Design and Development of Knuckle joint for Go-Kart

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Abstract

The main objective of the steering system is to provide directional stability to the vehicle. The main consideration in design for the steering system is producing pure rolling motion of the wheels while maneuvering the tightest turns on the road tracks .The driver should be able to turn vehicle with minimum eﬀort applied. The steering system is designed in a unique way taking into consideration the various effforts and the precise mathematical formulae. All of the Go-Karts use a knuckle as a major part of their steering systems, its controls the efforts applied as well as the turning capacities. We are proposing the modification in the materials used which will increase the strength of the knuckle. The recent technologies developed helps in reducing the stress and strains without affecting the physical properties. In the present work we have used ANSYS Software for analysis of knuckle joint with various materials and varying loads. Steering knuckle plays a major role in a vehicle linking the steering system, wheel hub and brakes to the vehicle body. During the dynamic conditions it undergoes varying loads under different conditions, not aﬀecting the steering performance and other vehicle performances. The results are validated in the ANSYS software then the results obtained are compared with the experimental analysis and validated.

Keywords—knuckle joint, SolidWorks, Ansys, Go-kart

I. INTRODUCTION

The steering mechanism is a vital a part of the dynamic design of any automobile to facilitate a smooth change of directions and make use of the tires ability to get lateral forces to the very best extent. The control of a GoKart is completed by means of mechanisms like tie rods, steering column and knuckle. The knuckle is a vital component in a GoKart because it steers and keeps the vehicle stable at high speeds. The knuckle together with tie rods converts the force applied at the wheel into rotation motion, helping the vehicle to turn. Failure of this component may cause fatal casualties. Therefore it's important that the knuckle must be designed in such the way that it shouldn't fail under extreme conditions, have high FOS, high strength and ruggedness and lightweight weight. In our Project the knuckle we built was to maximise the efficient use of space, weight and the safety of the driver. We approached our design by considering all the possible factors and modelling them in SolidWorks software and so doing the analysis on the ANSYS software. Then supporting the results, the model was redesigned, tested and finalised. Knuckles are made of Bright MS. With the

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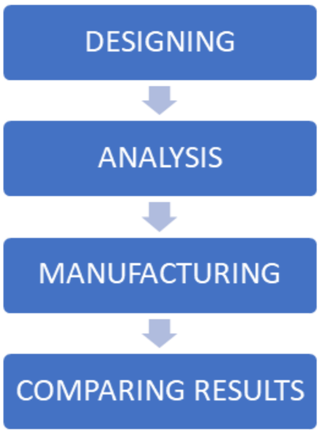
advancements within the field of polymers and Alloys, Teflon and stainless-steel are often used for knuckles. The results obtained after the analysis shows that such materials are often employed in the manufacture of knuckles. Because the steering knuckle is a vital part within the mechanism of a GoKart plenty of attention and importance should tend to that. It should be strong enough to face up to one applied force. Hence we've got tested the Knuckle on the Universal Testing Machine and therefore the obtained results are verified and compared to the virtual results and so the knuckle is manufactured. With this we had a view of our Knuckle. This started a our goal and that we founded our parameters for our work and distributed ourselves the technical designs of our project.



II. LITERATURE REVIEW

AUTHOR'S: Anjul Chauhan, Lalit Nagar and Sparsh Chawla
The objective of steering mechanism is to supply directional stability to the vehicle. The most consideration in design of the mechanism is to supply pure rolling motion of the wheels while manoeuvring the tightest Dirt road tracks. The mechanism must also provide adequate feel to the driving force while turning. For optimum lifetime of the tires the mechanism is intended specified it maintains proper angles between the tires while turning and while braking in corner together with straight ahead position. The driving force should be able to turn vehicle with minimum eff ort but it mustn't be directionally unstable. The mechanism is thus designed in an exceedingly very unique way by compelling many factors and formulating mathematic model. Outer vs inner wheel angle of ackermann conditions were studied. Various runs were performed and accordingly the geometry was finalised. Also length of knuckle joint was finalised considering steering eff ort.

AUTHOR'S: Nishant saxena and Dr. Rohit Rajvaidya
In this research paper it had been studied that the ascent of technology in recent decades has led to the reduction of cost and weight of materials. The modified system has become popular in industry similarly as in research. As a result, this there are reductions in accidents and safety has increased. Many systems employed in industries use knuckle joint which could be a combination of two materials: forged iron and chrome steel. Here we are proposing the modification of one of the material that's changing forged iron into composite material. The proposed system making the device is simpler and is having maximum safety and is ecofriendly. A knuckle joint is employed to attach two rods which are under the action of tensile loads whereas, if the joint is guided , compressive load is also supported by rods. Knuckle joints are made of forged iron and chrome steel.

With the advancements within the field of polymers, Teflon will be used for knuckle joint. The results obtained from simulation proves that for same loads, total deformation, stress and strain are much less compared to cast iron. Parts made out of composite materials are economical to provide, facilitate overall systems cost reductions by eliminating secondary operations for parts, like machining, similarly as facilitating reduction partially count in comparison with metal parts. A specific component was tested/ analysed using two different materials. Comparison between these two materials analysis was done and it had been observed that components showed better results for Teflon.

AUTHOR'S: Raut Nikhil and Dharashivkar N.S

In this research paper analysis and testing for steering knuckle which is one among the critical components of a 4 wheel vehicle was studied. It links suspension, wheel hub and brakes to the vehicle chassis. During the motion of the vehicle the steering knuckle undergoes varying load under different conditions, but it doesn't affect the steering performance and other desired vehicle characteristics. The Steering knuckle includes a strut mount at the highest, ball joint at the underside, and a steering arm on the side. The wheel spindle fits through a hole within the center. Each circumstances of the road give the different impact to the steering knuckle. Failures, or fractures, occur when cracks get so large that remaining material can now not endure stresses and strains. In classic structural analyses, failure predictions are based solely on material strength or yield strength. Durability analysis goes beyond this, evaluating failure supported repeated simple or complex loading. The idea that loads tug in one direction may be a simplification that works well, to a point. Within the universe, however, loads are simultaneously applied in several directions, producing stresses with no bias to a selected direction. The INSTRON UTM 5538 capacity of 100 KN and extensometer with original gauge length 25 mm was utilized in the static test, the ability is on the market at ARAI, Pune. The actuator is automated (PLC) which was connected to the pc. The software RS console was used as an input to the actuator. The static load was applied to the component break. The test specimen was held in two clamps and pull load was applied.

III. SPECIFICATIONS AND CALCULATIONS

Specifications	Values
Ackerman angle (α)	11.38°
Inner angle(a)	39.43°
Outer angle(b)	24.53°
Actual turning radius(R)	2.396m
Actual turning radius for inner front wheel (R_{IF})	1.532m
Actual turning radius for outer front wheel (R_{OF})	2.395m
Actual turning radius for inner rear wheel (R_{IR})	1.173m
Actual turning radius for outer rear wheel (R_{OR})	2.154m
Moment ratio	1.5
Normal force on front wheel (Fv)	304.11N
Force on steering arm due to friction (F_n)	243.288N
Steering Effort (Fst)	81.096N
Total weight transfer while cornering (Δw)	136.45N

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Calculations	**Values**
Front Track Width (TW)	990.6 mm
Wheelbase (WB)	1016 mm
Total Weight (W)	155 kg
Turning Radius (R)	1.73 m
Acceleration due to gravity (g)	9.81 m/s^2
Castor angle (γ)	7°
King pin inclination	14°
Camber angle	0°
Front Tier Radius (r)	127 mm
Steering Arm length (L)	101.6 mm
Length of Tripod	101.6 mm
Coefficient of Friction static (μ)	0.8
Coefficient of Friction Dynamic (μ)	0.017
Velocity of Vehicle(v)	8.33 m/s

Table No:3.1

Table No:3.2

IV.DESIGNING AND ANALYSIS

1. Designing of knuckle on SolidWorks

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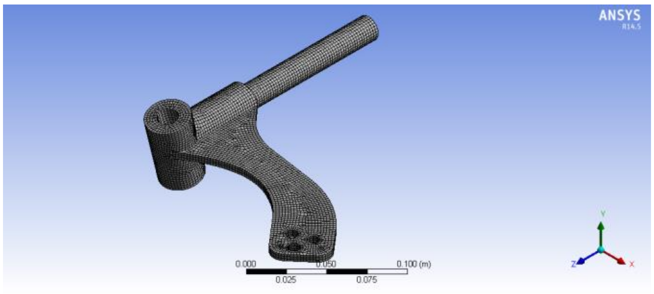
Fig No:4.1

2. Meshing of the Knuckle on Ansys



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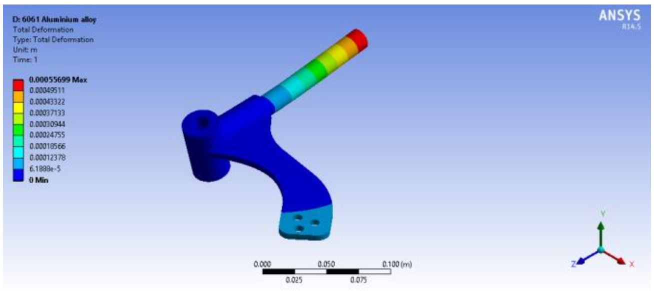
3. Analysis and Results

3.1.Aluminium 6061



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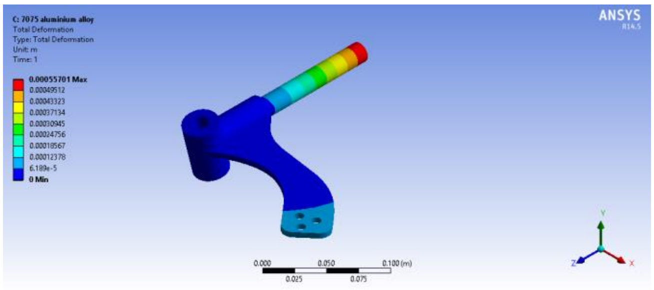
3.2. Aluminium 7075



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3.3. Mild Steel

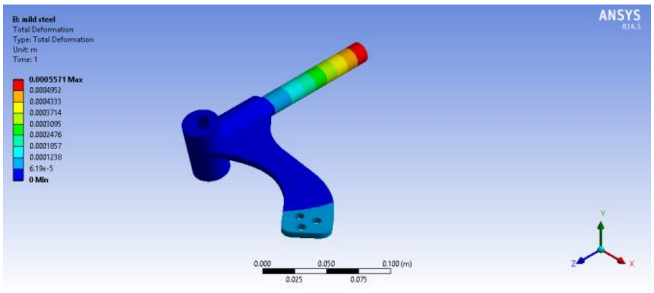

Fig No:4.5

3.4. Results

Material	**Max. Stress**	**Deformation**	**FOS**
Mild steel	196Mpa	0.557mm	1.8
Al. 6061	187Mpa	0.556mm	1.4
Al. 7075	198Mpa	0.557mm	2.5

Table No:3.1

V.CONCLUSION

From the above results we can conclude that FOS for Al. 7075 is best,selecting the best FOS from above materials, Aluminium 7075 can be used for manufacturing of the component.

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