

CUSTOMER SUPPORT NOTE

Nesting Smart Combinations into Envelopes and Envelopes into Smart Combinations and nodal average implications

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This support note is issued as a guideline only.

The logo for LUSAS, featuring the word "LUSAS" in a bold, white, sans-serif font on a blue rectangular background.

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1. Introduction

The present support note describes the different logics used by Smart Combinations and Envelopes. It also describes how the output results are calculated when an Envelope is present within a Smart Combination – i.e. nested situations. An example is included at the end of the document.

2. Smart Combinations and Envelopes: different logics

2.1 Envelopes Logic

Envelopes are used to pick out the maximum and minimum values from a number of results types (Simple Loadcases, Basic Combinations, Smart Combinations or other Envelopes). When an envelope has been defined, a pair of loadcases is created containing the maximum and minimum envelope values. These values are extracted during the post-processing stage of the analysis and are solely applicable where load superposition is valid (e.g. linear systems).

2.2 Smart Combinations Logic

Smart Combinations are used to combine a set of results loadcases (Simple Loadcases, Basic Combinations, Smart Combinations or other Envelopes) in a manner which produces the most adverse effects on the structure. Each Smart Combination is made up of two entries in the Treeview. The maximum entry contains the most adverse positive effects and the minimum entry the most adverse negative effects.

3. Nested Situations

Envelopes always extract the worst values for whatever is requested, average nodal, element nodal or gauss point results after the calculation is carried out, i.e. after nodal extrapolation or nodal averaging. So the results will depend on what is extracted through the Values layer or the Print Results Wizard.

Smart Combination on the other hand always uses gauss point results. The intention here is to always have the most accurate results when performing the Smart Combination calculations. Nodal extrapolation and nodal averaging calculations take place afterwards if requested. When an envelope is present within a smart combination, the rule above is ignored and the values from the envelopes are always taken on gauss point level as well. This ensures the consistency of the Smart Combination approach. Hence if one compares average nodal results from a smart combination containing envelope X and average nodal results from envelope X (containing the same loadcases) alone then these values might be different. The reason for that being that, the average value at a node always comes from a single loadcase when we

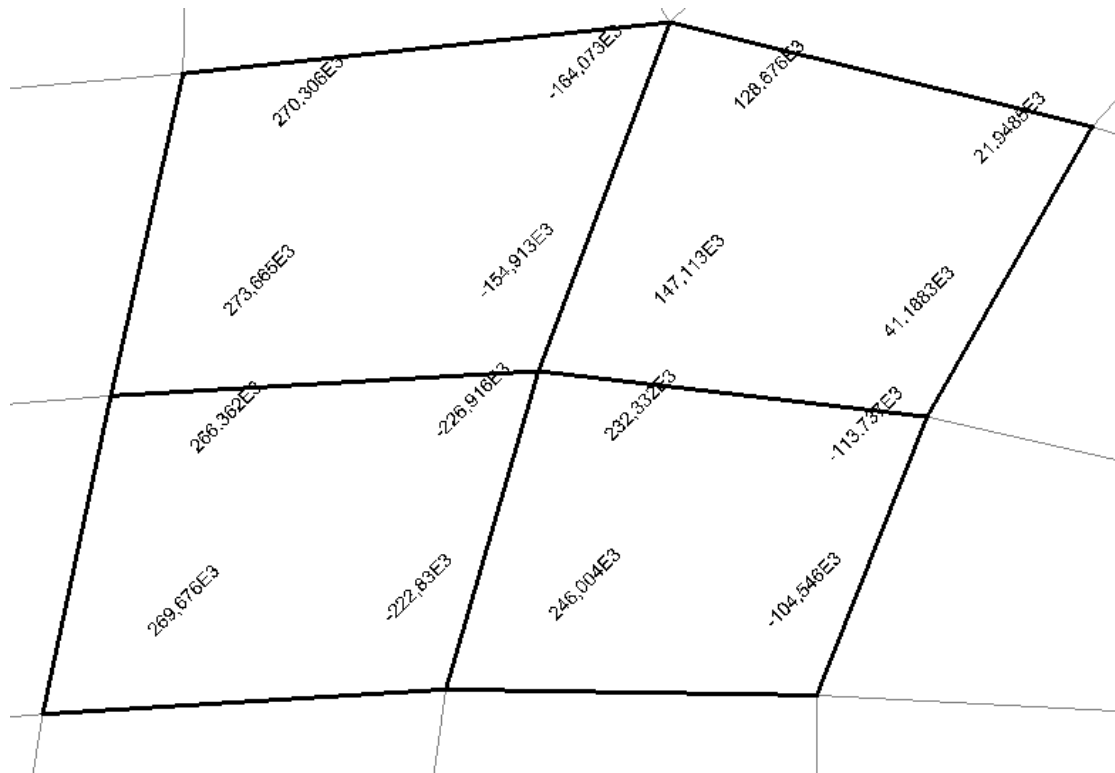
look at envelope X alone. When we look at the smart combination, the gauss point results are extrapolated and then averaged and we can no longer identify which loadcase which result came from. Therefore using smart combination will always ensure that the most adverse load effects are picked up.

4. Example with four elements

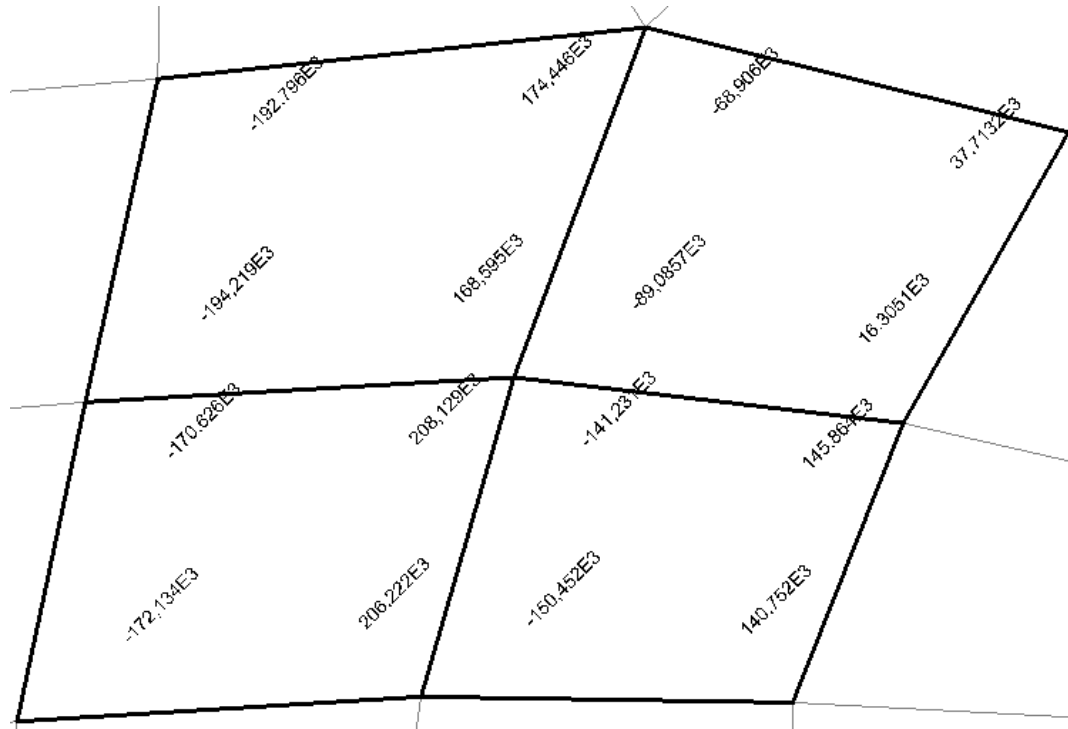
Let us consider a set of four arbitrary chosen shell elements for this example. We will examine three loadcases, namely LC1, LC2 and LC3.

Take Smart Combination SmComb (Max) into consideration. Now because smart combinations work on Gauss point level it is not necessary for them to output LCID (i.e. from which loadcase is the used result taken). This means that smart combination will extract the highest (in this (max) case) gauss point results from all the loadcases considered, extrapolates the unaveraged nodal values, averages them and plots this as the final result.

Gauss point results for LC1 for our four elements and Thick Shell Force/Moment – Sy:



Gauss point results for LC2 for our four elements and Thick Shell Force/Moment – Sy:

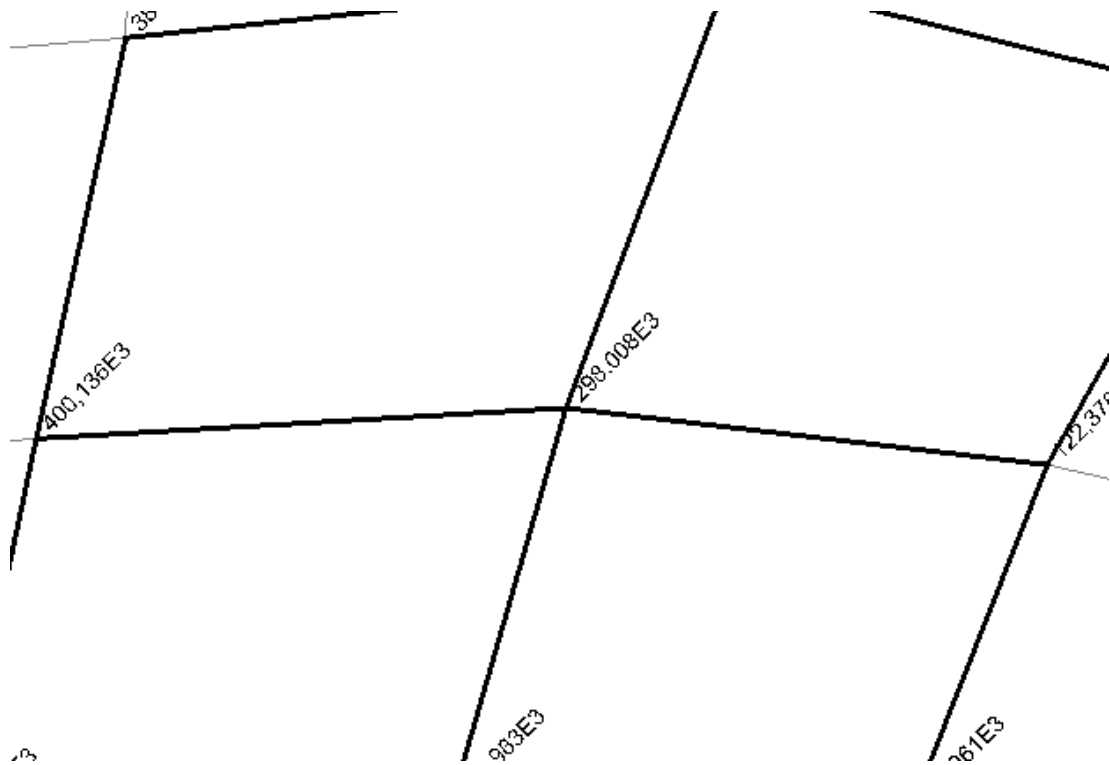


Gauss point results for LC3 for our four elements and Thick Shell Force/Moment – Sy:



For the middle node, the highest gauss point values obtained are 168E3; 208E3; 147E3; 232E3. LUSAS now extrapolates the values across the element to find the values at the nodes accordingly.

This can be seen by setting the smart combination active:



The nodal result is 298E3.

Now on the other hand, Envelope works on loadcase level (as all results should come from one load case only). This means that the above procedure is done for each loadcase if nodal average results are requested, i.e. gauss point values are extrapolated across elements and the average nodal value is obtained. Envelope then selects the maximum value from the three. It can be appreciated here that the above loadcases will have considerably lower average nodal results compared to the one obtained from the Smart Combination (max). In fact the highest value is selected for the Envelope (max) and can be seen by setting it active:

