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RESEARCH ARTICLE OPEN ACCESS

Investigation on the frequency analysis of bevel gear with different materials

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ABSTRACT:
Bevel gears are critically used to connect the shafts having the axes at an angle to each other. This paper aiming the comparision of bevel gear dynamic analysis natural frequencies over forced frequencies with AISI4340 Normalized steel and 2024 Aluminum alloy steel. Results are compared for the frequencies with the commercial software for both materials. A weight reduction of 64.29% is observed from AISI4340 Normalized steel to 2024 Aluminum Alloy steel. A slight variation observed for both materials from forced frequencies to natural frequencies proving material consistency for about 0.3%.

Keywords **–** Bevel gear, Dynamic analysis, Forced frequency and Natural frequency, Weight reduction.

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I. Introduction

Beveling is normally used to soften the edges of the gear tooth structure and ease in making the connection to the other mating gear. Accurate 3-D modeling is needed to perform dynamic analysis for good results and simulation [1]. Material selection is an important key factor for effective operation of the system and more improved transmission efficiency mechanism for bevel gear [2]. In this context, AISI4340 normalized steel 2024 Aluminum Alloy materials are chosen for the purpose of dynamic analysis. The material properties are given in the table (1)[3].

Table: 1 Material Properties

	Material	Yield Strength (N/mm^2)	Density(kg/m^3)	Poisson's Ratio	Young's Modulus (N/mm^2)
1	AISI4340 Normalized Steel	710	7850	0.32	205000
2	2024 Aluminum Alloy	75.829	2800	0.33	73000

II. Literature Survey

The biggest advantage with bevel gears to minimize or maximize the gear ratio between the drive and associated wheels to correspondingly reduce or increase the force transmission. Bevel gears are used for intersecting shafts and have a changeable operating angle due to their shape [4].

Rohit Sreekumar and T. Jeyapoovan in their project deals with the design and optimization of the differential gear box through use of composite material is compared against the other currently used to lower stress and density and weight of the differential gear box and increased efficiency [5]. Mohammad Qasim Abdullah et.al., investigated about numerical and experimental stress analyses to evaluate the contact and bending stresses on the teeth of spiral bevel gear drive [6].

However, bevel gear with different materials need to be studied for its dynamic analysis to the best suitable material consistency. The present study aims in dealing the frequencies under the influence of applied torque against no load conditions and results are compared accordingly.

III. Methodology and Results

A typical bevel gear model is chosen from the available commercial solid works toolbox for the synthesis and analysis. A solid mesh is used for discretization include 78% elements of with aspect ratio less than 3 and the remaining with more than

10. The surface attached with shaft is in fixed boundary condition for both loaded 10 N-m an arbitrary value for forced frequencies and also no-load natural frequencies using both materials. The results are compared accordingly.

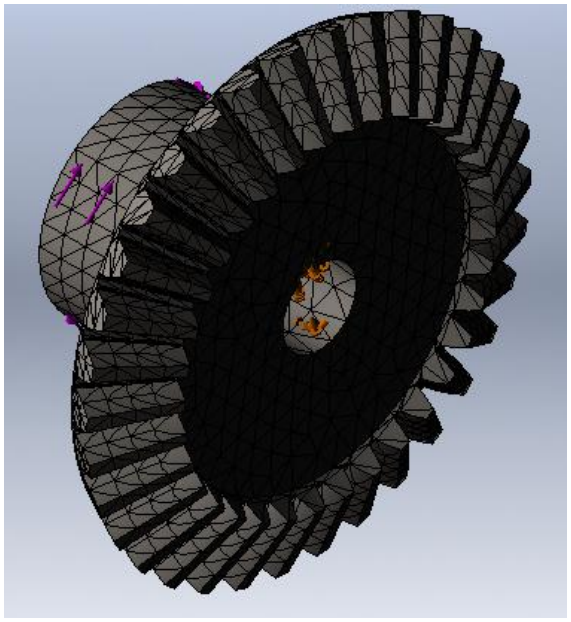


Fig: 1 Discretized Bevel gear with boundary conditions

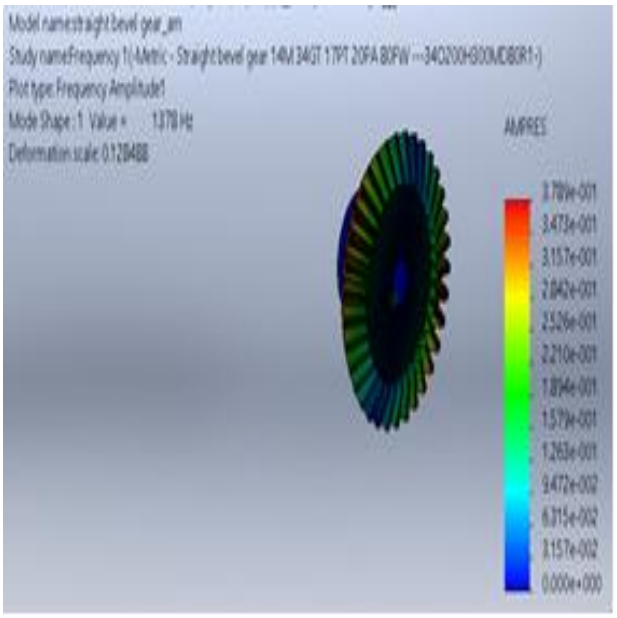


Fig:2 Natural frequncy 1 for AISI4340 normalized steel

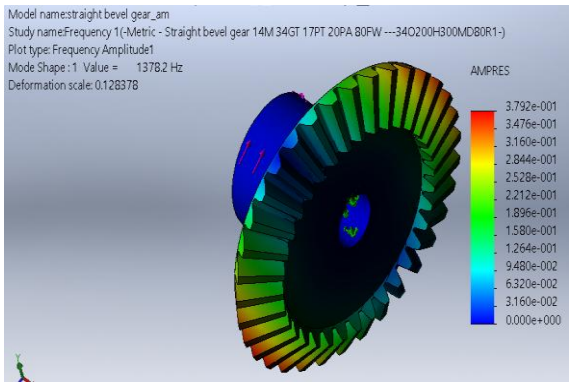


Fig:3 Forced frequncy 1 for AISI4340 normalized steel

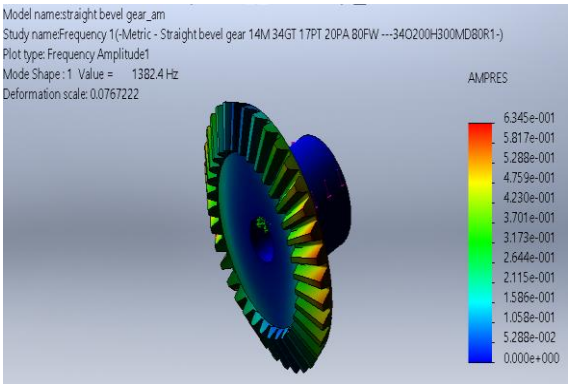


Fig:4 Forced frequncy 1 for 2024 Aluminum Alloy steel

TABLE: 2 Natural frequencies

Frequency Number	NATURAL FREQUENCIES (Hz)	
	AISI4340 NORMALIZED STEEL	2024 ALUMINUM ALLOY STEEL
1	1378	1382.4
2	1379.3	1383.6
3	1439.8	1446.8
4	1531.2	1529.1
5	1531.8	1529.9

Table: 3 Forced frequencies

Frequency Number	FORCED FREQUENCIES (Hz)	
	AISI4340 NORMALIZED STEEL	2024 ALUMINUM ALLOY STEEL
1	1378.2	1382.4
2	1379.3	1383.6
3	1439.8	1446.8
4	1531.2	1529.1
5	1531.9	1529.9

Table 4. Volumetric properites of AISI4340 Normalized steel

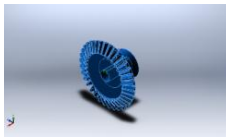
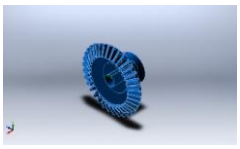
Solid Bodies			
Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Keyway 	Solid Body	Mass:85.3591 kg Volume:0.0108738 m^3 Density:7850 kg/m^3 Weight:836.519 N	C:\SOLIDWORKS Data\browser\Ansi Metric\power transmission\gears\straight bevel gear_am.sldprt Jun 28 10:33:36 2022

Table 5. Volumetric properites of 2024 Al. Alloy

Solid Bodies			
Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Keyway 	Solid Body	Mass:30.4466 kg Volume:0.0108738 m^3 Density:2800 kg/m^3 Weight:298.376 N	C:\SOLIDWORKS Data\browser\Ansi Metric\power transmission\gears\straight bevel gear_am.sldprt Jun 28 10:33:36 2022

IV. Conclusions

Bevel gear analysis with different materials have been performed and the results are concluded.

- A weight reduction of 64.29% is observed from the AISI4340 Normalized steel to 2024 Aluminum Alloy steel from the results.
- A slight variation observed for both materials from forced frequencies to natural frequencies proving material consistency for about 0.3%.

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