Structural Analysis HW 6

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March 2023

1 Introduction

The finite element code for this assignment is contained in **HW6_run.py** and uses the input files **HW6_Frame_i.json**. Note that the use of the JSON format is convenient for constructing structures by hand. If an input file is already given, a wrapper function can be used to automatically convert the input regardless of the formatting used (such as custom text files). We make the following assumptions for a unitless analysis:

$$E = 1 \tag{1}$$
$$A = 1 \tag{2}$$
$$P = 1 \tag{3}$$
$$L = 1 \tag{4}$$
$$I = 1 \tag{5}$$

We can modify the value of I to scale our results for the following cases:

$$EI = 0.1EAL^2 \longrightarrow I = 0.1 \tag{6}$$
$$EI = 0.01EAL^2 \longrightarrow I = 0.01 \tag{7}$$
$$EI = 0.001EAL^2 \longrightarrow I = 0.001 \tag{8}$$
$$\tag{9}$$

Note that here we are not deriving the value of I, but *assigning* its value so that we may achieve the appropriate scaling in the code.

2 Structure Analysis

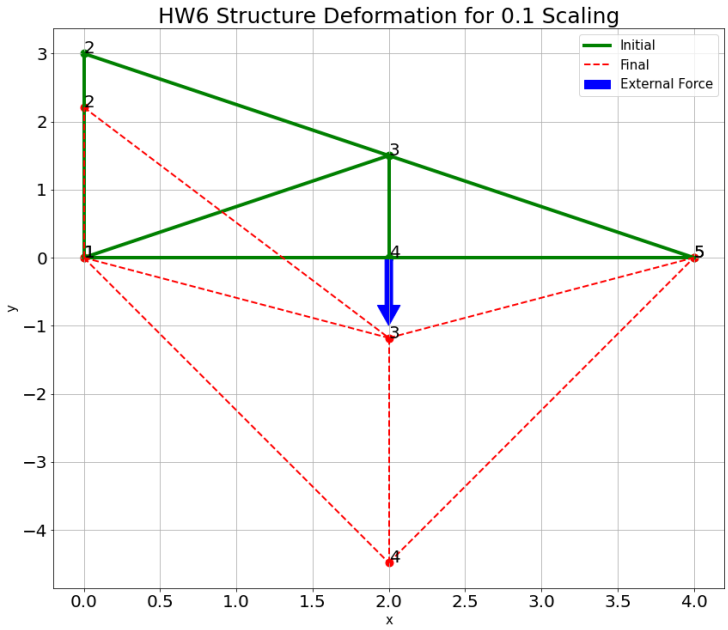

Figure 1: Here we show the deformation of the frame structure for the $EI = 0.1EAL^2$. Note that the nodal numbering here corresponds to the numbering in table 1.

Table 1 shows the nodal displacements for this particular structure and loading. Note that all values are in the units of $\frac{PL}{EA} = 1$ and thus scale accordingly. Table 2 shows the internal forces in each of the structural frame elements in units of $P = 1$. At first glance, the values between the truss structure and the $EI = 0.1EAL^2$ case are comparable at nodes and elements where displacements and internal forces are present. However, there are some notable discrepancies between which nodes and elements experience displacement and internal force. It is possible that this is due to the different constraints imposed on the truss problem, where rotation is not allowed. However, looking at the cases with even smaller scales does not inspire confidence in my code. I suspect that there is a unit conversion mistake happening or a mistake is present in the implementation of the local stiffness calculations.

DOF	Truss	$EI = 0.1EAL^2$	$EI = 0.01EAL^2$	$EI = 0.001EAL^2$
u_1	0	0.0	0.0	0.0
v_1	0	0.0	0.0	0.0
θ_1	0	0.0	0.0	0.0
u_2	0	0.0	0.0	0.0
v_2	-0.878	-0.7900732	-79.00732	-790.0732
θ_2	0	-0.529577	-52.9577	-529.577
u_3	-0.210	0.0	0.0	0.0
v_3	-3.190	-2.6795686	-267.95686	-2679.5686
θ_3	0	-0.984007	-98.4007	-984.007
u_4	0.552	0.0	0.0	0.0
v_4	-4.700	-4.483929	-448.3929	-4483.929
θ_4	0	-0.986266	-98.6266	-986.266
u_5	1.105	0.0	0.0	0.0
v_5	0	0.0	0.0	0.0
θ_5	0	3.075486	307.5486	3075.486

Table 1: Nodal displacements for HW6 2D frame structure at various values of I compared to HW1 2D truss structure.

DOF	Truss	$EI = 0.1EAL^2$	$EI = 0.01EAL^2$	$EI = 0.001EAL^2$
1-2	-0.292	-0.2633577	-26.3357	-263.357
1-3	-0.832	-0.6430964	-64.30964	-643.0964
1-4	0.276	0.0	0.0	0.0
2-3	0.488	0.453478	45.3478	453.478
3-5	-0.340	-0.6430964	-64.30964	-643.0964
3-4	1	1.202906	120.2906	1202.906
4-5	0.277	0.0	0.0	0.0

Table 2: Internal element forces for HW6 2D frame structure at various values of I compared to HW1 2D truss structure.