Calc4fem Getting Started Guide

Calc4fem (http://calc4fem.narod.ru/)— is the open source spreadsheet for plane frames, beams and trusses calculation. Finite Element Method for beam elements is used.

Scheme of use see here

INPUT DATA

All data must be added on the “Data” sheet. The program reads the data by the special keywords (in the green cells - “nodes”, “elements”, etc). You may tab it in arbitrary order in “Data”-sheet.

Nodes Array

nodes			
NUMBER	X	Y	SUPPORTS

NUMBER – node numbers (positive whole numbers);
X, Y - nodes coordinates (Cartesian CS);
SUPPORTS – node supports.
Next keys are allowed:
x;
y;
xy, hinge;
xrot, xrotz;
yrot, yrotz;
rot, rotz;
xyrot, rigid.

Section Types Array

Sec_Prop				
NUMBER	E	A	J	h

NUMBER – section type number (see “num SecProp” in Elements Array);
E – Young's Modulus;
A – cross section area;
J – moment of inertia (optional);
h – cross section height of section (optional).

For truss elements J=h=0 (or empty cell).

Elements Array

elements				CONNECTION TYPE	
EL_NUM	num i	num j	num SecProp	begin	end

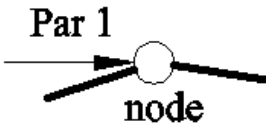
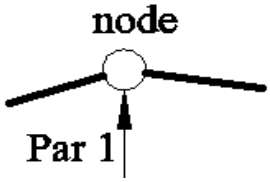
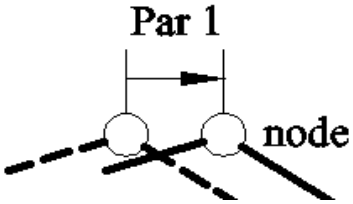
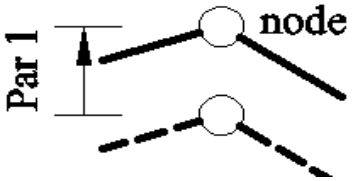
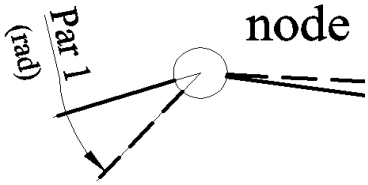
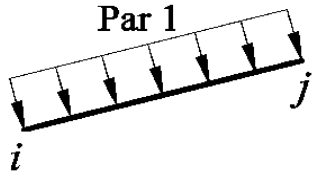
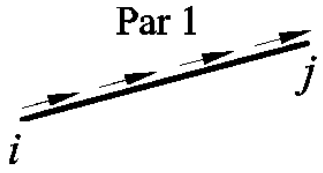
EL_NUM – number of element;
num i, num j – nuber of nodes (begin, end)
num SecProp – cross-section type number (See NUMBER in the Section Types Array)
CONNECTION TYPE – use the key “h” (“hinged”) for hinged connection in the begin or in the end of element.

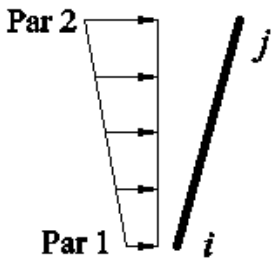
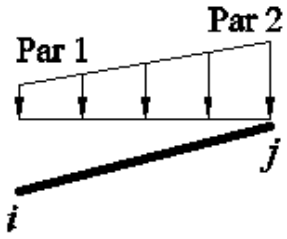
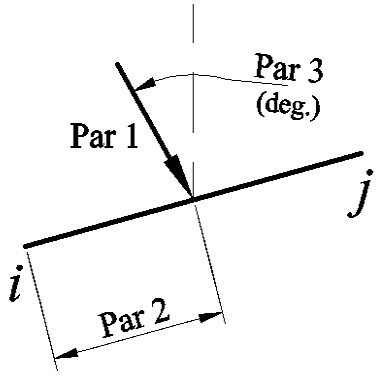
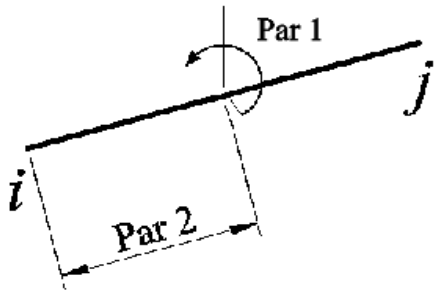
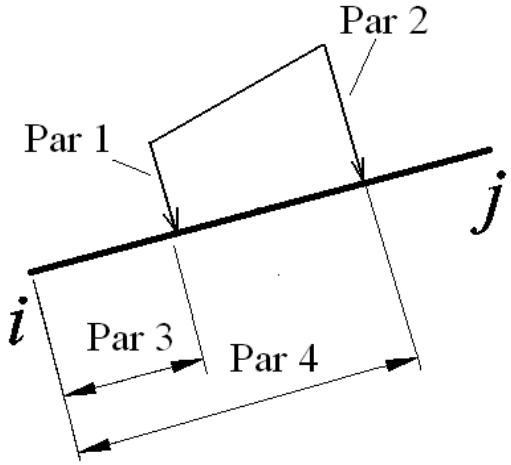
Base Loads Array

base_loads					
BL_NUM	EL/NODE NUM	LOAD KEY	Par 1	Par 2	Par 3

BL_NUM – Base load number for current load;
EL/NODE NUM – element/node number (in dependence on type of applying load);
LOAD KEY – literal key of load type (“fx”, “fy”,... “Pc”);
Par1, Par2, Par3 – parameters of load (values, distance, angels – see the table below)

Table 1 - Load Keys

Load Key	Scheme	Description
fx		Nodal load
fy		Nodal load
mz		Nodal moment
ux		Nodal displacement as a load (Is not converted into Wolsink's program)
uy		Nodal displacement as a load (Is not converted into Wolsink's program)
rotz		Nodal rotation as a load (Is not converted into Wolsink's program)
p1		Distributed load
p2		Distributed load

Load Key	Scheme	Description
qx		Distributed load (according a vertical projection)
qy		Distributed load (according a horizontal projection)
Pc		Point load on the beam
Mc		Moment load on the beam
q		Non-uniform distributed load

Load Combination Array

combs				
BL #1	BL #2	BL #3	BL #4	BL #5 (etc.)

Coefficients for base loads: Number of nonempty rows = number of combinations

For example:

combs	
BL #1	BL #2
0.9	0.8
1.2	1.4
1.2	-1.4

Combination #1: (base_load#1)*0.9+(base_load#2)*0.8
Combination #2: (base_load#1)*1.2+(base_load#2)*1.4
Combination #3: (base_load#1)*1.2+(base_load#2)*(-1.4)

The Results

After calculation the program creates (recreates) several sheets: “Results”, “Graph” and (optional) - “Matrix”.

The “Results” sheet contains:

- Nodal results (reactions and displacements at different base loads and load combinations)
- Element results (extremal moments, axial and shear forces over the all load combinations).

The “Graph” sheet contains geometry of frame or truss, node and element numbers.

The “Matrix” sheet contains the common stiffness matrix and the force vectors for all base loads.

User Functions

1) **eRes(element_number, key_of_result, base_load_number, t)**

key of result:
"nsec"- Section type number for current element
"len"- lenth of element: Lenth=$[(x_j-x_i)^2+(y_j-y_i)^2]^{1/2}$
"EA" – axial stiffness (E*A);
"EJ" – bending stiffness (E*J);
"l" : cosα = (x_j-x_i)/Lenth;
"m" : sinα = (y_j-y_i)/Lenth;
“Mt” - bending moment along beam axis (for x=t*Lenth);
“Qt”- shear force along beam axis (for x=t*Lenth);
“Nt”- axial force along beam axis (for x=t*Lenth);
“yloc” - Displacements along beam axis (for x=t*Lenth);
“phi” - Angle of rotation beam axis (for x=t*Lenth).

base_load_number and t = x/Lenth – optional variables (for result key = “Mt”, “Qt”, “Nt”, “yloc”, “phi”).

2) **eRes_epure(element_number, key_of_result, base_load_number, t)**

This function is used for quick getting of epures.
“eRes_epure is” is array function.
Use it with CTRL+SHIFT+ENTER to create table (array) of results.
key of result:
"yloc", "phi", "Mt", "Qt", "Nt" - displacements, angles of rotation, bending moments, shear forces, axial forces respectively. If key_of_result="all" then result of calculation is the table of all

listed values (but "yloc" are multiplied by -1000 and "phi" are in degrees).
t = x/Lenth is column vector for array function.
See http://www.youtube.com/watch?v=UMHpvS_BN7E

3) **eRes_comb(element_number, key_of_result)**

This function is for getting results for load combinations.

key_of_result:
Extremal values available: "Mmin", "Nmin", "Qmin", "Mmax", "Nmax", "Qmax", "ymax".

You can use arrays (the list with element numbers) "element_number" via columns selection.

Also see the lessons:
http://www.youtube.com/watch?v=xABqaWOywd4
http://www.youtube.com/watch?v=XoiVTdpThC4
http://www.youtube.com/watch?v=OkJFATf1ylk

Useful links

http://www.openoffice.org/	OpenOffice web site
http://portableapps.com/apps/office/openoffice_portable	Portable version for OpenOffice for Windows (it works without installation)
http://members.ziggo.nl/wolsink/	Homepage *Mechanical programs* (freeware). Calc4fem can convert data for 2D part of this program automatically.
http://maxima.sourceforge.net/	Maxima, a Computer Algebra System
http://pitonyak.org/	Andrew Pitonyak's OpenOffice Macro Information

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