FEM1 Assignment 4, Resonance frequency

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Theoretical resonance frequency

According to the assignment, we had to define first resonance frequency for our beam. Thus, we had to consider coefficient $\alpha_0 = 1.875$. And according to the formula for a resonance frequency we calculated:

$$\frac{1}{2\pi\sqrt{12}}\alpha_0^2\sqrt{\frac{E}{\rho}}\frac{h}{L^2} \approx 21.4507...$$

Frequency mode

For our frequency mode simulation we created three models with different size of meshes:

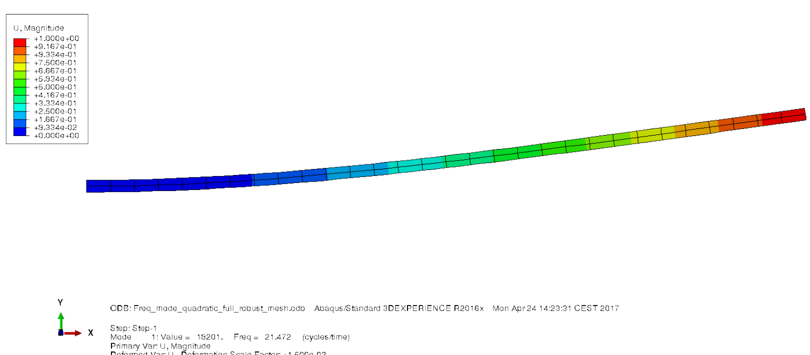


Figure 1: Robust mesh, approximal size of seed 0.005

Also, for this mode we tried different types of integration: linear full and reduced, as well as quadratic full and reduced. By this we wanted to see the influence of mesh AND type of integration. For this mode, our results could be organised like this:

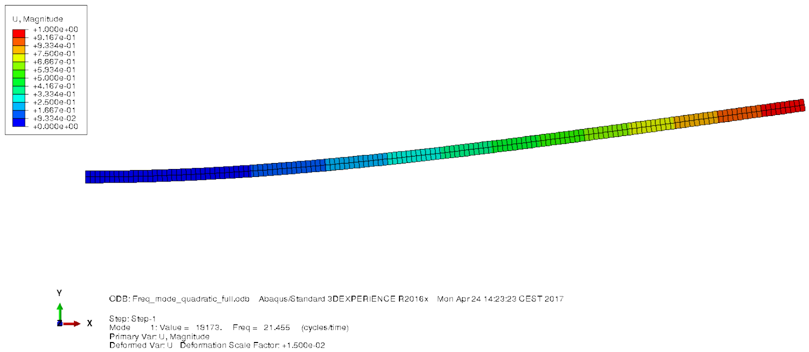


Figure 2: Medium mesh, approximal size of seed 0.001

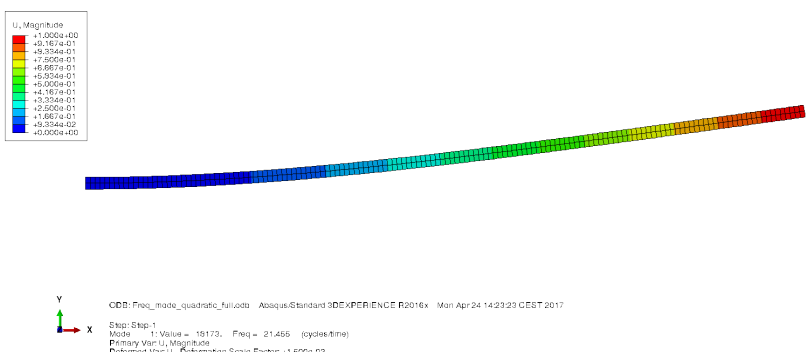


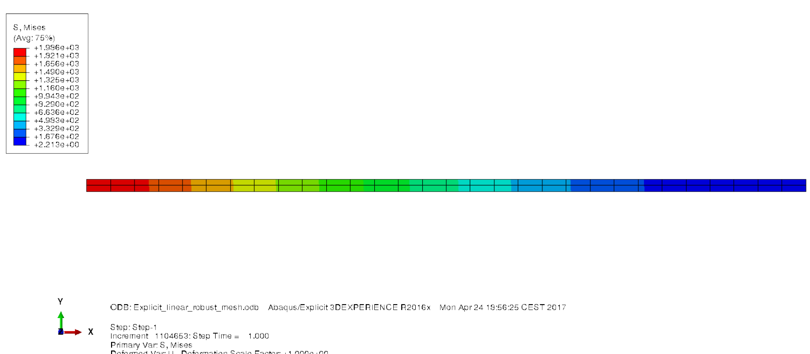
Figure 3: Medium mesh, approximal size of seed 0.001

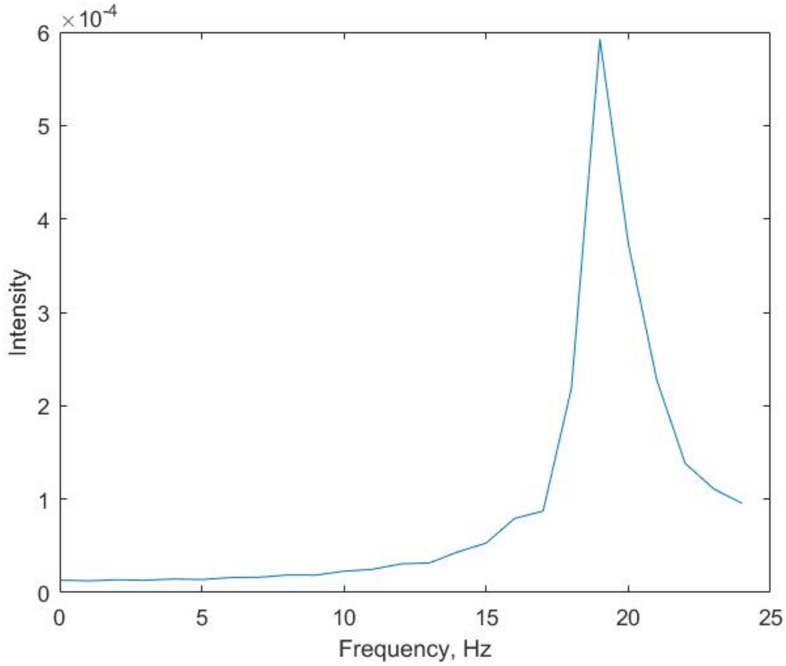
Type of integration	Linear reduced	Linear full	Quadratic reduced	Quadratic full
Size of mesh:				
Robsut	-	-	21.463	21.472
Medium	-	22.361	21.455	21.455
Fine	21.020	21.661	21.453	21.453

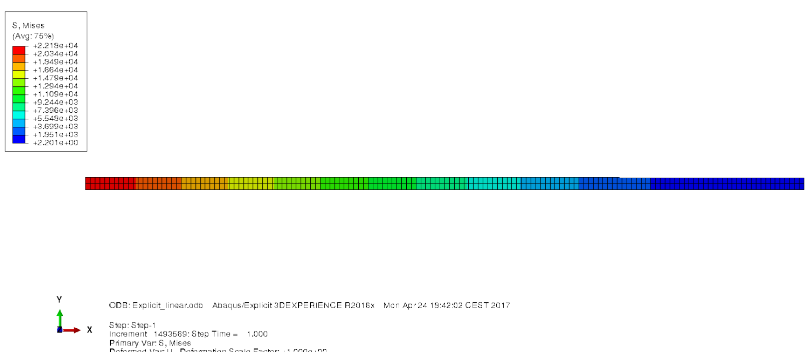
From this, it can clearly be seen that generaly, we get quite close results. For this mode, making the size of mesh smaller, does not really influence the final result. However, the method of integration definitely changes it. Nevertheless, we would choose quatratic method without doubt and reduced integration to reduce time needed for simulation.

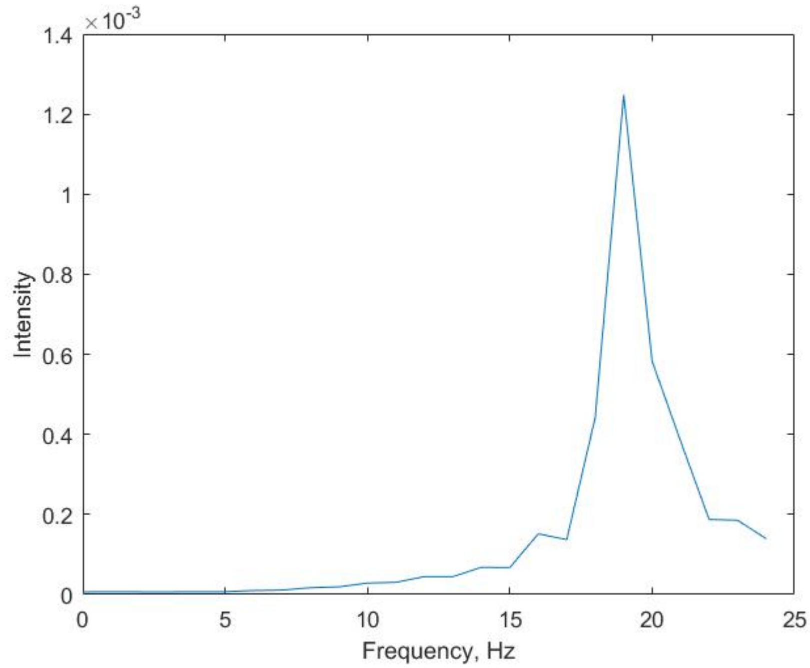
Impulse based analysis

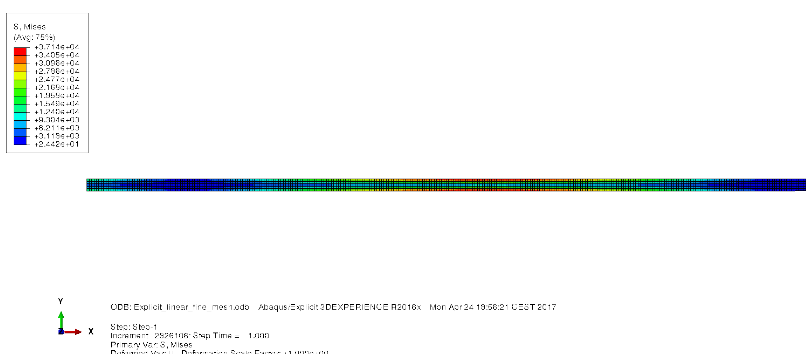
To have a clear comparison of different modes, we decided to use the same three meshes as for frequency mode. The obvious disadvantage of this method which we expectedly faced, is the time of simulation. For the fine mesh, simulation takes approximately 5 minutes, which is absolutely unexeptable for this type of problems.

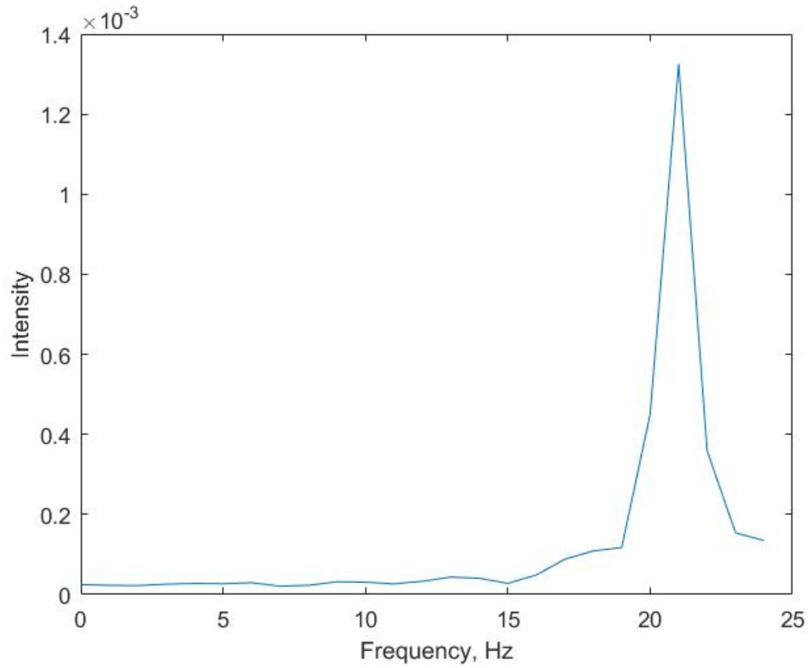



×10^-4
6
5
4
3
2
1
0
Intensity
0
5
10
15
20
25
Frequency, Hz


S, Mises
(Avg: 75%)
+2.218e+04
+2.034e+04
+1.849e+04
+1.664e+04
+1.479e+04
+1.294e+04
+1.109e+04
+9.244e+03
+7.396e+03
+5.548e+03
+3.699e+03
+1.851e+03
+2.201e+00
Y
X
ODB: Explicit_linear.odb Abaqus/Explicit 3DEXPERIENCE R2016x Mon Apr 24 18:42:02 CEST 2017
Step: Step-1
Increment 1493569: Step Time = 1.000
Primary Var: S, Mises
Deformed Var: U Deformation Scale Factor: +1.000e+00


×10^-3
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Intensity
0
5
10
15
20
25
Frequency, Hz


S, Mises
(Avg: 75%)
+3.714e+04
+3.405e+04
+3.096e+04
+2.786e+04
+2.477e+04
+2.168e+04
+1.858e+04
+1.549e+04
+1.240e+04
+9.304e+03
+6.211e+03
+3.118e+03
+2.442e+01
Y
X
ODB: Explicit_linear_fine_mesh.odb Abaqus/Explicit 3DEXPERIENCE R2016x Mon Apr 24 18:56:21 CEST 2017
Step: Step-1
Increment 2826106: Step Time = 1.000
Primary Var: S, Mises
Deformed Var: U Deformation Scale Factor: +1.000e+00



Size of mesh:	Robsut	Medium	Fine
	19	19	21

The other disadvantage is that we get quite unprecise results. This conclusion could be explained by two effects, which basicaly are connected with each other. First of all, we use quite a finite time step, for our simulation, which creates step like oscilation graph. The other thing is that we are using MATLAB function fft() which represents Fast Fourier Transform. One can find that this is very efficient type to compute discrete fourier transform. However, this type of fourier transform of course produces rounding errors, which also influences results heavily.

Conclusions

For finding the eigenfrequncy of simple beams, we can clearly say, that Abaqus frequency mode is definitely prefered. It is faster, it gives better results, and it is not so mesh depended as explicit method. To achieve results as close as possible to theoretically calculated, of course finer meshes are prefered. However, in case of problems which might consume more time with fine meshes, more robust could be used.