Review and Design of FDM printed Integrated Gear coupling overload protection clutch

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ABSTRACT

Gear couplings are used in the industry to transmit power between two inline shafts in machinery. The gears couplings are normally standard elements with two gear elements and a central sleeve. Although rarely occurring overloads must be considered during the design process of a power train. These overloads can be evoked by malfunctions in the transmission and installation control, by obstructions in the work flow, by misoperation etc. These overloads may create pre-damages which lead to full failure of the assembly or its components. Such affecting loads are avoidable by means of overload clutches. Thus reliable overload clutches are of strongly increasing interest for years.

Thus the combination of the gear coupling and the overload protection clutch is a desirable one and also essential. It is found that no such integral devices are available in the market and also that if these two elements if installed separated will increase the space required and also cost will increase.

The paper aims at the design development analysis of the FDM printed integrated gear coupling with overload protection clutch . The components have being designed using Unigraphix Nx and the analysis of the components is done using ANSYS work bench.

Key words : *Gear coupling , Overload protection clutch , FDM*

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1. Introduction

Gear couplings like all other shaft coupling devices perform the basic functions of connecting two shafts to transmit torque and compensate for misalignment. Gear couplings though are the king of the coupling types. While each type of coupling has its own niche, gear couplings are more power intensive, have more modifications, and a wider size, torque, and bore range than all the others. Gear couplings can also perform at extremely high rates of speed. As inferred by the name, gear couplings use the meshing of gear teeth to transmit the torque and to provide for misalignment.

Gear couplings are made up of hubs which attach to the machinery shafts, and sleeves that span the gap from one hub to the next. Sometimes the sleeve is one piece as in the Sier-Bath &HercuFlex continuous sleeve couplings and sometimes each hub has its own sleeve which in turn bolts to the other half or other side of the coupling. The gear teeth are found on both the hub and the sleeve of the flexible unit.

Overload clutches

Rarely occurring overloads must be considered during the design process of a power train. These overloads can be evoked by malfunctions in the electronics of inverter and installation control, by obstructions in the work flow, by misoperation etc. These overloads may create pre-damages which lead to full failure of the assembly or its components. Such affecting loads are avoidable by means of overload clutches. Thus reliable overload clutches are of strongly increasing interest for years.

Fig. Overload clutch, control element: ball

2. Literature review :

Guy James Burlington, et.al.[1] have done invention related to clutch mechanism, such as that employed in conjunction with the drive of agitator of a vacuum cleaner. Vacuum cleaners typically comprise a downwardly direction dirty air inlet arranged in the cleaner head or a floor tool through which dirty air is sucked, by means of a motor driven fan, into dirt and dust separation apparatus. An agitator, such as a brush bar, may be arranged in the mouth of the dirty air inlet so as to agitate the fibers of a carpet over which the vacuum cleaner is passed. A problem which may encounter with vacuum cleaners having an agitator is that, on occasion, the agitator may become jammed by becoming entangled with objects on the floor surface. Where the agitator is driven by vacuum motor sensing of such overload condition is more difficult. Thus actuator may be arranged to interrupt torque when the relative speed rise above predetermined value.

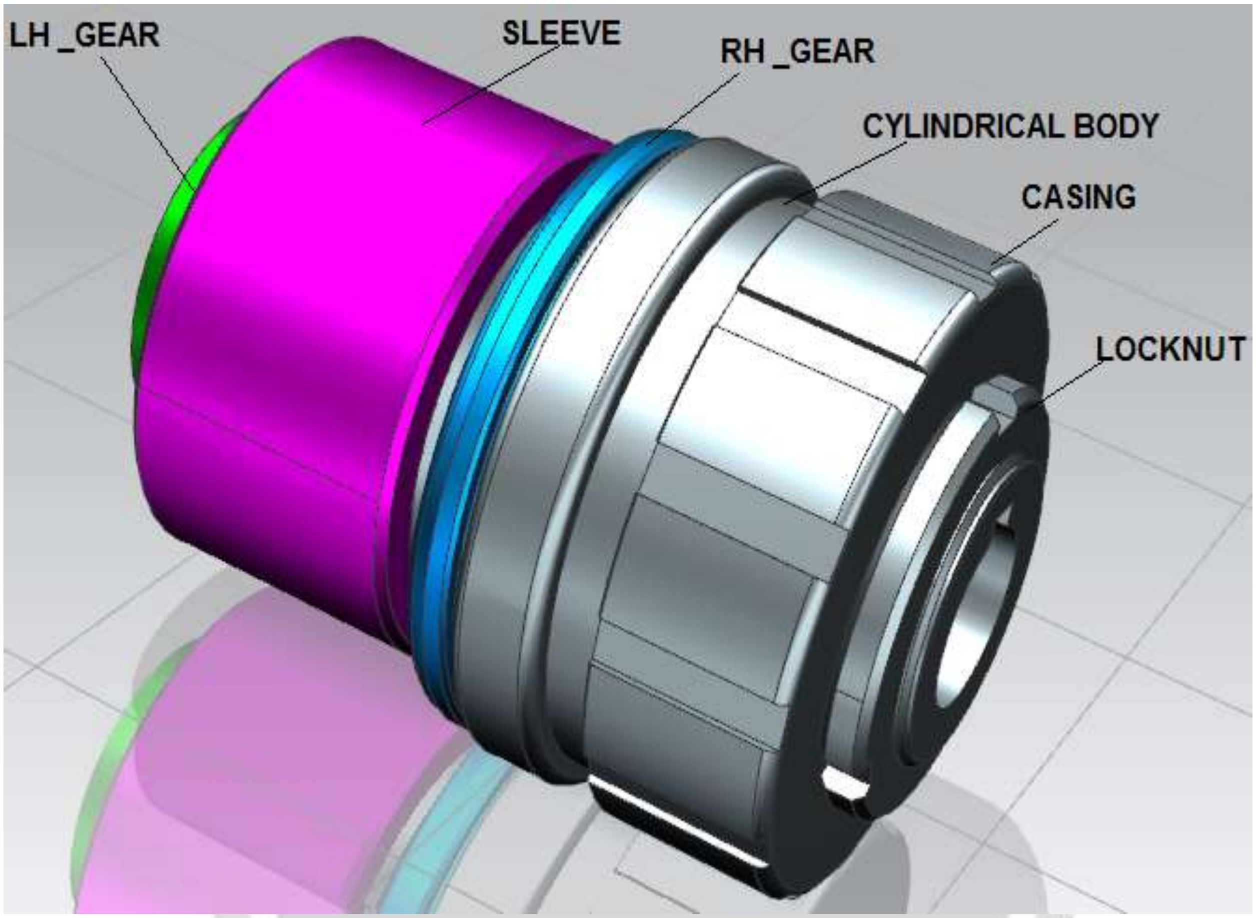
2. **Charles W. Yeiser, et.al.[2]** have work done the torsional design and analysis process associated with revamping a 7000 hp synchronous motor-driven compressor train with a 8000 hp synchronous motor driver. The paper details multiple issues associated with revamping the compressor drive train, including the selection of the replacement driver and low-speed coupling assembly, torsional vibration analysis, and the mechanical operation of the controlled slip clutch mechanism. The main objective in revamping the compressor trains was to extend the life of the plant while being able to operate at substantially higher than design production. The second objective was to reduce the amount of electrical power consumed per unit volume of product produced. The third objective was to reduce the amount of projected maintenance for the compressor train. The fourth objective was to minimize the amount of modification required to install the new motors. The fifth objective was to design the revamped compressor train for 5000 starts. The final objective was to minimize the risk of the revamp. The first three objectives were achieved by using a higher horse power solid pole rotor synchronous motor whose design was optimized for this application. The fourth objective was achieved by having the motor frame designed to fit the existing sole plate sand duplicating all-important dimensions of the original motor. The fifth and final objective was achieved by using the controlled slip clutch coupling. Accordingly, the revamp met the objectives and is considered a success.

3. NicolaeEftimie[3] has discussed that by taking into considerations both the proposed kinematic and dynamic modeling, and the numerical simulations presented, & concluded that the most important parameters, which influence in a major manner the safety clutches working are; the ratio between the inertia moments at the driven and driving parts, the spring's type and consequently their rigidity and the pretension springs force. The proper adjustment of the inertia moment to the driven part of the clutch to the possibility of taking over the medium value shocks. This situation is necessary in case of the clutch assembling in the frame of the striking machines transmissions. Finally, it must be remarked the fact, the proposed computer simulations were made with a view of the main characteristics identification of the safety clutches with implications in kinematic optimization and more, their dynamic optimization.

2.1 Literature Gap

After careful review of the literature on the overload protection clutches it is clear thatthe combination of the gear coupling and the overload protection clutch is a desirable one and also essential. It is found that no such integral devices are available in the market and also that if these two elements if installed separated will increase the space required and also cost will increase

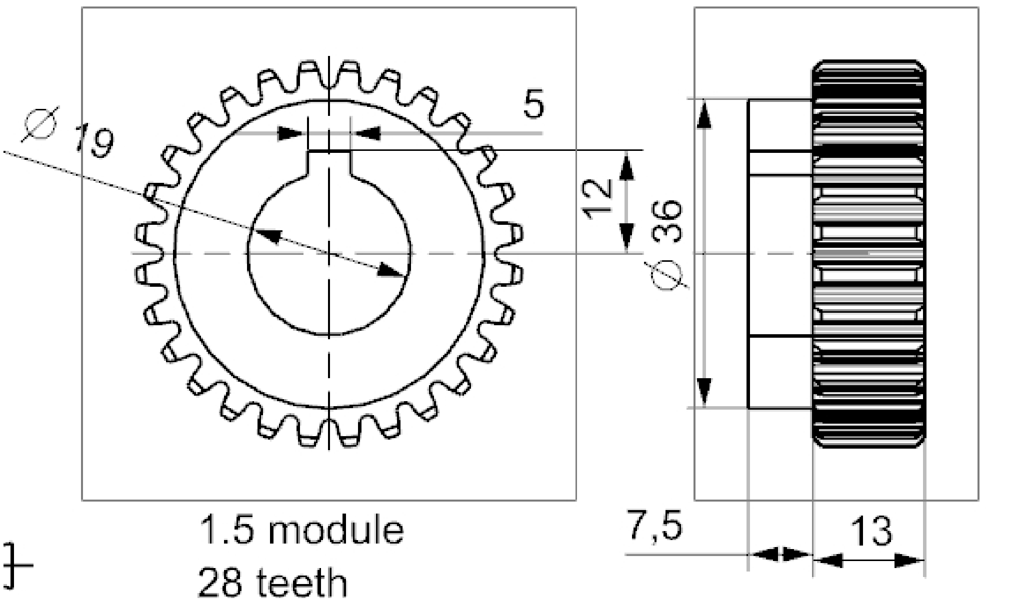
3. Proposal of FDM printed gear coupling with overload protection



The parts of the Gear coupling and overload protection clutch are shown above
The main parts are as follows :

1. LH Gear :
2. RH_Gear integral with the Base flange
3. Cylindrical body
4. Casing
5. Locknut
6. Plunger
7. Spring
8. Ball
9. Locknut

DESIGN AND NALYSIS OF INPUT SIDE LEFT HAND GEAR :



MATERIAL SELECTION : -Ref :- PSG (1.10 & 1.12) + (1.17)

DESIGNATION	ULTIMATE TENSILE STRENGTH N/mm^2	YEILD STRENGTH N/mm^2
Abs polymer	60	42

⇒ fs allowable = 60/2 = 30 N/mm^2

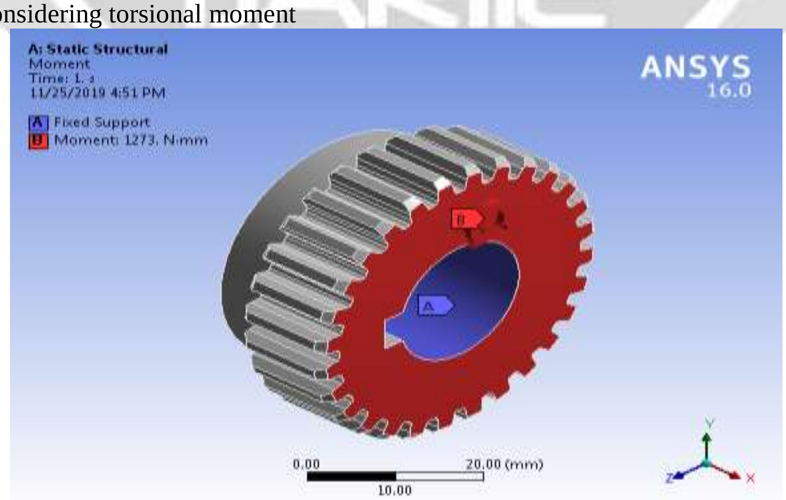
⇒ T design =1.273 Nm

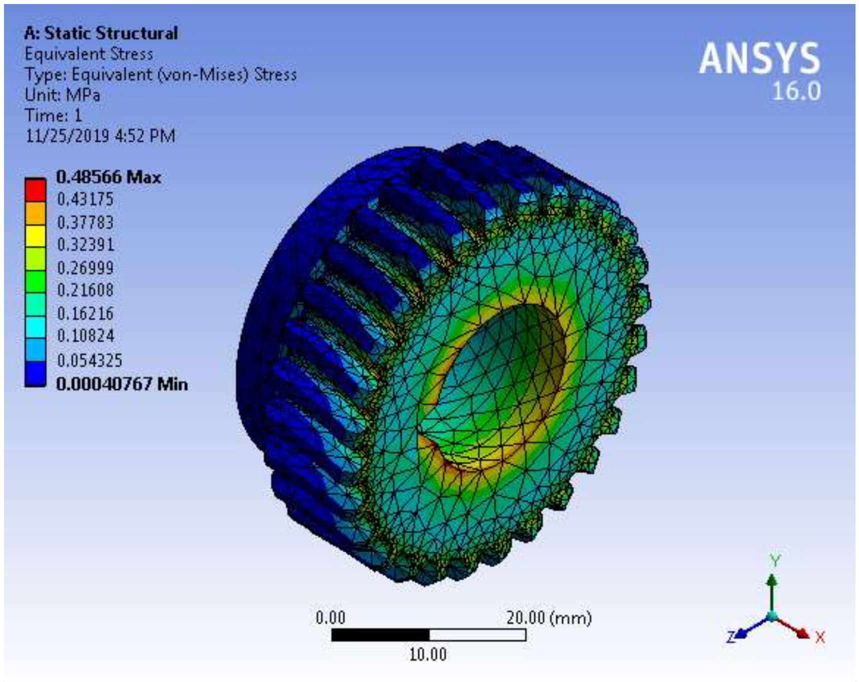
⇒ fs_{act} = 0.15 N/mm^2

As $fs_{act} < fs_{all}$

⇒ Gear is safe under torsional load.

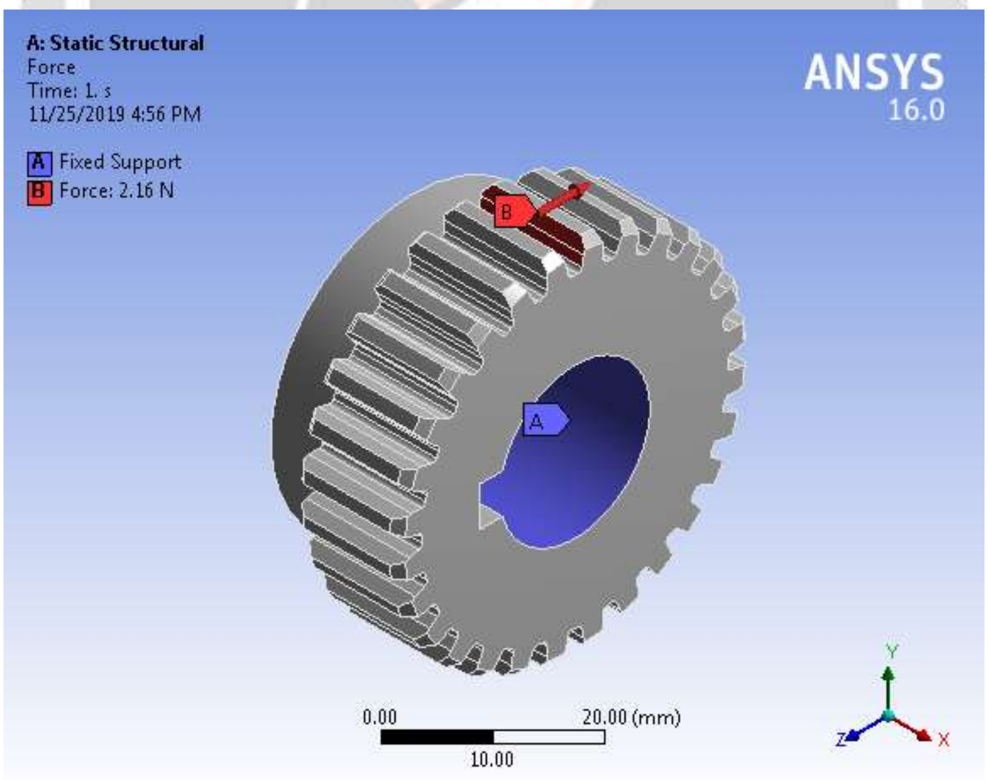
Analysis of the gear considering torsional moment

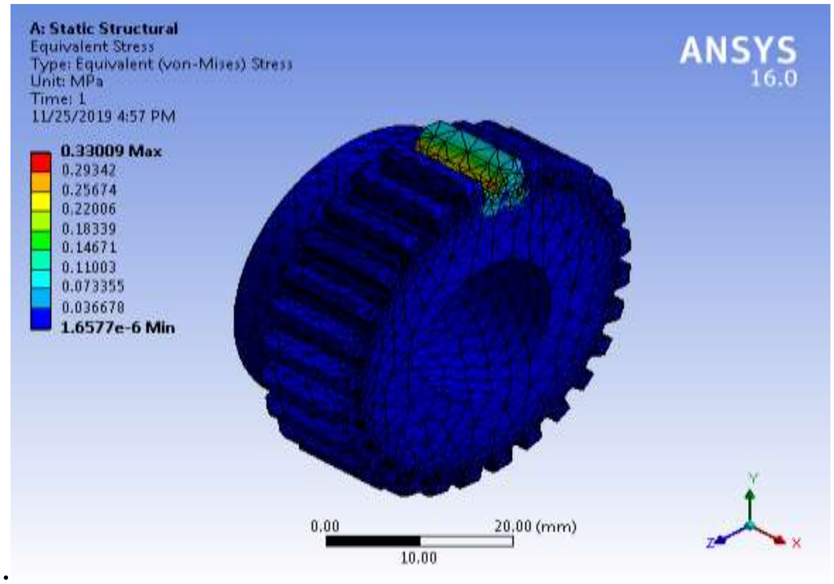




The maximum Von-misses stresses in the part are 0.485 MPa which is far below the allowable value 32 MPa hence the part is safe under given loading conditions.

Design Analysis of Gear considering tangential tooth load





Von-mises Stresses :

The maximum Von-misses stresses in the part are 0.309 MPa which is far below the allowable value 32 MPa

4. CONCLUSIONS

After careful review of the literature on the overload protection clutches it is clear that the combination of the gear coupling and the overload protection clutch is a desirable one and also essential. It is found that no such integral devices are available in the market and also that if these two elements if installed separated will increase the space required and also cost will increase Design of analysis of the LH _gear showed that the part is safe both by theoretical method and also by ansys analysis.

5. ACKNOWLEDGEMENT

In the due course of project with the valuable guidance of Guide. Dr. R. R. Arakerimath. the papert was completed as per schedule and desirable results were achieved.

6. REFERENCES

1.Guy James Burlington, Martin David Townsend, “Clutch Mechanism”,United States Patent 2005
. 2. Charles W. Yeiser, Volker Hütten, AkramAyoub&Robert Rheinboldt, “Revamping A Gas Compressor Drive Train From 7000 To 8000 Hp With A New Synchronous Motor Drive And A Controlled Slip Clutch Mechanism”,Proceedings Of The Thirty-Fifth Turbomachinery Symposium 2006.
3. NicolaeEftimie, “Dynamic Simulation Of The Safety Clutches With Balls”, Transilvania University of Brasov Faculty of Technological Engineering Romania 2007.
4. Duane W. Woltjen, “Torque Limiting Overload Coupling”, United States Patent 1977.
5. Donald. Miller, Horseheads. N. Y, “Electric Overload Clutch”,United States Patent 1971.
6. Thomas C. Kilwin, “Torque Limiting Clutch”, United States patent 1988.