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Design of chain tensioner for FSAE car

Ashish V. Dewade[1], Mayuresh S. Joshi[2], Shubham R. Agarwal[3], Mohit D. Agrawal[4], Mrs. J. P. Wagh[5]

[1-4]B.E. Mechanical, PCCOE, Pune, Maharashtra, India
[5]Professor, Dept. of Mechanical, PCCOE, Pune, Maharashtra, India

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Abstract - *The purpose of this paper was to design the 2017 combustion car differential mount for Team Kratos racing. The goal of this paper was to improve upon the 2016 differential mount design by reducing complexity, weight, and maintenance time. To reduce complexity the differential mount are placed on engine mount which reduces the alignment problem. These changes were able to reduce weight and the complexity of machining by making the designs simpler. The differential mount had its complexity reduced by moving to a eccentric chain tensioning design. This was chosen because it reduced the time to adjust the chain and reduced the overall part count of the system.*

Key Words**:** Chain Tensioning, Differential, Differential mount , Eccentric, Alignment

1. INTRODUCTION

The entire FSAE car is designed around the engine. This allows us to take advantage of the strength of the engine while minimizing structural components in the frame. Despite the obvious benefits of direct engine mounting, this scheme is uncommon for FSAE teams. There are many factors outside of the load path that contribute to the mounting position. The choice of a different style differential, the chain tensioning method, interferences caused by the sprocket and chain and the manufacturing capabilities of the students and the school all play a role in the final decision. There is no specification for chain tension on a project like this FSAE (custom race) car and while trying to also align the differential this made determining when they were finished hard. With an easy method to measure position or a discrete number of locations this problem would be eliminated.. Because of this fact, four designs were developed that deal with properly aligning and tensioning the chain and are detailed below.

2. SELECTION OF TYPE OF CHAIN TENSIONER

2.1 Rigid Differential Mount

The rigid differential mount has no moving components used to tension the chain. This arrangement provides a very robust and simple means to hold the differential in position relative to the drive sprocket, but relies on an accurately sized chain that can be difficult to attach. This is not possible because accurate manufacturing is not achievable at all at student level.

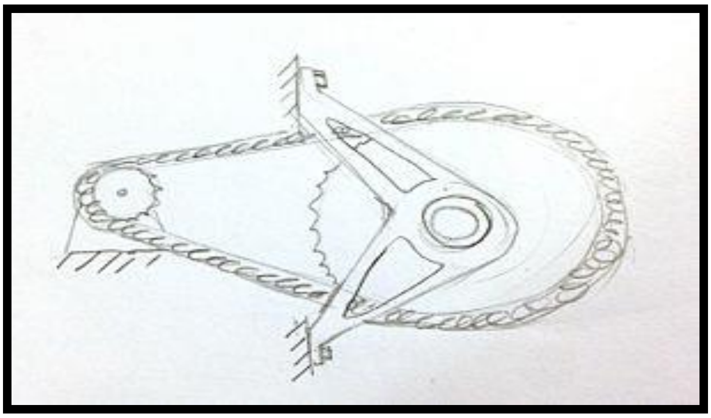

Fig -1: Rigid differential mount

2.2 Spring Tensioner

Taken from many industry chain drives, the mechanism utilizes a fixed differential and takes up slack in the chain with a spring loaded idler gear. The tensioning mechanism is of the drive sprocket and differential so can be attached in a variety of convenient locations within the rear box of the vehicle. The spring mechanism can be adjustable to provide a post-installation determine preload. This tensioner is used in first car. This is simple way if your design does not allow chain tensioning. But mounting of this spring tensioner must be rigid to reduce loosening effect.

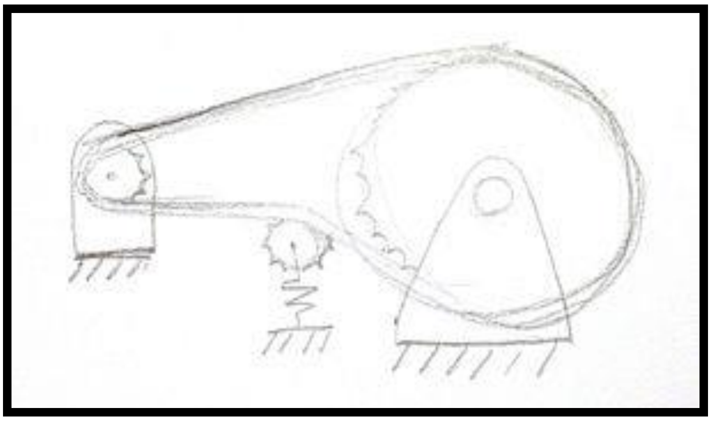

Fig -2: Spring Tensioner

2.3 Indexable Pivot Tensioner

The mechanism, pictured below, works to tension the chain by pivoting the differential mounting plate about a pin above the axle axis. A turnbuckle is attached to the point below the axle axis and is twisted to shorten the distance between the lower pin on the differential plate and the rear chassis tube, swinging the differential and sprocket further from the engine thus tensioning the chain. In order to ensure alignment from side to side, features on the chassis and on the swinging differential plate to use as an index. This mechanism is used in our second car. The problem with this is tensioning is equal to pitch of cone.

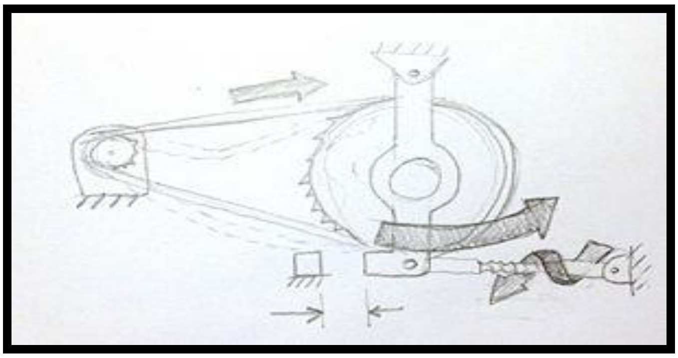

Fig -3: Indexable Pivot Tensioner

2.4 Eccentric Chain Tensioner

The mechanism has a pair of symmetrical plates with an outer frame and inner eccentric plate. The first component is the horizontal frame which has features on the top and bottom suitable for mounting to a forward chassis tube. The A frame is also bored out for the inner eccentric mount. The final feature is a split at the tip of the 'A' that allows a bolt to pass through and apply a clamping pressure on the inner eccentric mount when tightened. Before that bolt is tightened and the clamping force applied, the inner eccentric mount is free to rotate, providing fore-aft translation of the differential and sprocket, allowing slack to be removed from the chain. Alignment is preserved throughout the rotation, once initially installed.

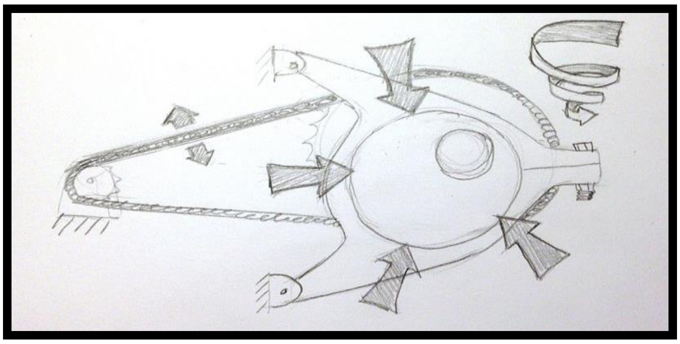

Fig -4: Eccentric Chain Tensioner

3. PUGH CHART

The Pugh chart below compares the design with 4 alternatives: hard mounted differential (not adjustable), spring pretentioner systems, Indexable pivot pre-tensioner, and eccentric clamp pressure. Based on needs, our most important criteria included minimized weight, easy manufacturability, and adjustability, ease of use, robustness, adaptability, compatibility, and minimized cost. Weight must be minimized for increased speed, and the design must be robust so that the car is reliable. It should be easy to use so that even less experienced participants can have proper chain tension, and low cost for teams with tight budgets. Adjustability is important so that it can be used on various chassis with different mounting. The design also needs to be compatible with various differentials so that it can appeal to a wider range of consumers.

While the weighting was subjective, we attempted to weight the categories to best match the needs described by experts. Weight and robustness were most important. Most of our designer would not bother about a design that is heavy because it is more advantageous to risk a slightly loose chain and decrease weight of the vehicle. The design also must be robust because if it fails, the car can lose traction, which slows it down and negatively affects handling. Manufacturability was not weighted quite as important because it would be fairly low-volume. Ease of use was also important enough to get weighted as a '2' because it needs to be usable by less experienced people and difficult adjustment is the main issue encountered by team mates. Adaptability, adjustability, and compatibility got weighted the lowest, with cost, simply because designers prioritized the other factors; however, they should still be considered because scoring well in these categories can make a design desirable to more consumers. The first alternative, a hard mounted differential got the baseline score of '0' for all criteria. Reason is points for weight and cost because it does not add any weight, materials, or processes. It is about as easy to use and manufacture but it would needed improvements in adaptability, and compatibility. It does, however, lose several points because it is not adjustable.

Table -1: Pugh's matrix

Description	Hard mounted differential	Spring pre - tensioner	Indexable pivot pre-tensioner	Eccentric tensioner
Weight	0	-1	-1	-1
Number of components	0	-1	-1	-2
Manufacturability	0	0	0	0

Adjustability	0	1	1	2
Ease of use	0	1	1	2
Robustness	0	-1	0	0
Adaptability	0	1	1	2
Compatibility	0	1	1	1
Cost	0	-1	-1	-2
Total	0	0	1	2

Overall, the eccentric design got the highest score, but it was surprisingly close to the Indexable pivot pre- tensioner option.

4. DESIGN

While starting the design of eccentric chain tensioner the first consideration is bearing outer diameter .For left mount outer diameter is 85mm and right mount diameter is 68 mm. Bearing selection is done by standard calculation method considering how much force is transferring through these mounts. This diameter is directly taken from bearing catalogue. The left bearing outer diameter is greater than right because the sprocket is on outer left side of left mount. The another reason is differential should mount only to the engine to achieve a modular design.

The forces are applied based on our calculations.

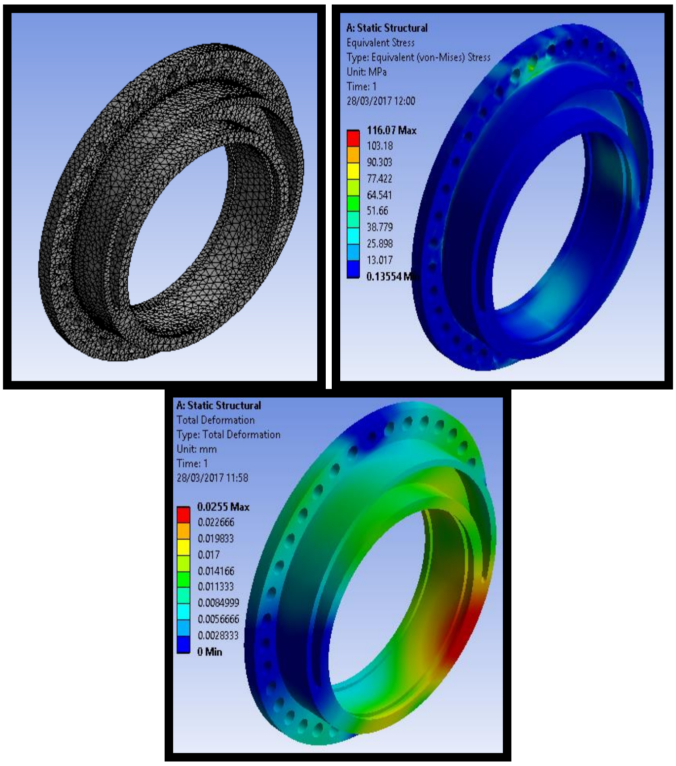

Fig -5: Eccentric hub FEA

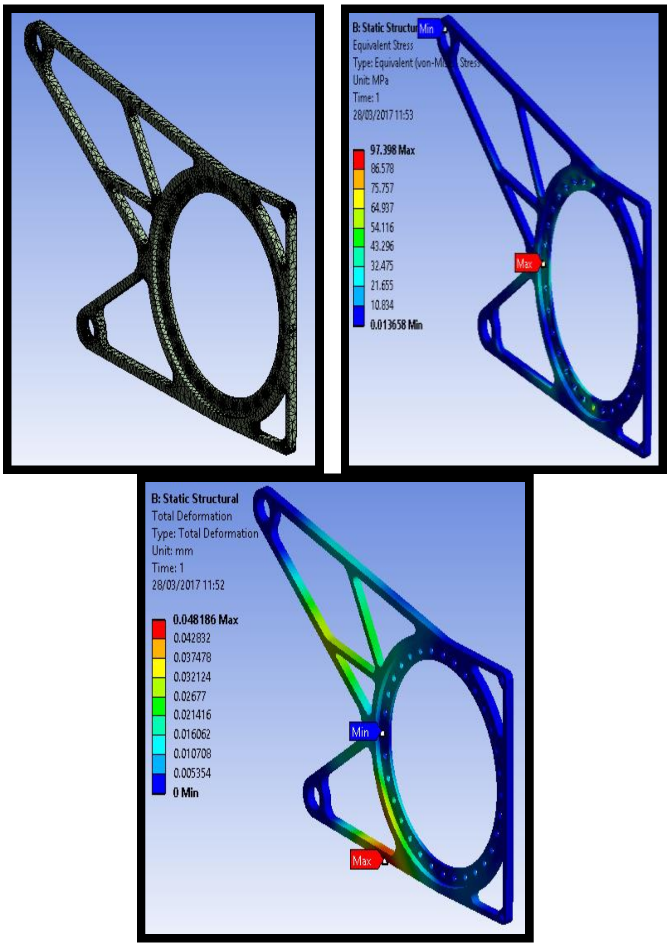

Fig -6: Differential mount FEA

Table -2: FEA result

Description	Maximum Stress(MPa)	Maximum Deformation(mm)	Meshing
Eccentric hub	116	0.025	Triangular
Differential mount	97	0.048	Triangular

Maximum stress is within permissible limit. Our design is safe.

There are 36 holes on eccentric hub and 32 holes on differential mount. We are using 4 bolts of M8 size. At any time of rotation the 4 holes of hub matches with differential. The arrangement is such that it give total tensioning of 16 mm. The table of tensioning is given below.

5. CONCLUSIONS

Based on our Pugh chart, it is most favorable to pursue the eccentric chain tensioner. This design is not only robust but allows for the highest level of adjustability. Though the manufacturing is challenging, it allows for the best possible chain tensioning and differential aligning experience. It will be a challenge to adapt it to other applications with different size differentials since the split-hub friction force is highly dependent on tolerance, but the challenges are far outweighed by the benefits it offers. This design is very closely followed by hard mounting the differential, a solution that assumes that the chain does not lose its integrity over time, which may or may not be the case depending on how long the car is expected to last and also by mounting the differential brackets directly to the engine, we take advantage of the many benefits provided by a direct load path.

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REFERENCES

1. Tom Bakker," Design of a drive train for a FS race car", March 2009, 0578475, Technische Universities Eindhoven Department Mechanical Engineering, DCT Group, Eindhoven.
2. Justin Lebowsky," Drive train Design for the 2016 Global Formula Racing Combustion Car", Presented June 1, 2016, Oregon State University.
3. Tony Scelfo," Lightweight Torsen Style Limited Slip Differential and Rear Driveline Package for Formula SAE", JUNE 2006, MASSACHUSETTS INSTITUTE OF TECHNOLOGY.
4. Seiji SATO," Technology Trends in Auto Tensioner", Automotive Business HQ, Axle Unit Engineering Dept.
5. Michael Honeychuck, William Jay Kistler, Nick Piacente, Adam Stager," Powertrain and drive line", December 13th 2010.

BIOGRAPHIES

Ashish Vyankat Dewade
B.E. Mechanical
PCCOE, Pune,
Maharashtra,
India

Mayuresh Shirish Joshi
B.E. Mechanical
PCCOE, Pune,
Maharashtra,
India

Shubham Ravikant Agarwal
B.E. Mechanical
PCCOE, Pune,
Maharashtra,
India

Mohit Daudayal Agrawal
B.E. Mechanical
PCCOE, Pune,
Maharashtra,
India

Mrs. J. P. Wagh
Professor,
Dept. of Mechanical,
PCCOE, Pune,
Maharashtra,
India