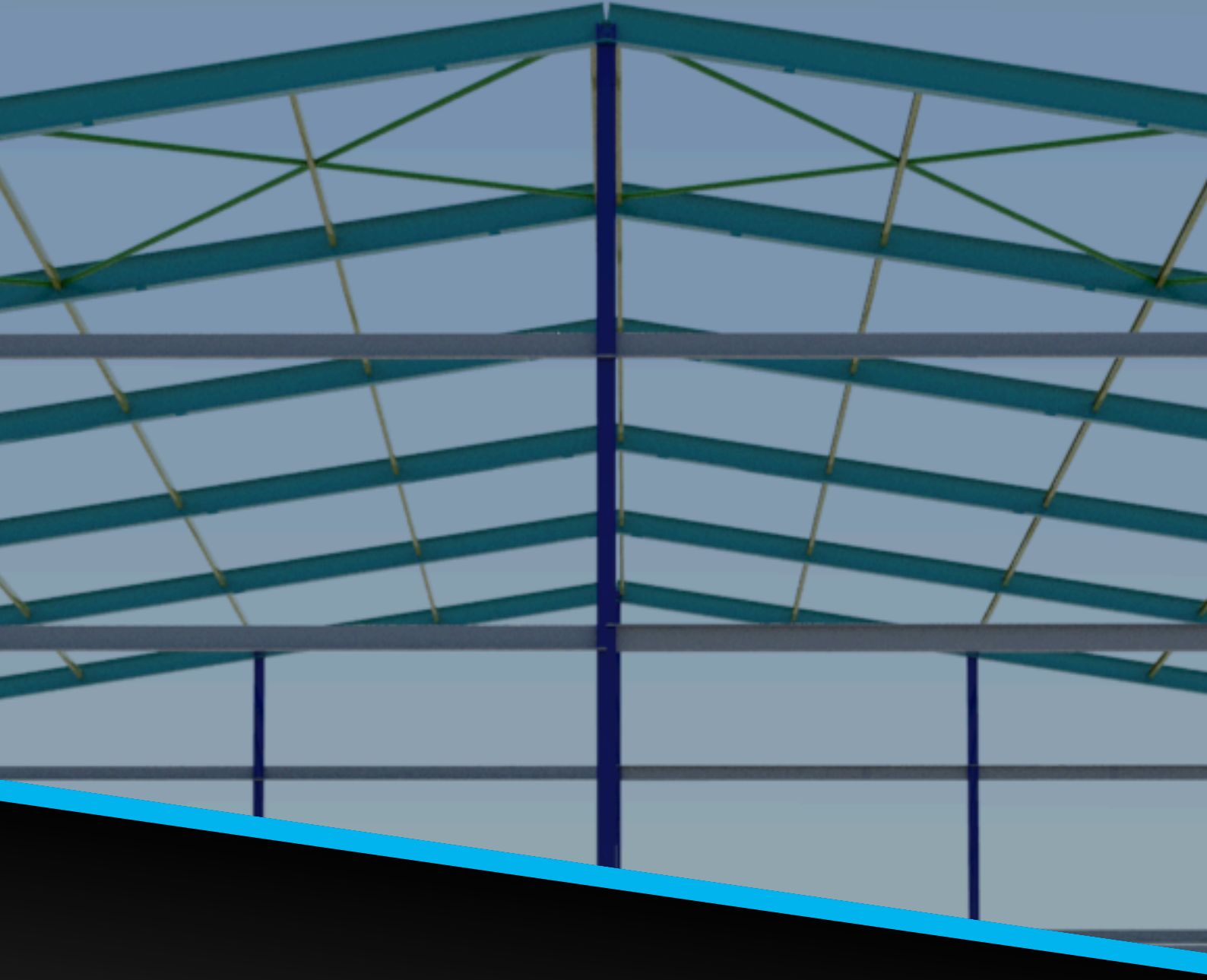


GenFEA

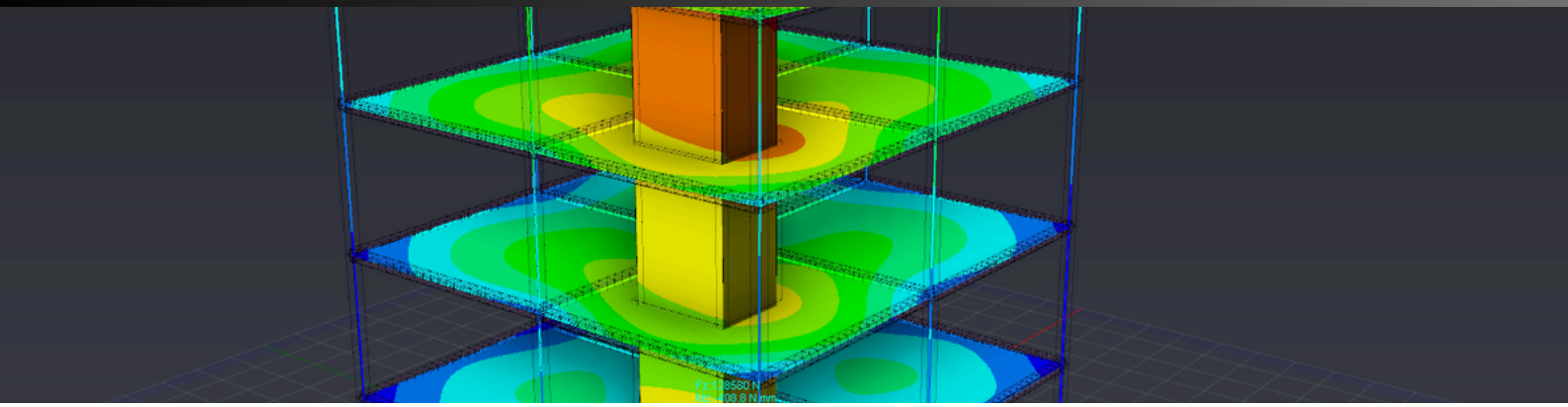
Benchmark & Validation

2024

About

Below is a collection of benchmarks against known problems and validated results compared against GenFEA.
We have taken applicable NAFEMS Benchmark Challenges as it relates to GenFEA components and analysis types.

We have also provided some manual calculated problems and compared them with GenFEA outputs.



NAFEMS Benchmark Challenge 7

Modelling Beam Members with Finite Elements:

The NAFEMS Benchmark Challenge Number 7 is designed to explore the effectiveness of different finite element formulations in modeling beam members.

Specifically, the challenge compares the Euler-Bernoulli beam theory against the Timoshenko beam theory, highlighting the differences in assumptions and results between these two approaches.

The Euler-Bernoulli model, based on classical beam theory, assumes that plane sections remain plane and normal to the beam's neutral axis after deformation, leading to deflections that are typically modeled linearly. In contrast, the Timoshenko beam theory accounts for shear deformation and rotational effects, allowing for quadratic deflection profiles, which tend to provide more accurate predictions in scenarios where beam thickness cannot be neglected.

The conclusion drawn from this challenge underscores the superiority of the Timoshenko model for more accurately predicting the behavior of beams, especially in practical engineering applications where the effects of shear deformation are non-negligible.

This benchmark challenge serves to remind engineers of the critical need to choose the appropriate beam theory based on the specific requirements and accuracy needs of their projects.

Results

	NAFEMS Euler-Bernoulli	NAFEMS Timoshenko	GenFEA	Variance to NAFEMS
Va	15.625 kN	16.475 kN	16.453 kN	0.13%
Ma	4.6875 kN.m	5.112 kN.m	5.10196 kN.m	0.20%
Vb	84.375 kN	83.525 kN	83.546 kN	0.03%
Mb	14.0625 kN.m	13.637 kN.m	13.648 kN.m	0.08%
Mx = a	7.031 kN.m	7.244 kN.m	7.23848 kN.m	0.08%
Deflection a	0.2501 mm	0.435 mm	0.443 mm	1.81%
Max Deflection	0.3201 mm	Not Provided	0.458	--

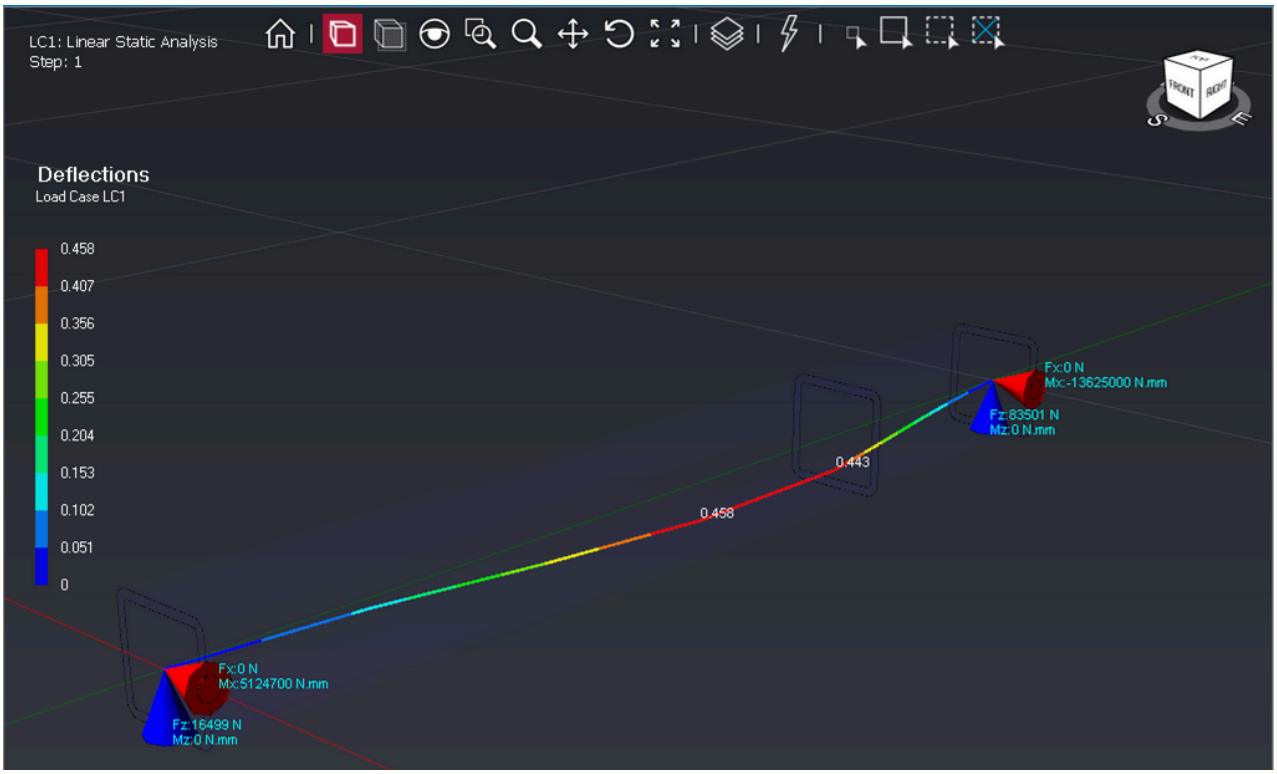
Conclusion

From these results we can see that GenFEA is within 1% variation compared to NAFEMS published values for forces and moments, while deflection is slightly higher (more conservative) than that of NAFEMS, at 1.81%

Results Workbook

A2 LC1

Load Case	Element ID	Group	Type	Node 1	Node 2	Distance	N	V_x	V_y	T	M_xx	M_yy	D_x	D_y	D_z
LC1	1		Beam3D	1	2	0	0.00000	-16499.30000	0.00000	0.00000	0.00000	-5124670.00000	0.00000	0.00000	0.00000
LC1	1		Beam3D	1	2	188	0.00000	-16499.30000	0.00000	0.00000	0.00000	-2031040.00000	0.00000	0.00000	-0.11254
LC1	1		Beam3D	1	2	375	0.00000	-16499.30000	0.00000	0.00000	0.00000	1062580.00000	0.00000	0.00000	-0.30668
LC1	1		Beam3D	1	2	563	0.00000	-16499.30000	0.00000	0.00000	0.00000	4156210.00000	0.00000	0.00000	-0.45813
LC1	1		Beam3D	1	2	750	0.00000	-16499.30000	0.00000	0.00000	0.00000	7249830.00000	0.00000	0.00000	-0.44259
LC1	2		Beam3D	2	3	0	0.00000	83500.70000	0.00000	0.00000	0.00000	7249830.00000	0.00000	0.00000	-0.44259
LC1	2		Beam3D	2	3	63	0.00000	83500.70000	0.00000	0.00000	0.00000	2031040.00000	0.00000	0.00000	-0.32225
LC1	2		Beam3D	2	3	125	0.00000	83500.70000	0.00000	0.00000	0.00000	-3187750.00000	0.00000	0.00000	-0.19283
LC1	2		Beam3D	2	3	188	0.00000	83500.70000	0.00000	0.00000	0.00000	-8406540.00000	0.00000	0.00000	-0.07765
LC1	2		Beam3D	2	3	250	0.00000	83500.70000	0.00000	0.00000	0.00000	-13625300.00000	0.00000	0.00000	0.00000



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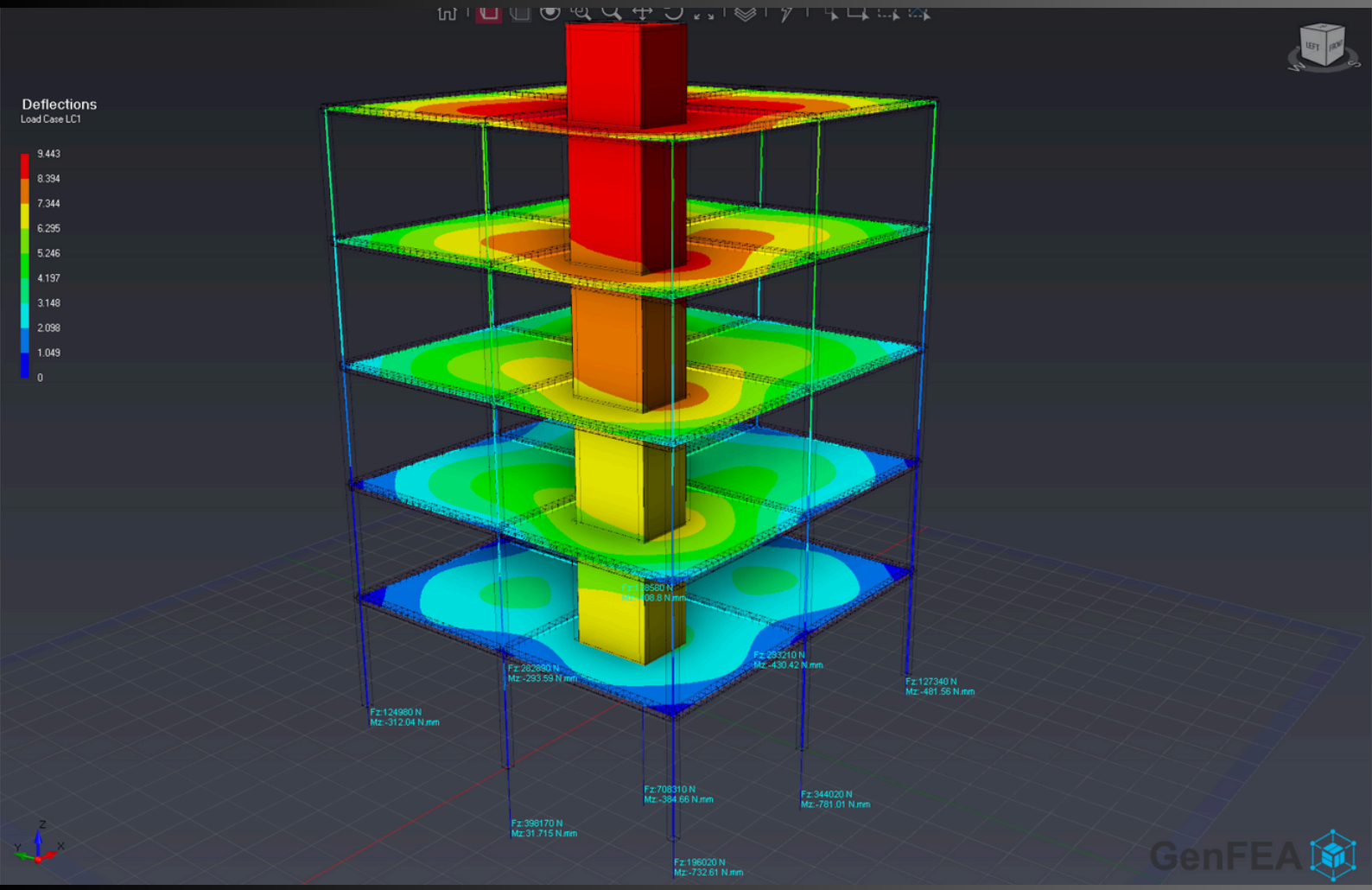

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