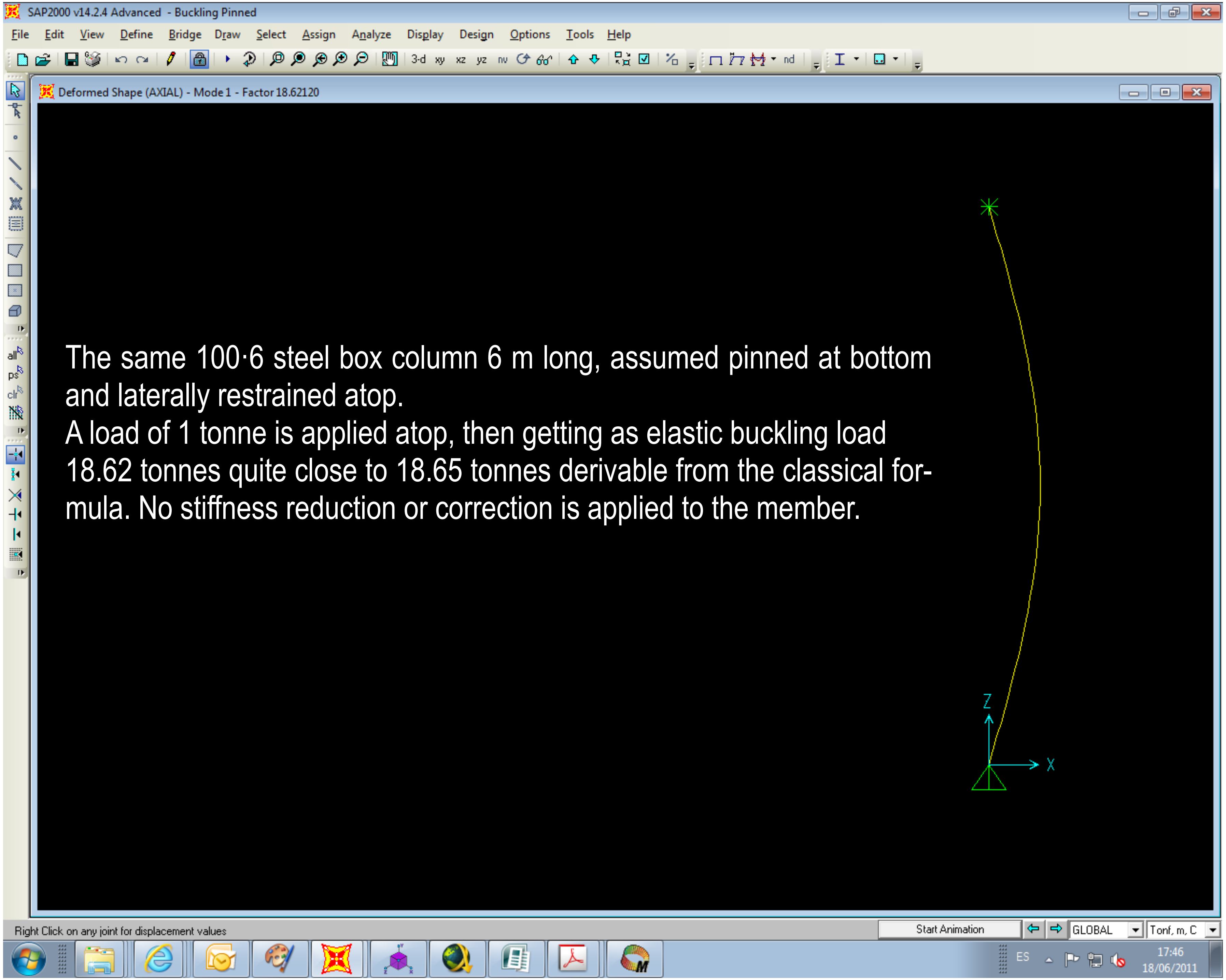
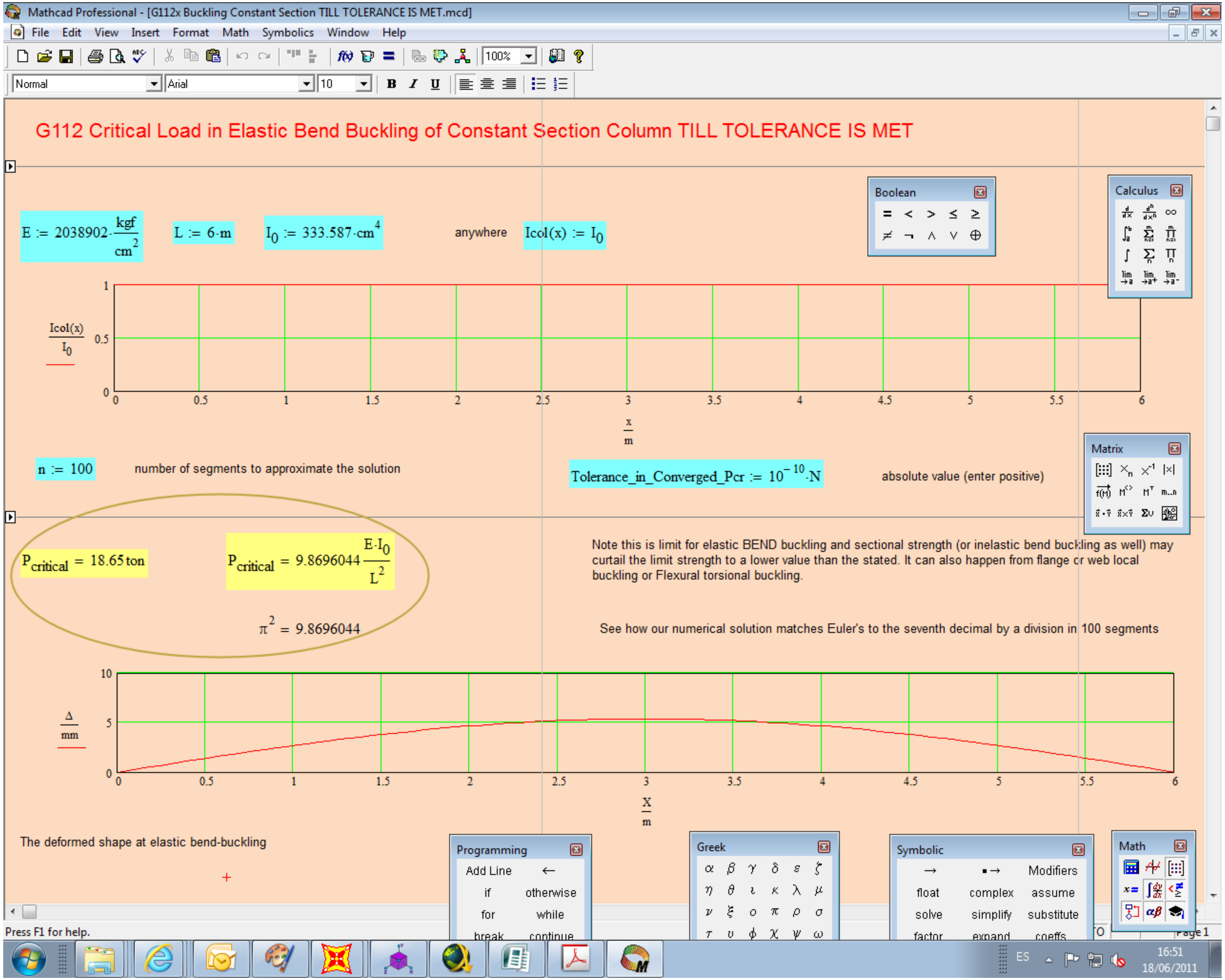
SAP 2000 Euler Critical Elastic Buckling Load



18.65 tonnes Critical Elastic Bend Buckling Load per Iterative evaluation as per Godden's book



What stated about the elastic buckling stress in AISC 360-10 (skin color, inset, evaluation)

The *critical stress*, F_{cr}, is determined as follows:

(a) When $\frac{KL}{r} \le 4.71\sqrt{\frac{E}{F_y}}$ (or $\frac{F_y}{F_e} \le 2.25$)

$$F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right] F_y$$

(b) When $\frac{KL}{r} > 4.71\sqrt{\frac{E}{F_y}}$ (or $\frac{F_y}{F_e} > 2.25$)

$$F_{cr} = 0.877 F_e \quad \text{(E3-3)}$$

$$F_e := \frac{\pi^2 \cdot E}{\left(\frac{1 \cdot L}{\sqrt{\frac{I_0}{A}}}\right)^2} \qquad F_e = 826.54 \frac{kgf}{cm^2}$$

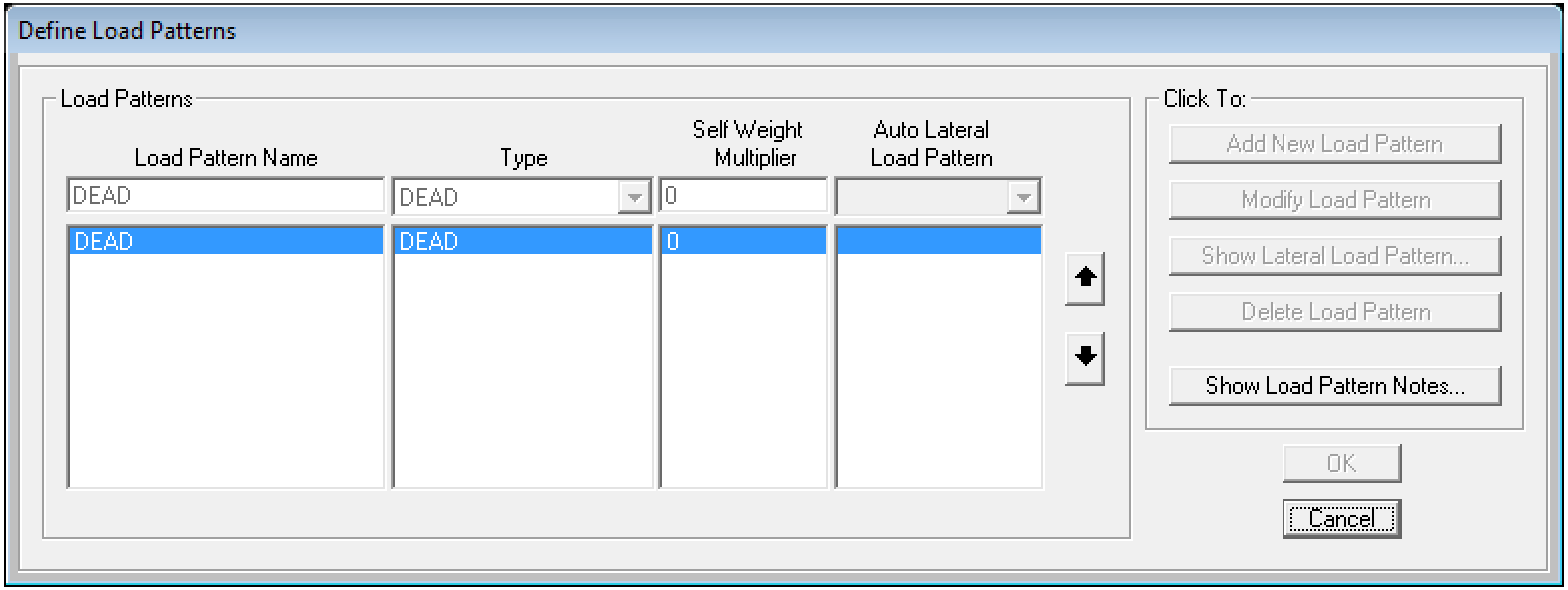
$$P_{ey} := F_e \cdot A \qquad P_{ey} = 18.65\,ton$$

where

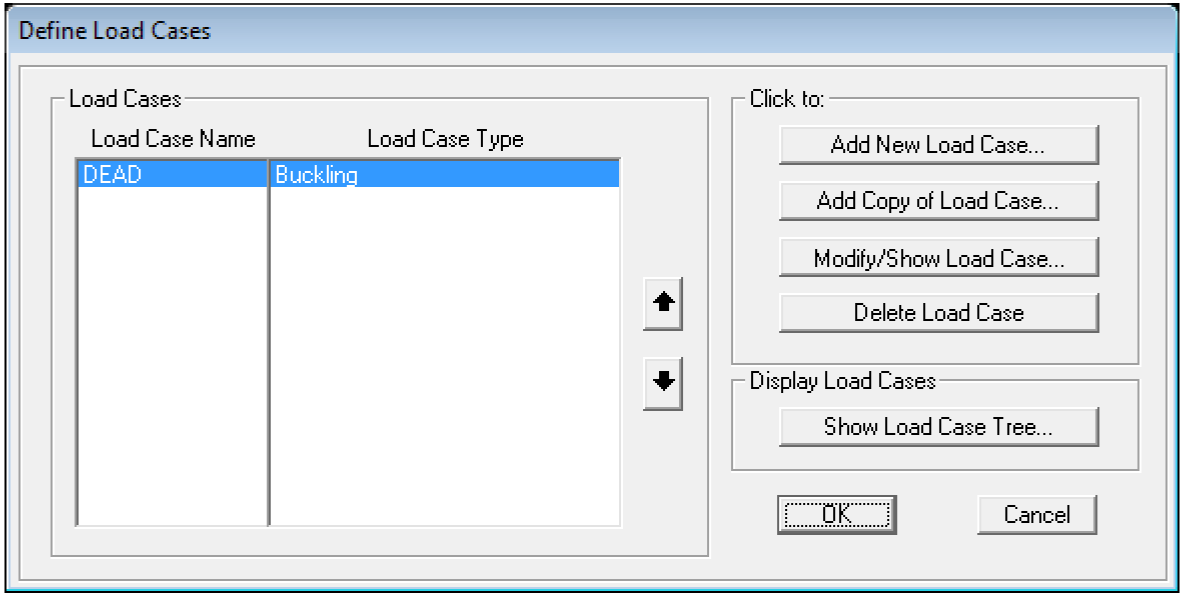
F_e = elastic *buckling* stress determined according to Equation E3-4, as specified in Appendix 7, Section 7.2.3(b), or through an elastic buckling analysis, as applicable, ksi (MPa)

$$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2} \quad \text{(E3-4)}$$

We can proceed as if assigning the case to a Dead load type in a on XZ **plane frame** analysis, except that the analysis will be for (elastic) buckling load.

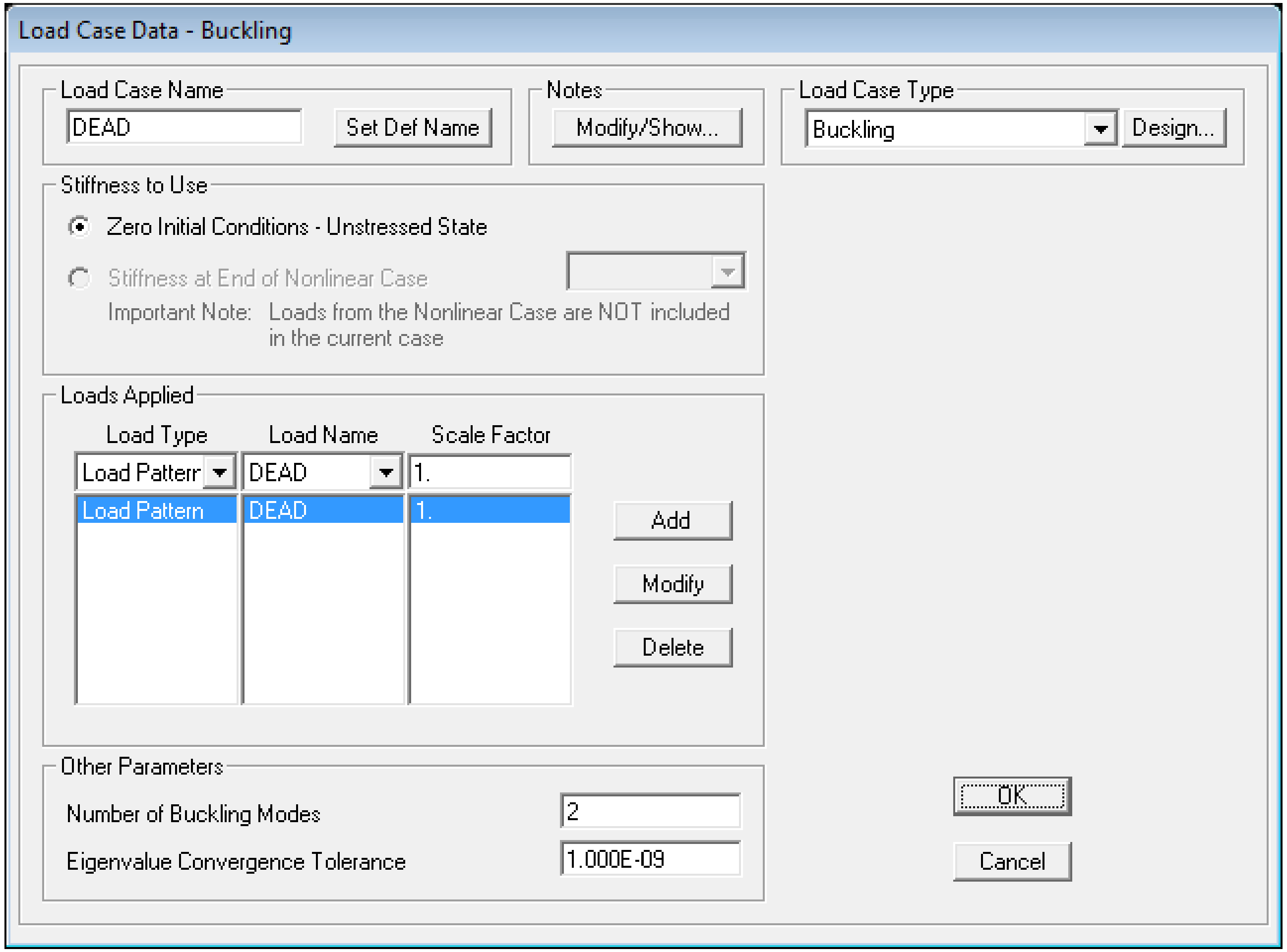


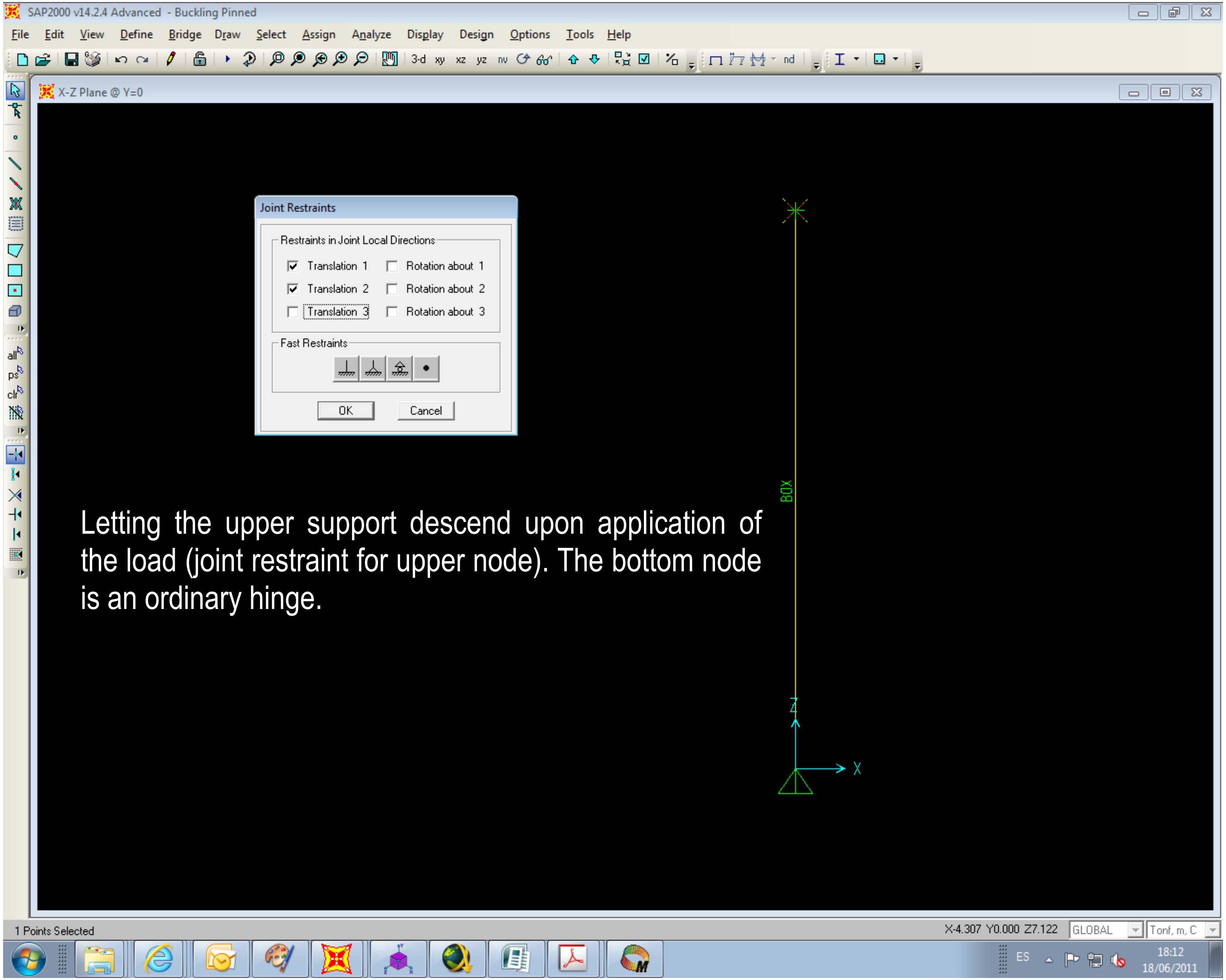
The **Load Patterns** definition. Note the Self Weight is assumed null, as in the Euler formula. If not, the weight of the member becomes a factor and produces a lower load factor, i.e., a lower elastic critical buckling load.



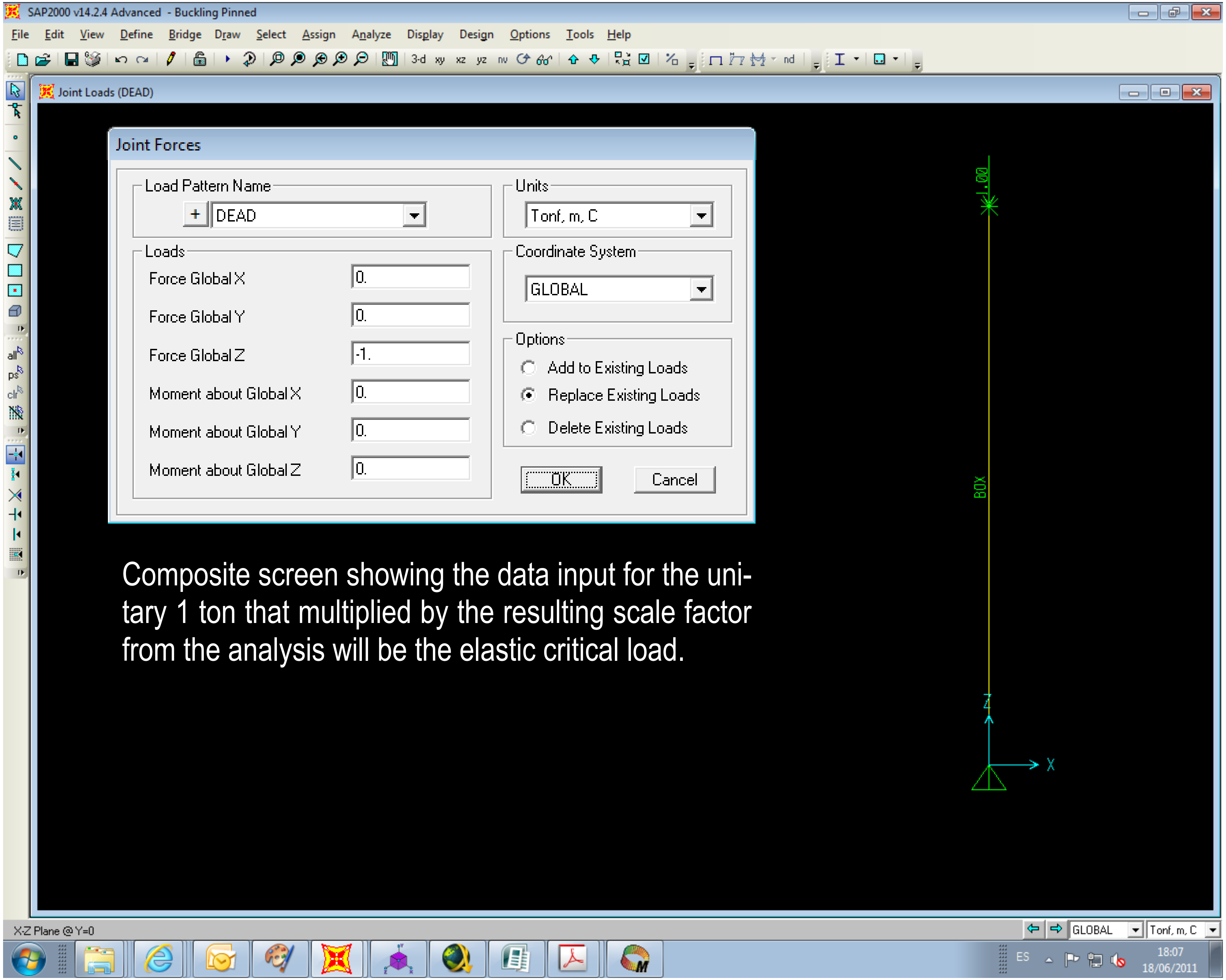
The **Load Cases** definition.

Press the Modify/Show Load Case… key to get to the dialog in the following page.

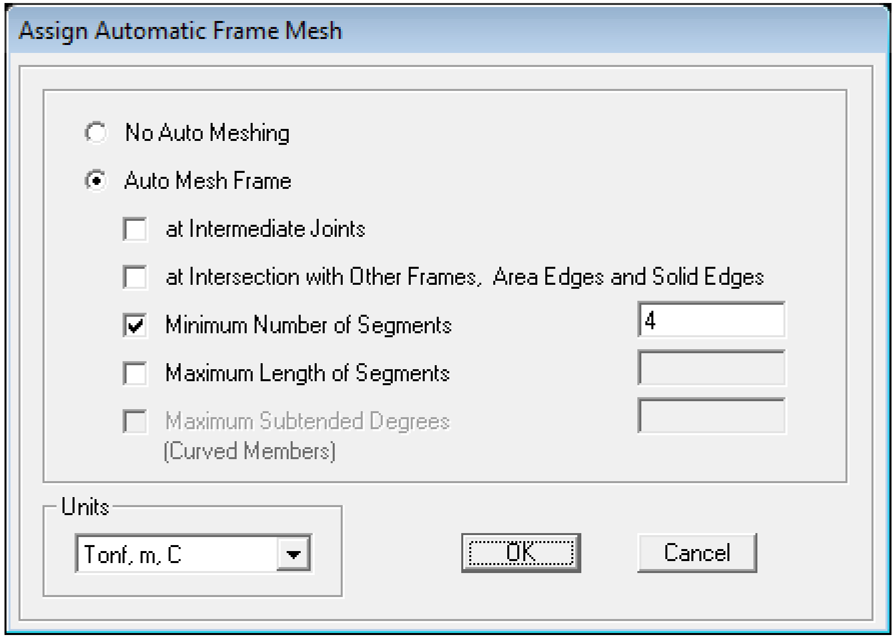

Load Case Data - Buckling
Load Case Name
DEAD
Set Def Name
Notes
Modify/Show...
Load Case Type
Buckling
Design...
Stiffness to Use
Zero Initial Conditions - Unstressed State
Stiffness at End of Nonlinear Case
Important Note: Loads from the Nonlinear Case are NOT included in the current case
Loads Applied
Load Type
Load Name
Scale Factor
Load Patterr
DEAD
1.
Load Pattern
DEAD
1.
Add
Modify
Delete
Other Parameters
Number of Buckling Modes
2
Eigenvalue Convergence Tolerance
1.000E-09
OK
Cancel



Letting the upper support descend upon application of the load (joint restraint for upper node). The bottom node is an ordinary hinge.



Composite screen showing the data input for the unitary 1 ton that multiplied by the resulting scale factor from the analysis will be the elastic critical load.



Do not forget to set the **Assign Automatic Frame Mesh** definition to a mínimum number of segments. You can Access this feature from the **Assign/Frame** menú

Running the analysis gives the resulting Buckling Scale Factor –here at page 1- that gives you the elastic critical load of this structure under this loading. As said, including the self weight will produce a lower Scale Factor for the applied load (lower net elastic critical load).