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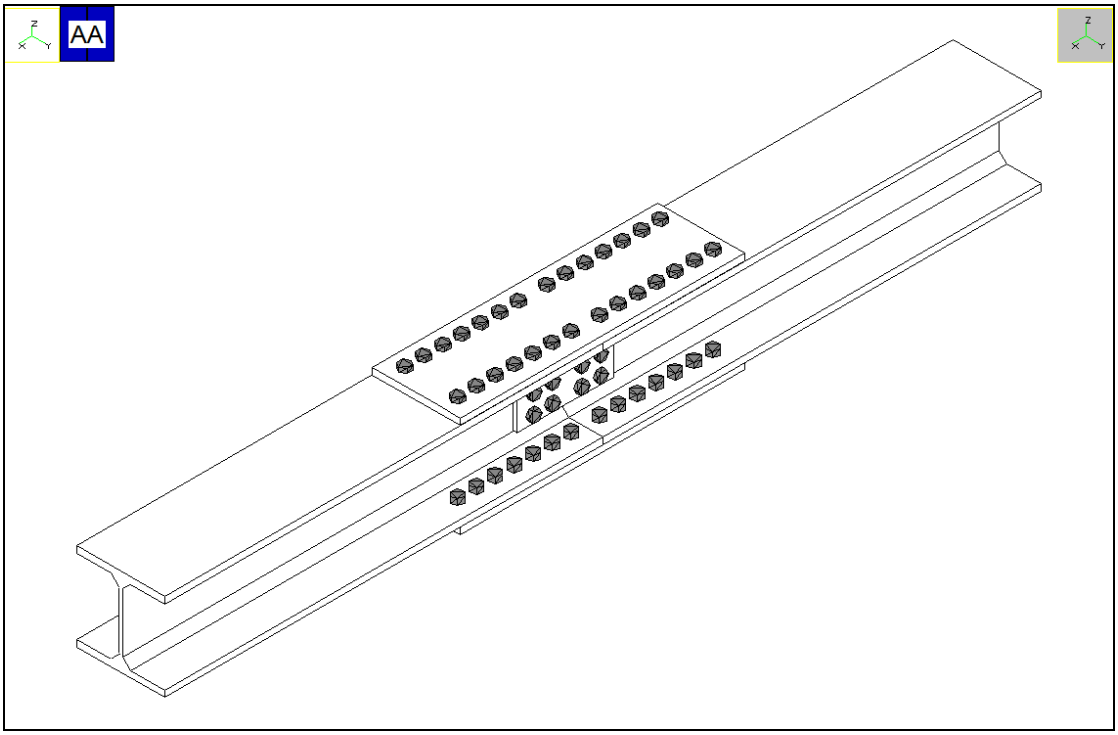
C.S.E.

Connection Study Environment

Tutorial 5 - Addition: Slip resistant bolts



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Parole chiave:

connessioni acciaio, collegamenti acciaio, saldature, bullonature, bulloni, software, verifiche, piastra di base, flessione, compressione, no-tension, contrasto, supporto, acciaio, snervamento, sforzo, deformazione, connessioni bullonate, connessioni saldate, ancoraggi, unioni ad attrito, piastre, vincoli, incastro, colonna, irrigidimento, analisi fem, modelli fem, elemento piastra, spessore, mappa di sforzo, CSE, Castalia srl, steelchecks.com, castaliaweb.com, C.S.E.

1 INTRODUCTION

This tutorial is a tool to start the understanding of how CSE works. It is an addition to Tutorial 5; no special efforts to have realistic force values have been made, however this will explain several features of the program. By following this tutorial you will be able to:

- Use slip resistant bolt layouts

We have explained step by step anything with images, however it takes very few minutes to actually do these things.

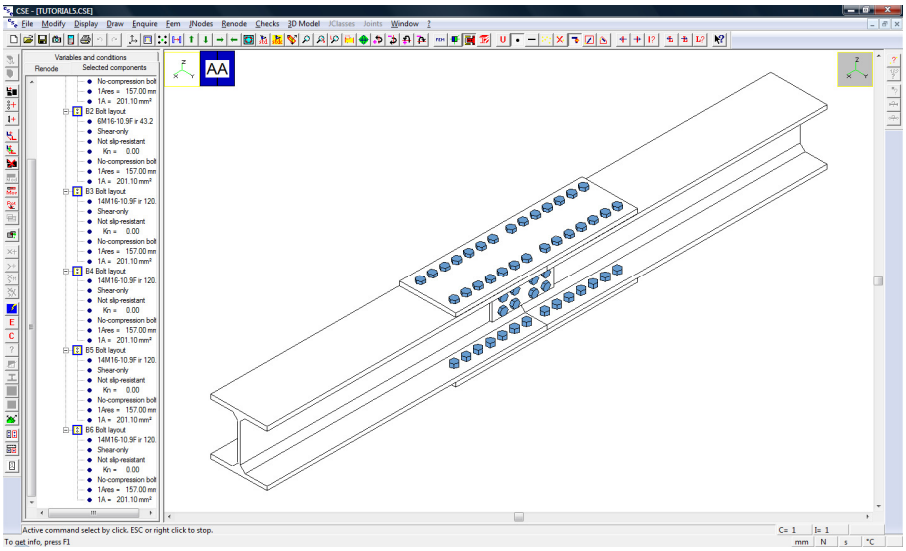
N.B. this tutorial refers to CSE version reported on the first page of this document. If you are using a newer version, keep in mind that some dialog or commands may be different, although the logic of the program has remained the same. If you find some differences, see the up-to-date PDF guide or the context sensitive help for information.

2 SPLICE JOINT (BOLTED CONNECTION)

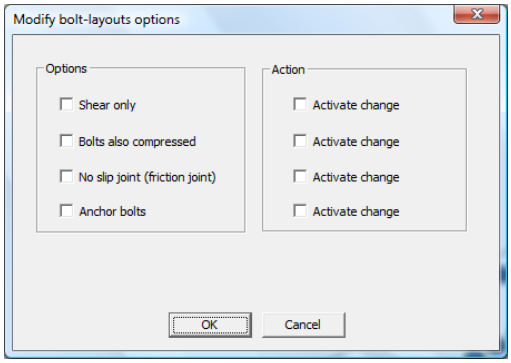
2.1 BOLT LAYOUTS MODIFICATION

The starting point is the renode built up in tutorial 5. First of all, use **File – Save as** to create another copy of the model; name it, for example, *TUTORIAL5ADD.CSE*.

Select all bolts layout clicking them or, alternatively, select all components  (the command we are going to use next acts on selected bolt layouts only, so it does not matter if there are any other selected components).



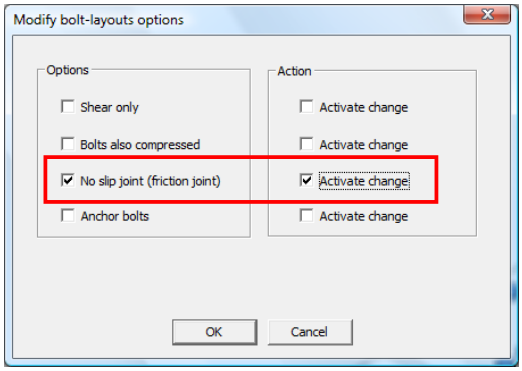
Use **Renode – Component –Modify bolt layout setting**s: the following dialog will appear.



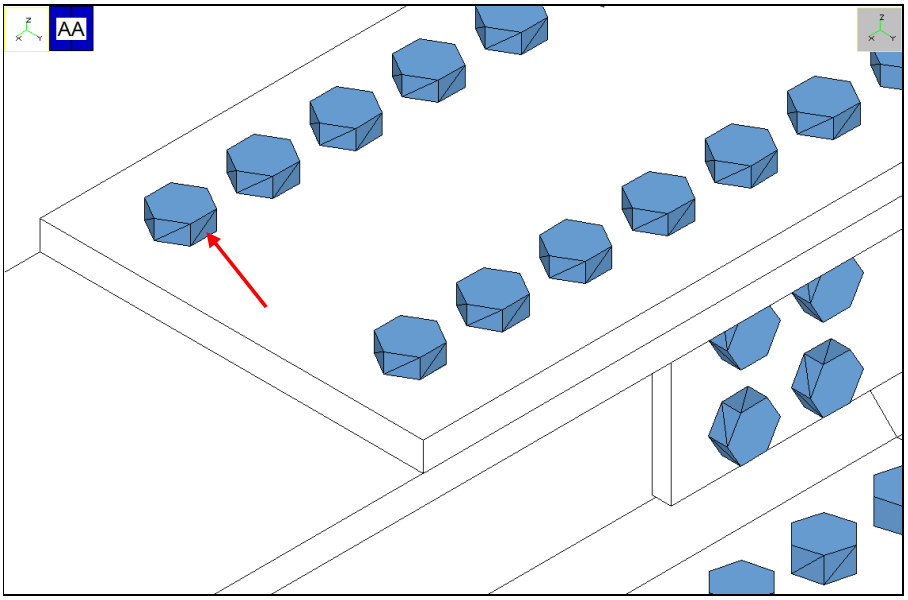
This dialog allows to change some settings of selected bolt layouts. You can change the following options:

- Shear only bolts
- Compression bolts
- **Friction joint**
- Anchor bolts

Tick “No slip joint (friction joint)” and the correspondent “Activate change”.

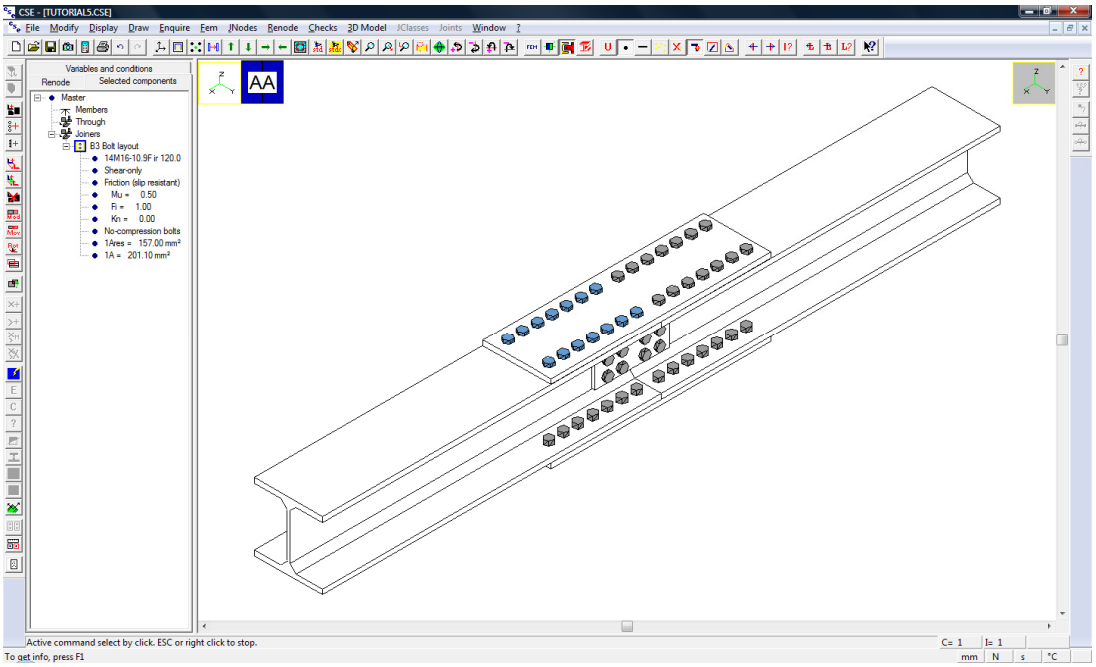


Press OK, and all selected bolt layout will be friction joints. Friction bolts are displayed in the scene with diagonal lines on bolt head lateral faces.

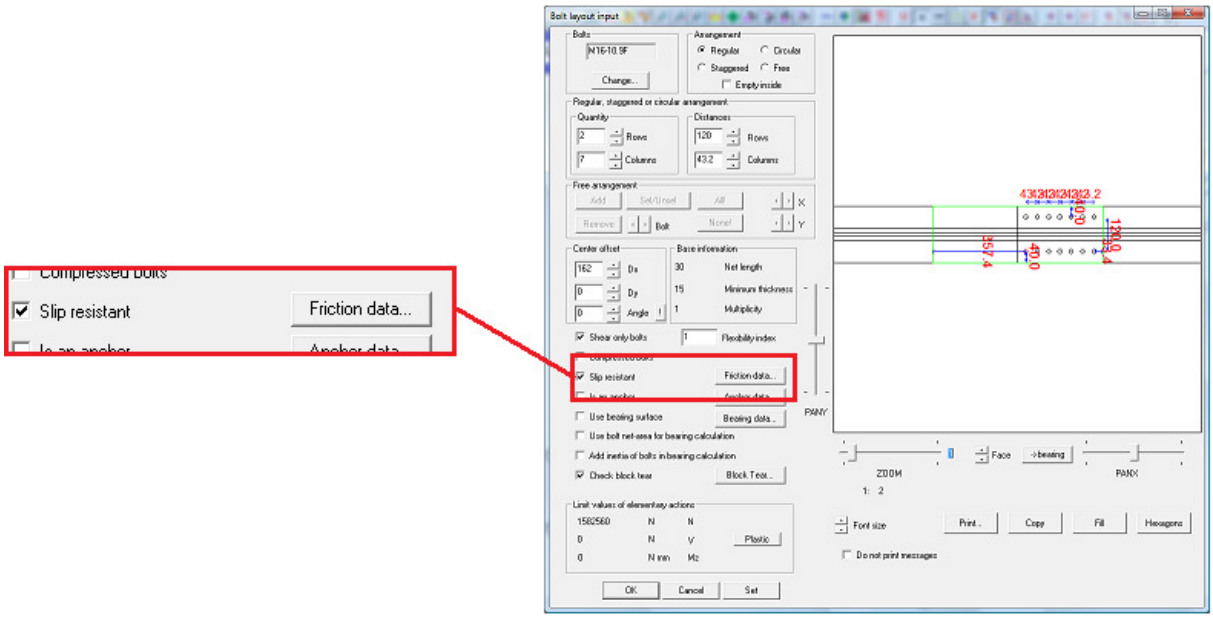


Now we have to define friction parameters; to do that, we need to modify bolt layouts one by one.

Unselect all the components , then select B3 bolt layout with a click.



Use **Renode – Components – Modify** . The following dialog box appears. Note that "Slip resistant" is now ticked.

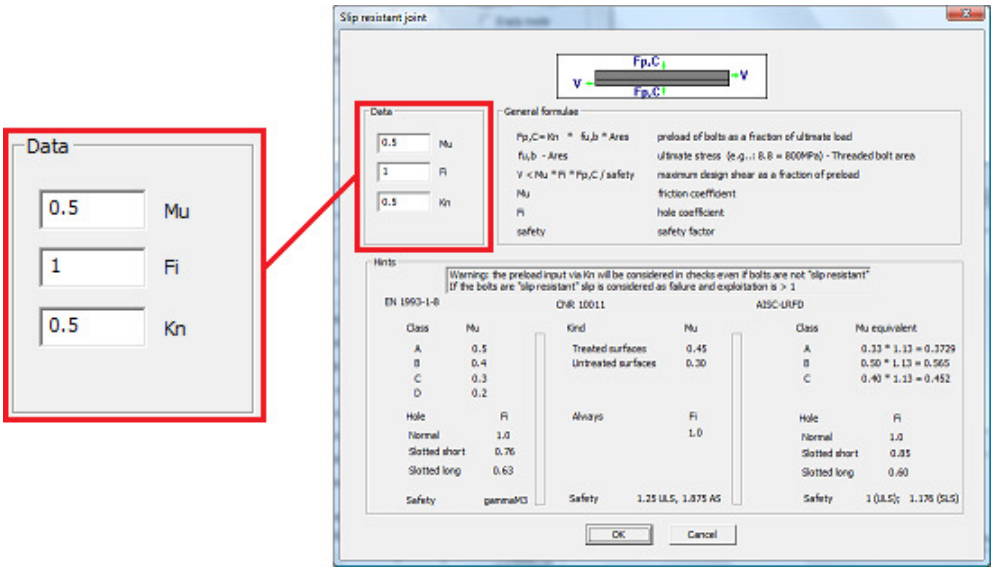


Click "Friction data" button to get the "Slip resistant joint" dialog box.

Mu (μ) is friction coefficient: leave default value 0.5

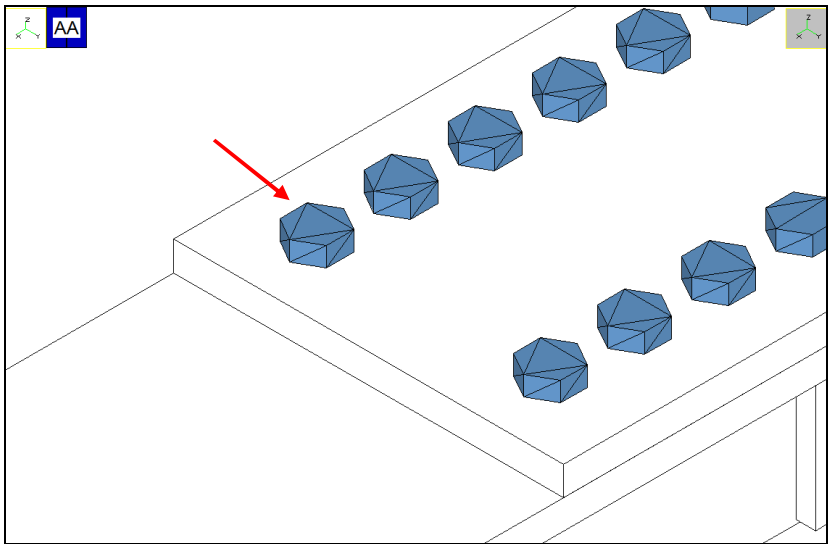
Fi (ϕ) is hole coefficient: leave default value 1

Kn (K_n) is the ratio between preload and bolts ultimate load: type *'0.5'*



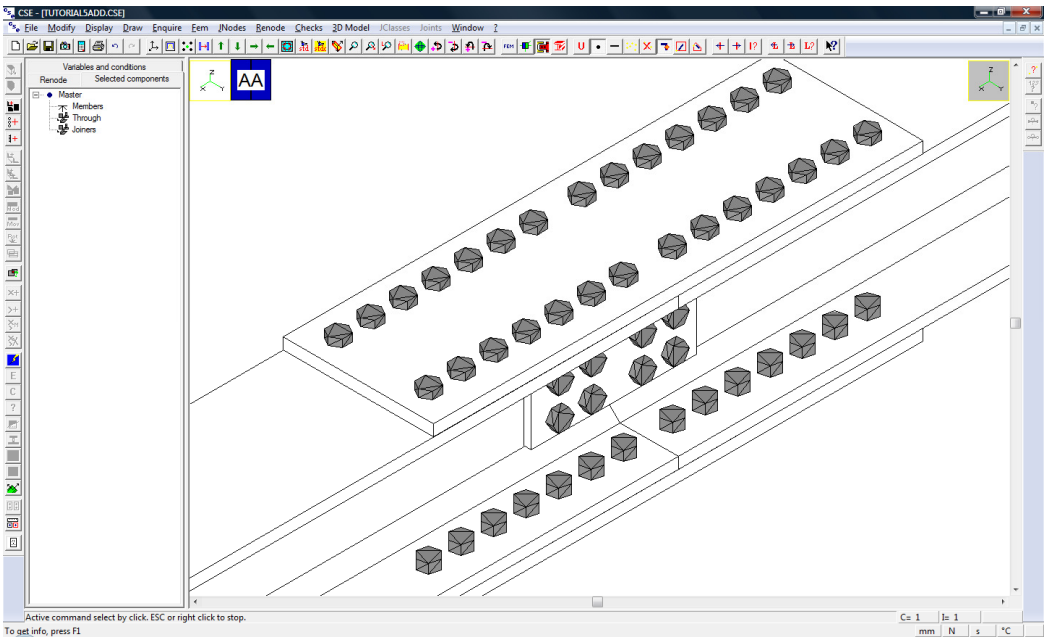
Preload $F_{p,C}$ is defined as $Fp,C = Kn * fu,b * Ares$, where $f_{u,b}$ is bolt ultimate stress and A_{res} is bolt threaded area.

Press OK in "Slip resistant joint" dialog box, then press OK in main "Bolt layout input" dialog box. B3 bolts are now displayed with diagonal lines on side bolt head faces and a triangle on bolt head upper face, because a preload has been defined.



Now unselect B3 and do the same with all other bolt layouts, modifying them one by one and defining a *Kn* equal to 0.5. Do not change any other parameter.

When all bolt layouts have been modified, all bolts will have the triangle on bolt head upper face.



Renode is ready for checks.

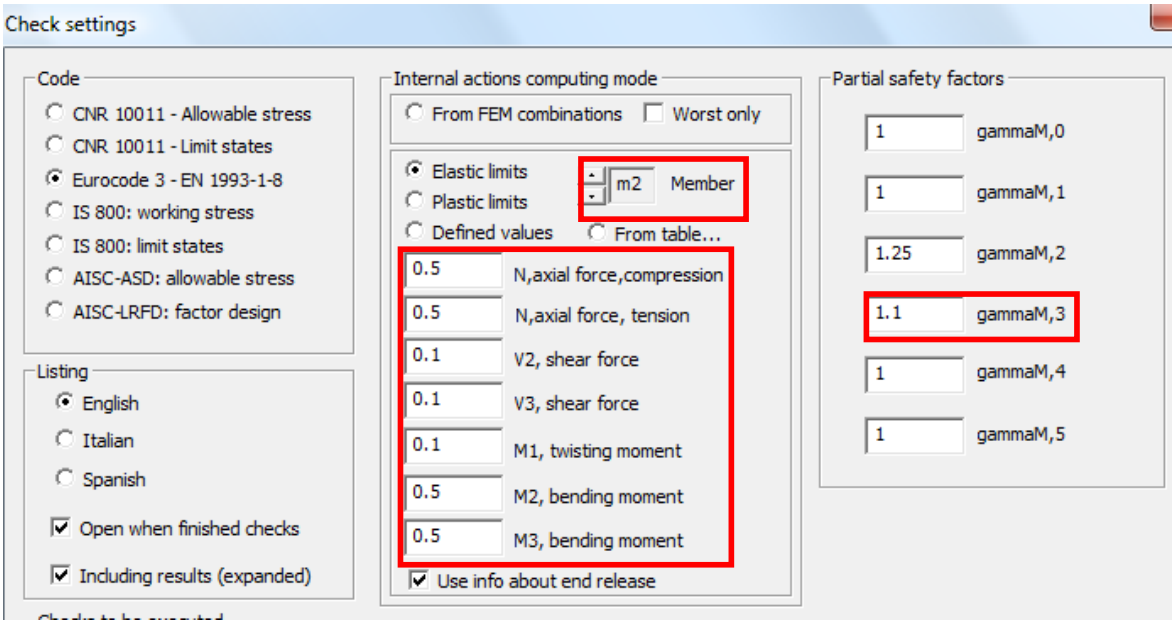
2.2 CHECK SETTINGS AND EXECUTION

Bolt pressure bearing checks are not executed if a component is connected with a slip resistant joint. Since we have only friction bolt layouts here, bolt pressure bearing checks will not be executed for any component even if this kind of check is required in the settings

In "Check settings" dialog box (**Checks – Set** command to get the dialog), control that m2 elastic limits multipliers are those previously defined:

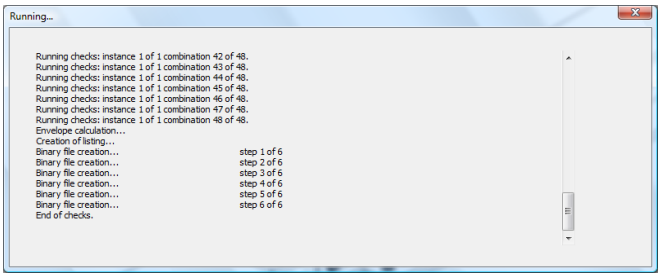
- 0,5 for compression, tension and bending moments
- 0,1 for shears and twisting moment

When using Eurocode 3, γ_{M3} (gammaM,3) is the safety factor used in slip checks when using Eurocode 3 (use default value).

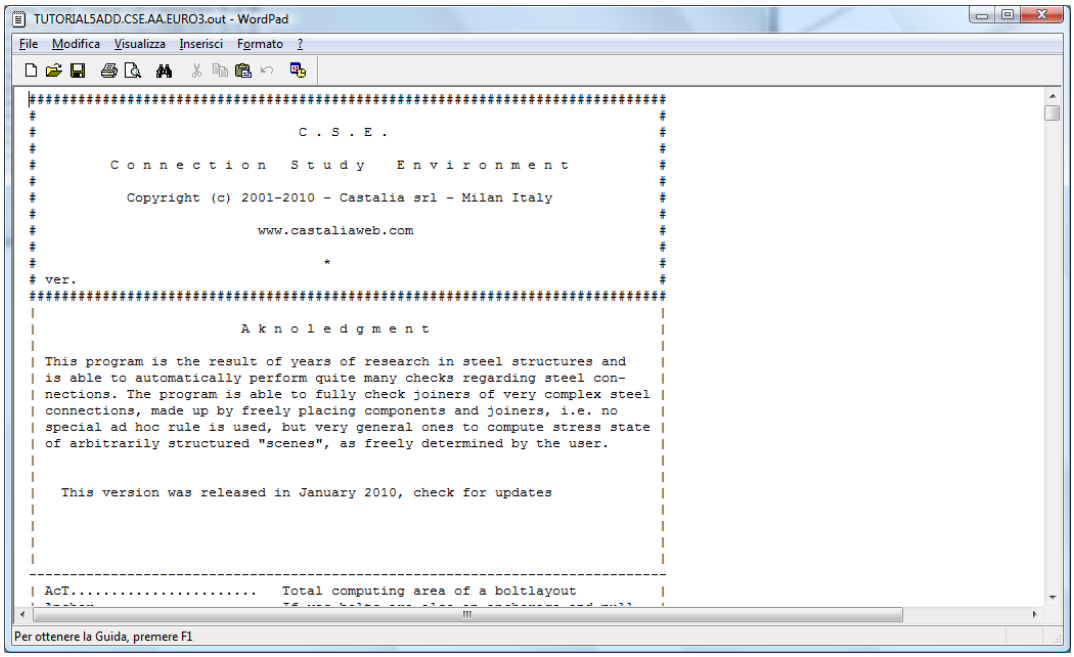


Press OK to save settings and execute checks  .

A log window will appear, it explains what happens. At the end just close it by clicking over the red-background cross.

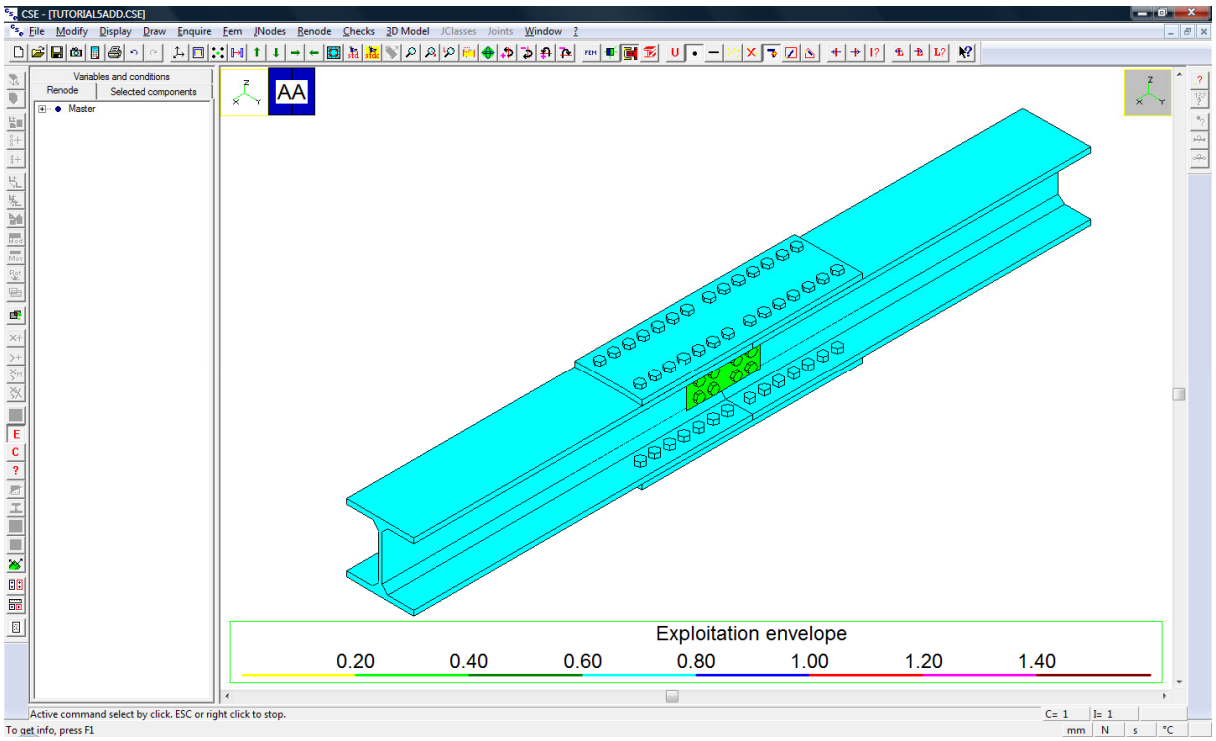


The output file has been automatically opened (if require in check settings). Have a look at the file if you wish, then minimize or close the output file window.

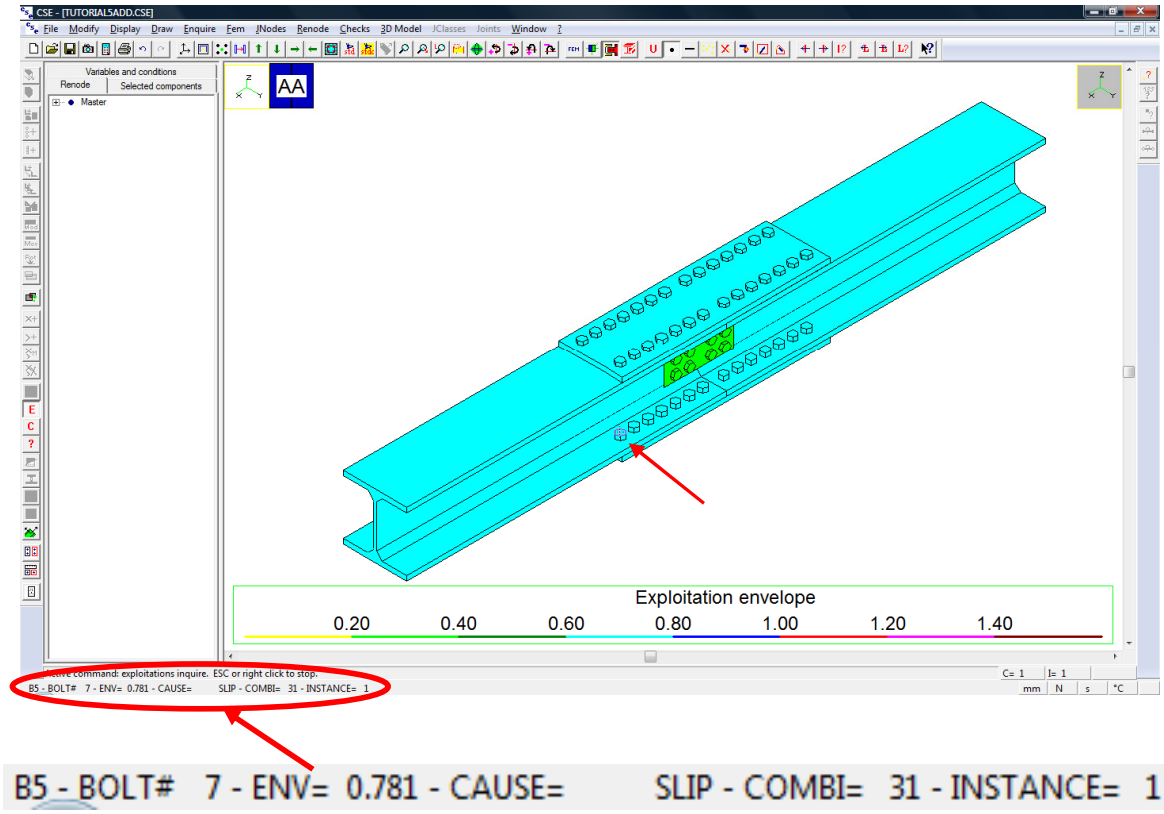


2.3 RESULTS

Use **Checks – Envelope** E to display components exploitation envelope on all combination.



Use **Checks – Enquire** ? to know which is maximum exploitation (with its cause and combination) for each component. Move mouse pointer towards a face of desired component and read information in status bar.

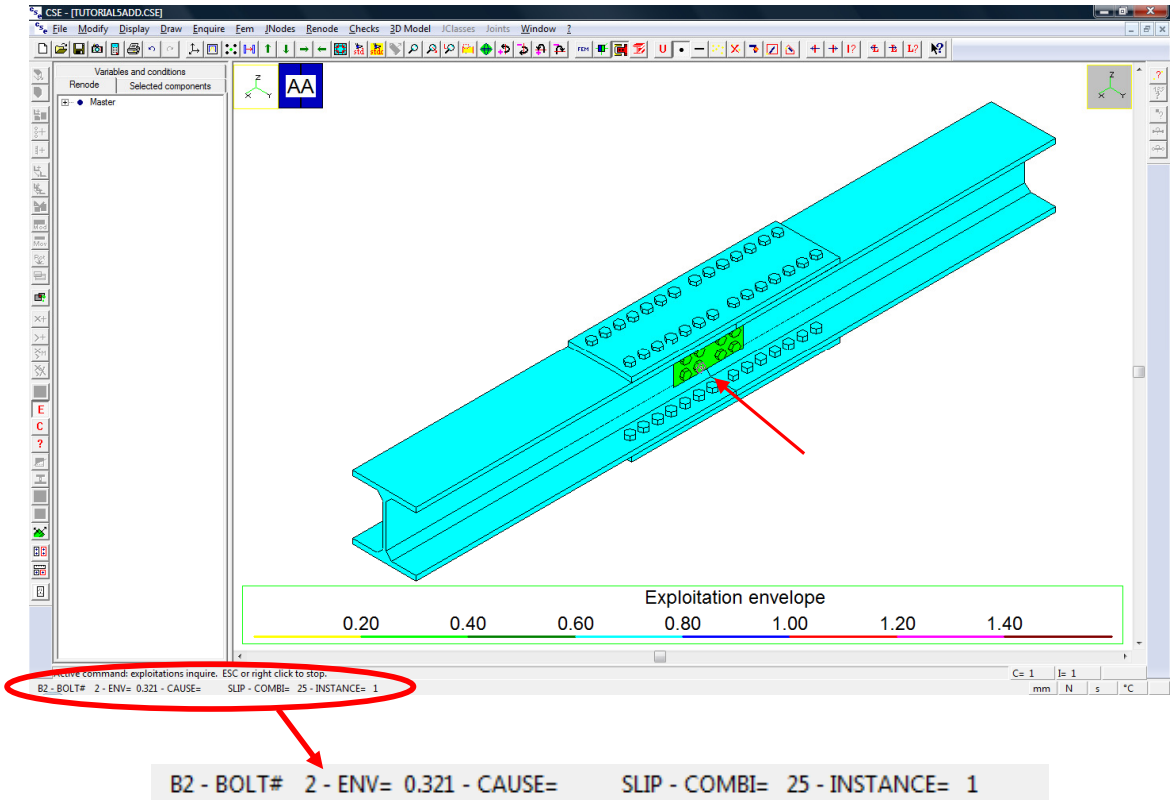


For bolt #7 of bolt layout B5, maximum exploitation is 0,781 in combination 31 (compression) and the cause is slip. It means that there is no slip (0,781 < 1), and a load increase of about 28% should cause connected plates slipping.

Note that slip causes maximum exploitation for all flanges bolts.

Now enquire web bolts: resistance check is the cause of their maximum exploitation.

For example, maximum exploitation for bolt #2 of B2 bolt layout is equal to 0,704 in combination 25 (tension).



2.4 NOTES ABOUT SLIP CHECKS AND PRELOAD

Slip check is the following: applied shear V must not exceed preload multiplied by μ and ϕ and divided by the safety factor (γ_{M3} for Eurocode 3).

$$V < \frac{\mu \cdot \phi \cdot F_{p,C}}{\gamma_{M3}}$$

As said in previous paragraphs, μ and ϕ are defined by the user, $F_{p,C}$ is function of bolts diameter, bolts class and K_n, another parameter defined by the user. γ_{M3} is defined by the user in check settings. Exploitation due to slip is associated to bolt layout, and its value is:

$$\frac{V}{\frac{\mu \cdot \phi \cdot F_{p,C}}{\gamma_{M3}}}$$

N.B.: in bolts resistance checks, preload is considered as additional axial force (even if bolt layout is not slip resistant but a preload has been defined).

