BCMS FRAME ANALYSIS

Torsional Stiffness and Compliance

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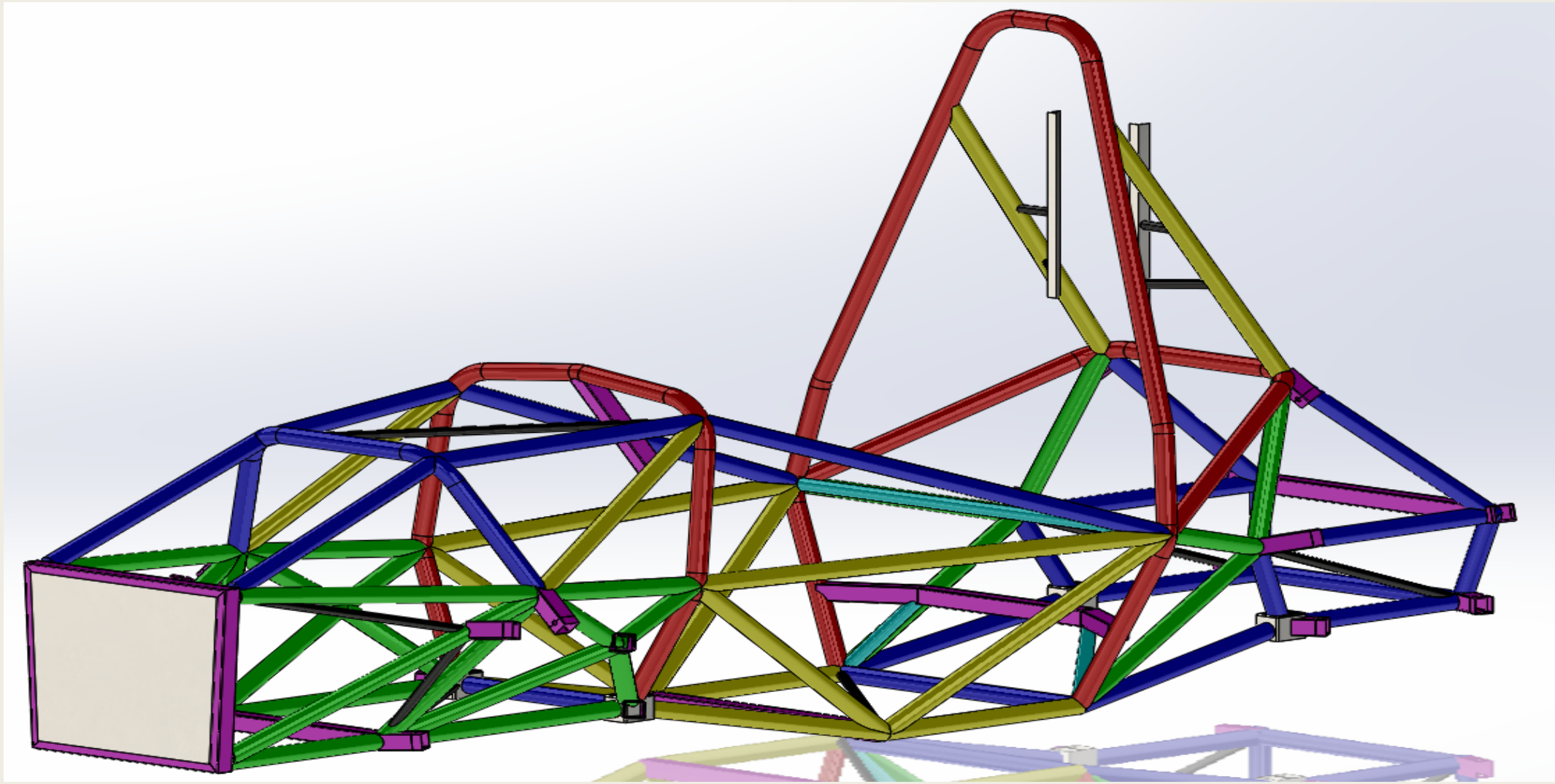
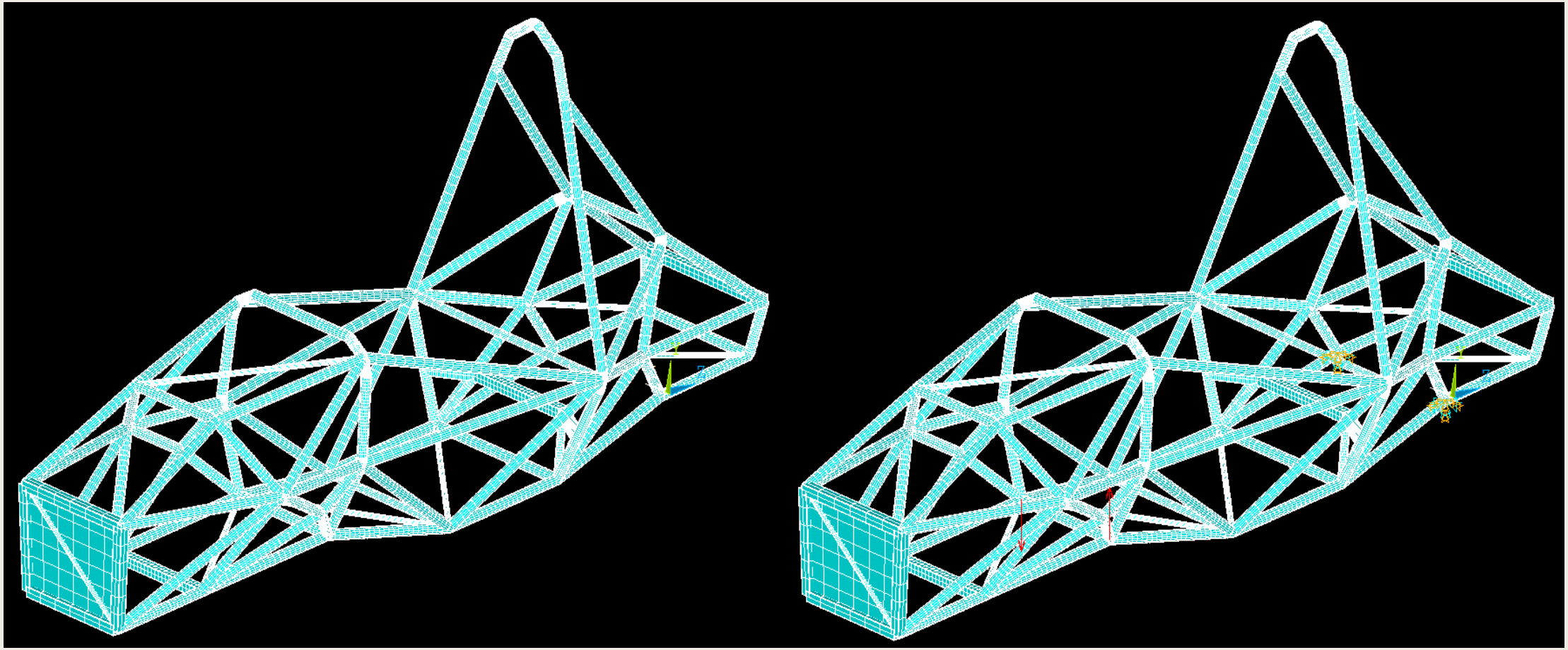
Design Goals

- In order for a race chassis to be successful in competition, it must be adequately stiff in order to isolate the suspension tuning characteristics. If the chassis is able to flex too much, it invalidates important assumptions needed to design and tune the suspension. It is then necessary to ensure that the frame is at least twice as stiff as the suspension equivalent compliance. Making an “uber-stiff” chassis may completely isolate the suspension, but there are diminishing returns and the added mass of doing this can even make the frame less stiff in certain modes. This design takes the approach that many race programs use: make it only as stiff as necessary and save as much weight as possible.

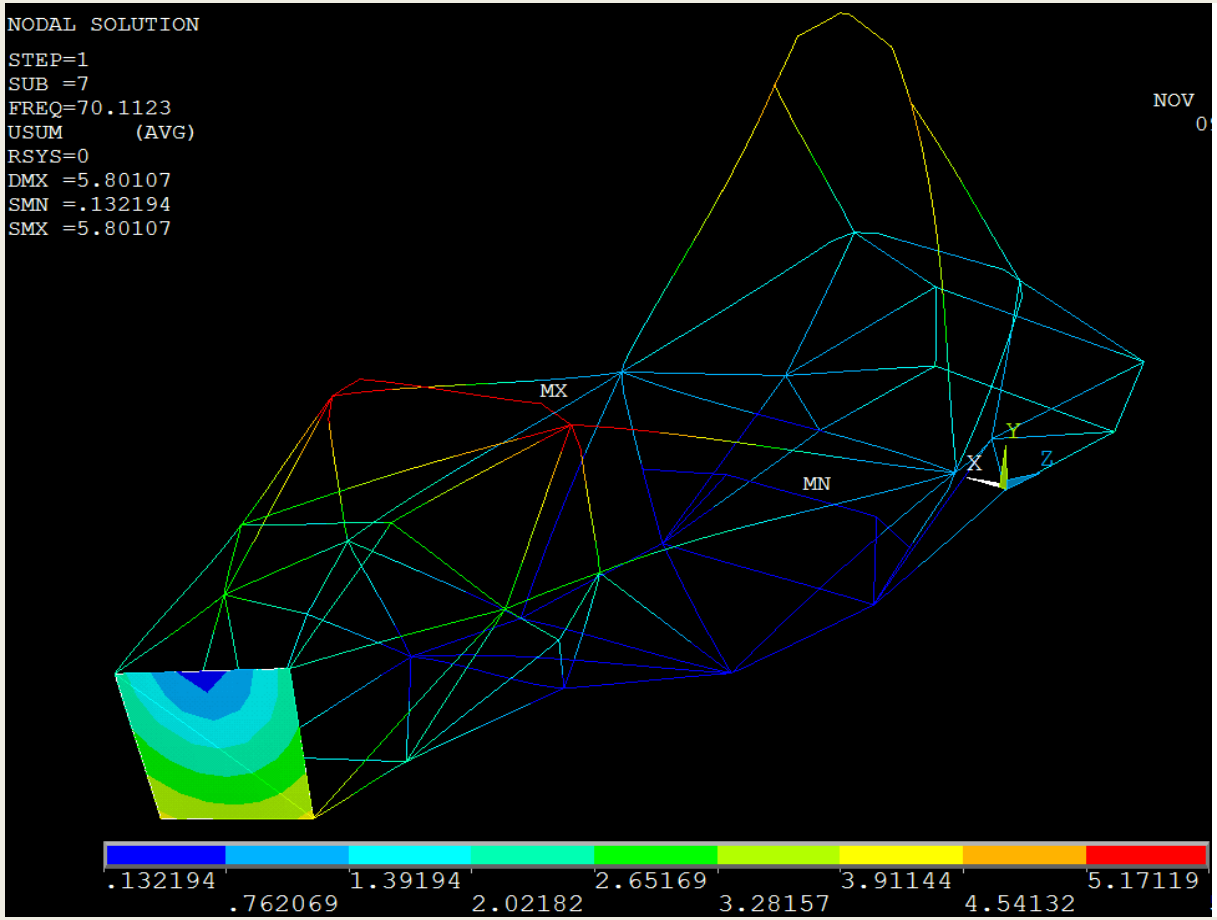
The Design



Twist Test



Modal Analysis



***** INDEX OF DATA SETS ON RESULTS FILE *****

SET	TIME/FREQ	LOAD STEP	SUBSTEP	CUMULATIVE
1	0.0000	1	1	1
2	0.0000	1	2	2
3	0.56690E-03	1	3	3
4	0.67137E-03	1	4	4
5	0.90498E-03	1	5	5
6	0.67274E-01	1	6	6
7	70.112	1	7	7
8	114.51	1	8	8
9	127.71	1	9	9
10	134.37	1	10	10
11	155.83	1	11	11
12	172.58	1	12	12
13	182.80	1	13	13
14	185.15	1	14	14
15	188.53	1	15	15
16	209.81	1	16	16
17	213.07	1	17	17
18	240.76	1	18	18

Results

	Twist Test	Modal Analysis
Torsional Stiffness	1534.613 lbf·ft/deg	1534.014 lbf·ft/deg
Natural Frequency	70.430 Hz	70.112 Hz

$$\omega_n = \sqrt{\frac{K}{I}} = \sqrt{\frac{87926.848 \frac{lbf \cdot ft}{rad}}{1.796\ slug \cdot ft^2}} = 442.525 \frac{rad}{s} = 70.430\ Hz$$

Discussion

- Based on the results shown above, the frame is adequately stiff for the application. The main improvements would be to reduce the mass of the frame, which would be beneficial for both the stiffness (since $\omega_n = \sqrt{\frac{k}{m}}$) and the acceleration characteristics of the car on a racetrack (since $f = ma$). This would also reduce the overall cost of manufacture, using less material for the tubes as well as the weld for the joints.