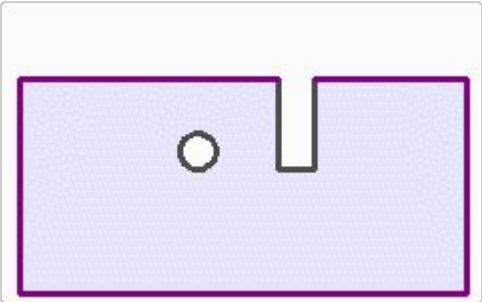
In the above Seismic Load dialog, simply type in the horizontal and/or vertical seismic load coefficient and then select the method of application. If you wish to apply the load in a particular stage, select the first option and define the stage in which the load is applied. In the above dialog, a horizontal seismic load is applied in stage 4 using a seismic load coefficient of 0.1.

Example

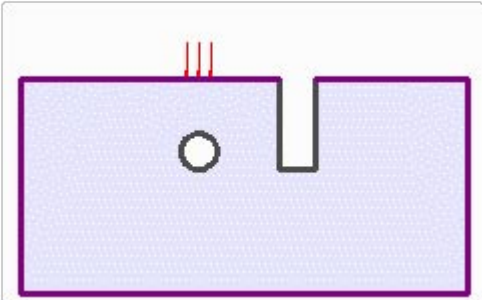
This example is an extension of tutorial 4 in which a seismic load is applied in the last stage of a sequential excavation of a small tunnel and trench. It is a very simple model intended to demonstrate the application of seismic loading. In the first stage, a small circular tunnel is excavated. In the second stage, a trench is excavated. In the third stage, a pressure load representing a footing is applied to the ground surface above the tunnel. In the fourth stage the seismic load is applied using a horizontal seismic coefficient equal to 0.1.



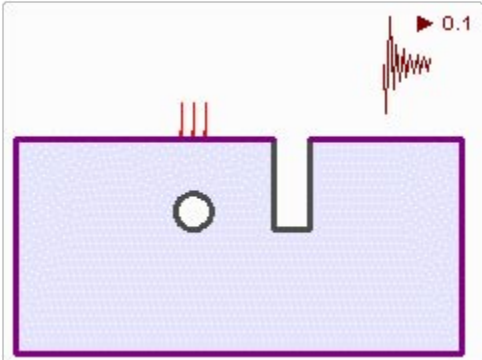
Stage 1 - Excavation of circular tunnel



Stage 2 - Excavation of trench

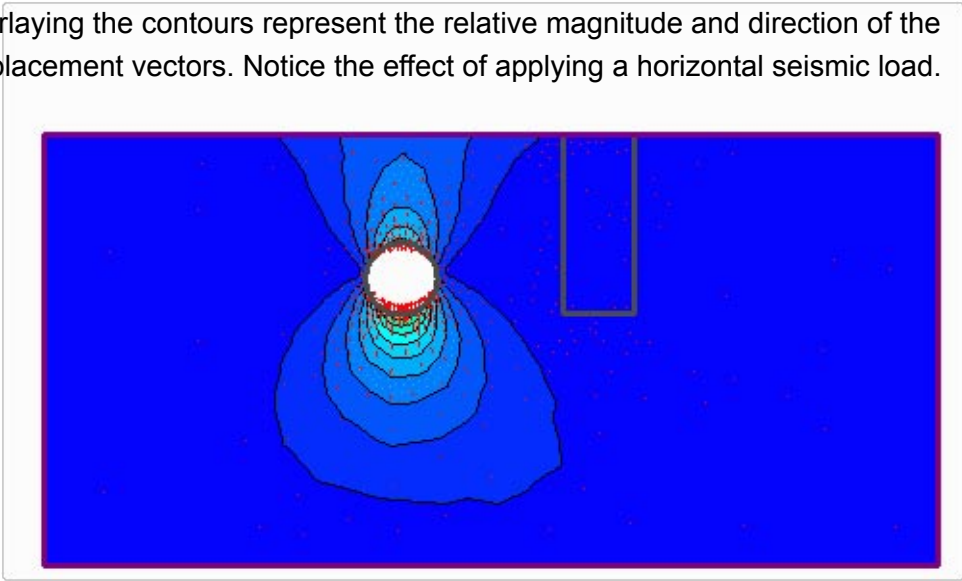


Stage 3 - Pressure load application

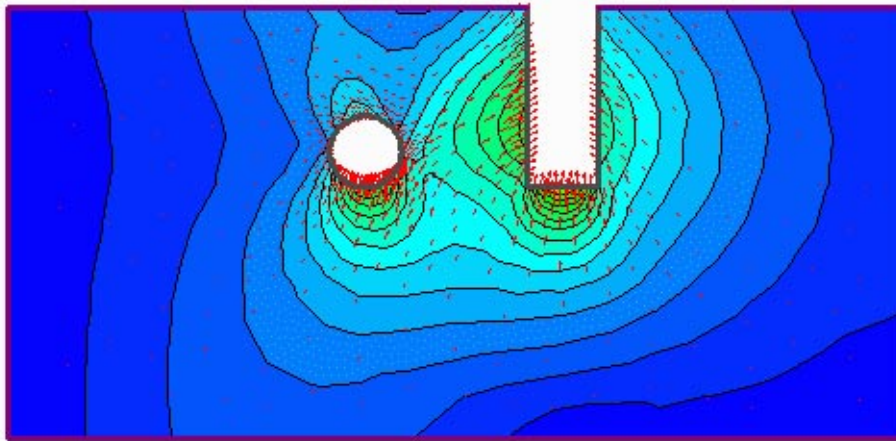


Stage 4 - Seismic load application

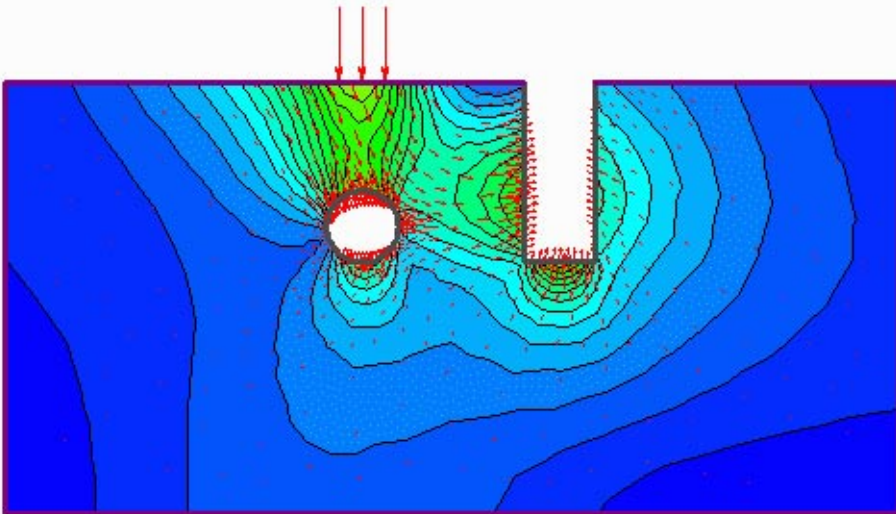
The following figures illustrate the displacements after each stage. The red arrows overlaying the contours represent the relative magnitude and direction of the displacement vectors. Notice the effect of applying a horizontal seismic load.



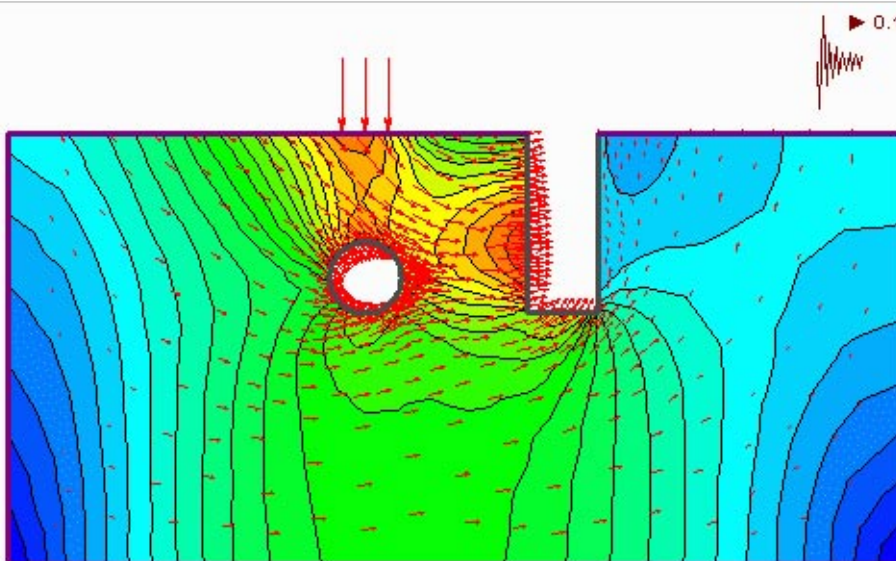
Stage 1 - Displacements after excavation of the circular tunnel



Stage 2 - Displacements after excavation of the trench



Stage 3 - Displacements after applying surface pressure



Stage 4 - Displacements after applying seismic load