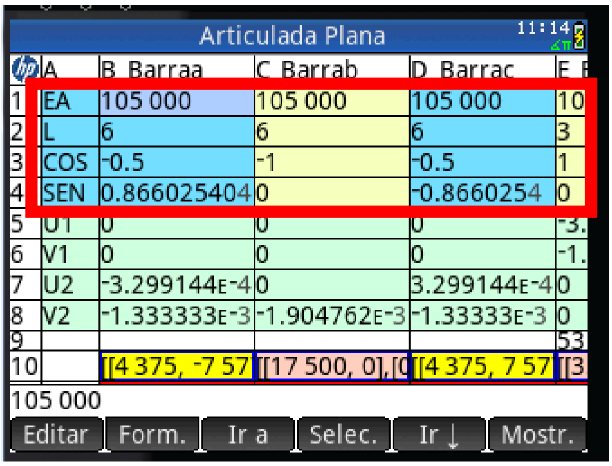
Articulated Structures (Nodes with 2 degrees of freedom)

This is a spreadsheet I made for myself because I am a civil engineer student and I needed something like this for the HP Prime, so for someone in the same conditions as me could be useful.

As I said it is something I made for myself and I didn’t have the intention to share it, that’s the reason it’s not a very elegant program and a little messy.

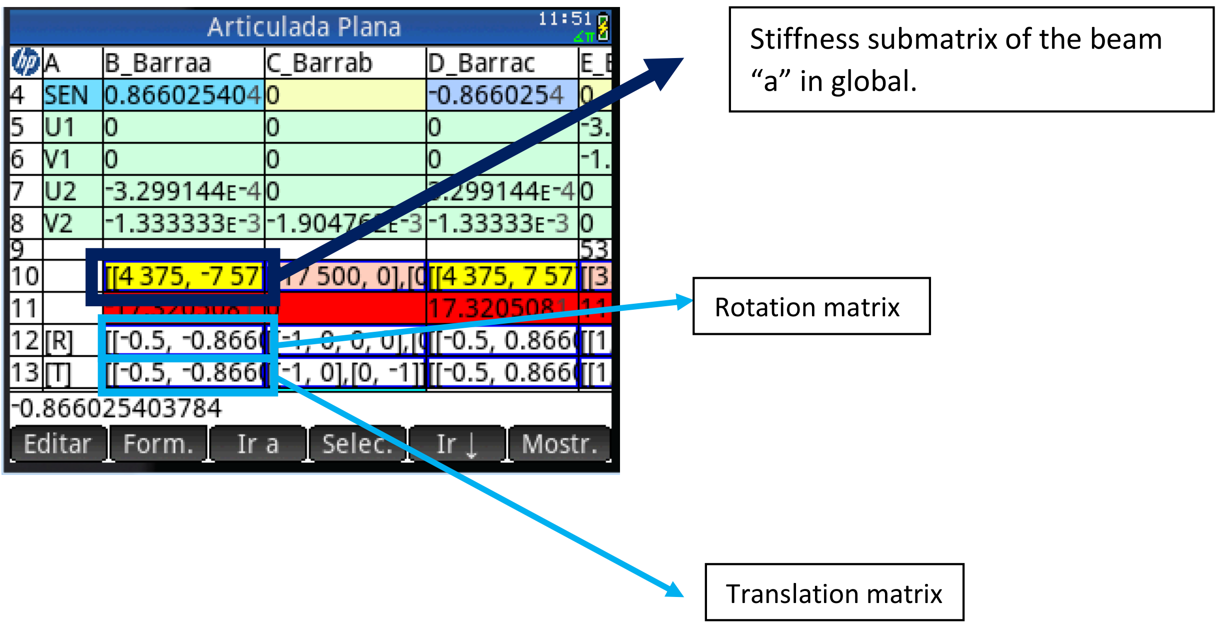
I’m going to explain how to use it.   (I’m Spanish so sorry for my English)

1.-Introduce the characteristics of all the beams (barra)



- **E:** is the elastic modulus (or Young's modulus)
- **A**: is the cross-sectional area.
- **L:** is the length of the beam.
- **COS :** cosine of the angle between the main axes and the beam.
- **SIN:** sine of the angle between the main axes and the beam.

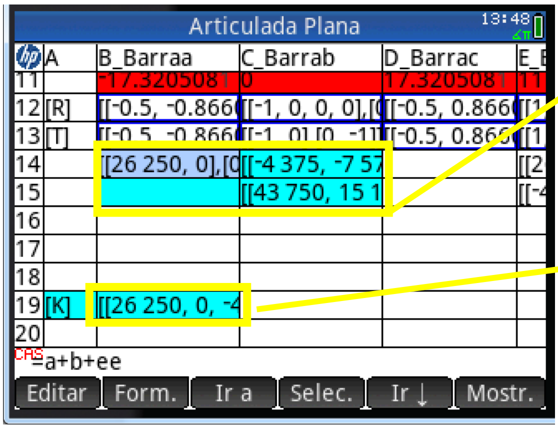
2.-You get the stiffness matrix of the beams



3.-Assembly the stiffness matrix of the structure

You need to write in a paper the stiffness matrix of your structure.

-If you have 2 nodes: you have to go to the cells B14:C15 (the blue ones) and there you write each element of the stiffness matrix (I explain then with an example how to put it). You get the assembly matrix of the structure in the cell B19.

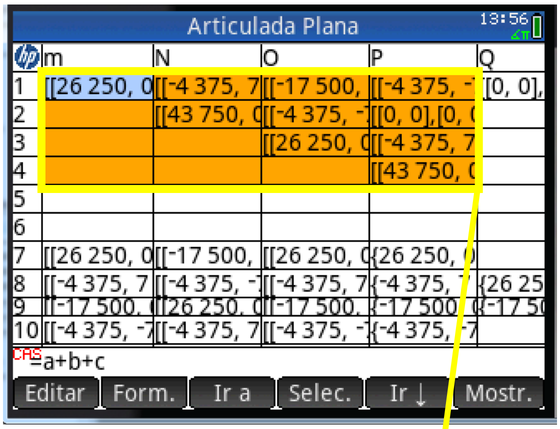


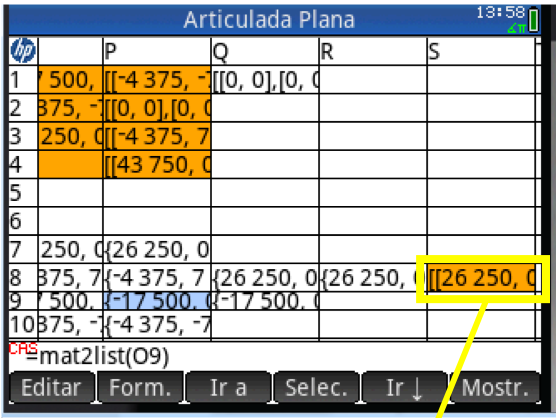
In each cell you put each element of the stiffness matrix.

Stiffness matrix of the structure

-If you have 3 nodes: you have to go to the cells m12:O14 (the greens) You get the stiffness matrix of the structure in the cell R19

-If you have 4 nodes: you have to go to the cells m1:P4 (the oranges). You get the stiffness matrix of the structure in the cell S8.





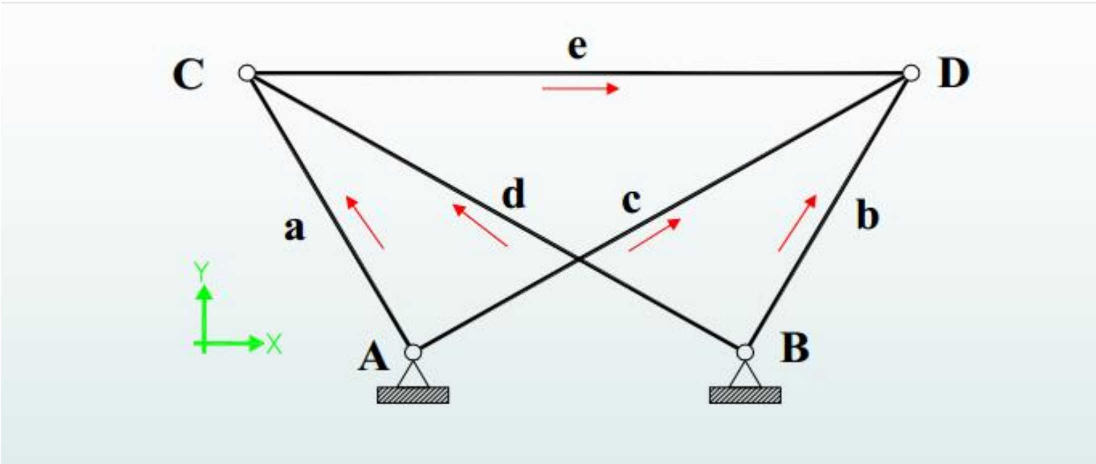
In each cell you introduce each element of the stiffness matrix.

Stiffness matrix of the structure

-If you have 5 nodes: you have to go to the cells m22:Q16 (the blues). You get the stiffness matrix of the structure in the cell T29

-If you have 6 nodes: you have to go to the cells m34:R39 (the yellows). You get the stiffness matrix of the structure in the cell T41.

For example if we have this structure



1. We Introduce the characteristics of all the beams in our spreadsheet.
2. We write in a paper the stiffness matrix of the structure, in this case:

$[K_{11a}]+[K_{11c}]$	[0]	$[K_{12a}]$	$[K_{12c}]$
	$[K_{11b}]+[K_{11d}]$	$[K_{12d}]$	$[K_{12b}]$
		$[K_{22a}]+[K_{22d}]+[K_{11e}]$	$[K_{12e}]$
Simétrica			$[K_{22b}]+[K_{22c}]+[K_{22e}]$

3. We have 4 nodes so we go to the cells m1:P4 (oranges) and we introduce each stiffness submatrix of each beam. (the stiffness submatrix of the beam “a” is named by “a”, so if you write “a” you call that matrix; in the same way the submatrix of the beam “b” is named by “b”;…;**the exceptions are the beams “e”,”g”,”i” that are named by “ee”,”gg”,”ii”** , there were some conflict and I can`t name them by only one letter).
   If some cell is zero you have to write **the matrix zero 2x2.**
   In **the cells that are not the main diagonal you have to put minus** “-“ before.

   In our case we have to introduce in our spreadsheet:

=a+b	=[[0,0],[0,0]]	=-a	=-c
	=b+d	=-d	=-b
		=a+d+ee	=-ee
			=b+c+ee

It`s better to use CAS mode to introduce it, if not, sometimes crash.
It is non necessary to introduce the symmetric part.

Writing that in the cells m1:P4 you get the stiffness matrix of the structure in the cell S8. Then you go to the home view, write S8 and you get it there, where you can to inverse it, or delete rows and columns, in order to solve and obtain the displacements.

4.-It's possible to obtain too the axial force of each beam.