International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.3, pp 225-228, 2017

Design of Chain Differential for a Race Car

Bridjesh P*[1], Vinayak J[2], Teja N[3] and Madhu S[4]

[1,2,3,4]Department of Mechanical Engineering, MLR Institute of Technology, Hyderabad, 500043, India.

Abstract : This present study addresses the issue of acceleration efficiency by discussing the overall design of sprocket chain open differential. A special focus on sprocket and the material employed in production of chain differential and factors that leads to sprocket failure. It is an approach to invent the effective current methodology and technologies available to enhance to the overall differential and to avoid sprocket failure due to sprocket cracking. In particular, the effectiveness of certain steel alloys in resisting creep and fracture in differential sprocket. The effectiveness of hardening in protecting the sprocket substrate from cracking when exposed to load acting on it.
Keywords: Design, Chain differential, Race car.

Introduction

The Differential is device which necessarily excludes the usage of gears and is mostly suitable for transmitting torque and turns through 3 shafts to receive one input and deliver to outputs this out puts later combine and forms the overall sum, difference, or average of the input 1 [1]. Open differential incorporates the adaptation of planetary gear set mechanism that enables to disturb torque evenly between drive axles and permit wheels to rotate and varying speeds [2]. The input shafts facilities the transmission of torque from the drive line to the rig gear outside the differential carrier. When a vehicle negotiates a straight line motion mechanism stands disengaged without any significant variation in the rotation of shafts as that of drive axles. When a vehicle is leading a turn the gear set engages followed by smashing of pinion gear that allows the drive axle to rotate at different speeds [3]. In the present work, modeling and structural analysis of chain differential is carried out.

Design and analysis of chain differential

Table 1. It illustrates the input data required for design and analysis of chain differential bearing the reduction ratio of 4:1. It reduces output speed 4 times and multiplies output torque 4 times.

Table 1. Description and specifications of differential.

S. No	Description	Specification
1	Laden weight distribution	290kg
2	Wheel tread (Min-Max)	1250-1275(mm)
3	Max. load (Breakout)	400kg
4	Engine power /Engine speed	26.15BHP/10500 rpm
5	Engine max.torque/Engine speed	22.9 Nm / 9000 rpm
6	Tyredata index radius	0.25m

7	Front axle specification bevel set ratio	1:1
8	Final drive ratio(Differetial)	3.9:1
9	Total ratio	36.03

Design parameters of cad model for differential parts

Input Parameters

Input power - 19.48 kW
Input speed - 900 rpm
Input torque - 22.19Nm

Reduction ratio - 4:1

Design of inner bevel set

Constraints for Inner Bevel Set Miter Gears: Pitch geometry (D) = 41.96 mm Pitch cone Angle (φ) = 45° Back cone Angle (β) = 45° Pressure Angle (ψ) = 20° Module (m) = 1.5mm Velocity Ratio (G) = 1 (1:1)

- Calculate Diametric Pitch (P)
  P = N/D = Number of Teeth/Pitch Diameter
  Chosen N & D = 22/40 = 0.55
  P = 0.55
- Calculate Pitch Diameter (D, d)
  D = n/P
  D = 22/0.55 = 40
- Calculate Pitch Angle
  Lp = tan -1 (Np/Ng)
  Lp = tan -1 (22/22) = 45
- Calculate Addendum (a)
  a = 1/P = 1/0.55 = 1.818
- Calculate Whole Depth (ht)
  ht = (2.188/P) + 0.002
  ht = (2.188/0.55) + 0.002 = 3.980
- Calculate Dedendum (b)
  b = ht – a
  b = 3.980 – 1.818 = 2.162
- Base Circle Diameter (Db)
  Db = D*cos(20)
  Db = 40*cos(20) = 37.5877
- Root Diameter
  Dr = D - 2b
  Dr = 40 – 2(2.162) = 35.676
- Outside Diameter
  DO = D + 2a = 40 + 2(1.818) = 43.636

Modelling

After developing a theoretical model of gear & pinion with help of provided data it is mediatory perform analysis of any component to obtain a solid model of the design crown gear & pinion [4]. Therefore we constructed crown gear & pinion in solid works. We carried out analysis of gear tooth in ansys by importing IGES file. Modeling being the firestone followed by geometric clean up, element property definition and meshing. Furthermore solutions embedded by boundary conations and applying loads on the model runs the solution the Process end with post processing that include analyzing the result plotting different parameters like Stress, Strain [5,6].

4. Finite element analysis and results

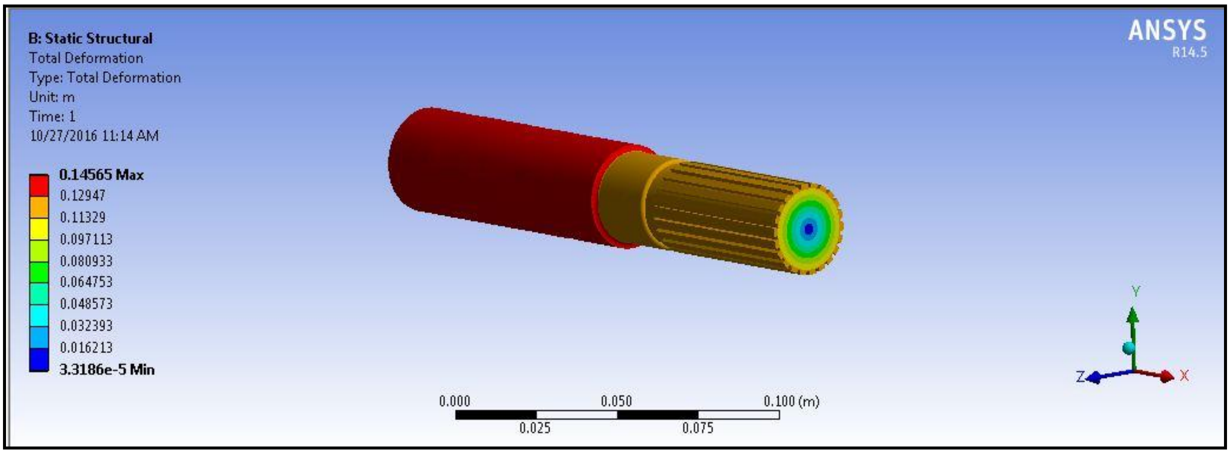

Figure 1. Finite element analysis of differential sub axle

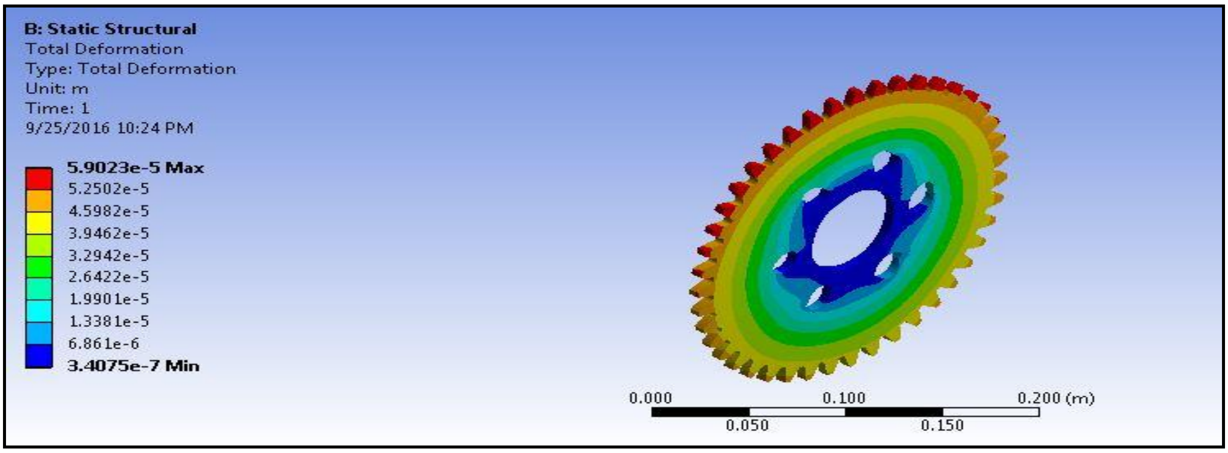

Figure 2. Finite element analysis of sprocket

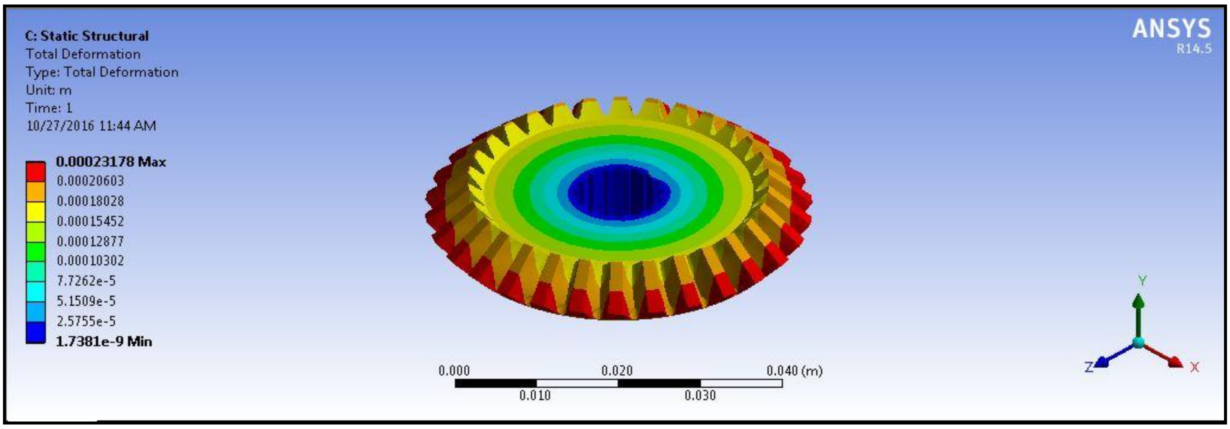

Figure 3. Finite element analysis of involute bevel gear

Conclusion

In the present work, design and analysis of differential for Race Car is presented. Different materials Aluminum Alloy, Plain carbon steel, and Grey Cast Iron. Structural analysis were hence carried out to identify the suitable material considering stress, displacement, weight etc., Observation stated that structural analysis using aluminum alloy surface values of stress ranging with in permissible stress value. There we conclude saying that aluminum can be used safely for differential body grey cast iron, for sprocket, steel for gears and the values were found satisfactory. So using aluminum alloy is more convenient due to its light weight which reduces almost 3 time when compare to three material when because of its less density there by mechanical efficiency.

References

1. Khurmi. R.S and Gupta. J.K., A Textbook of Machine Design, 25th Ed, S Chand publications.
2. Bhandari. V.B., Design of machine elements, 3rd Ed, Mc Graw hill publications,
3. Hosokawa.R, Stevaux. R and Martins. A, Lightweight differential, SAE Technical Paper. 2011-36-0105, 2011, doi:10.4271/2011-36-0105.
4. Derse. M and De Souza. M., An innovative lightweight differential for small and midsize cars, SAE Technical Paper. 2011-36-0078, 2011, doi:10.4271/2011-36-0078
5. Sumair. S, Siddhesh. O and Sunny. P., Design of an automotive differential with reduction ratio greater than 6, International Journal of Research in Engineering and Technology. 2014, 3(7), 72-82.
6. Design data hand book, PSG Coimbatore, kalaikathirAchchagam.

*****