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Design and Analysis of Composite Spur Gear using Al-Ti Materials

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Abstract- Gears are the easiest and most broadly utilized parts in power transmission. It is required to work machines at different burden and speed. Rigging teeth can typically come up short when the heap is expanded past a farthest point. Apart from other metallic apparatuses composite materials give much improved mechanical properties, for example, better solidarity to weight proportion, hardness and henceforth less shot of disappointment. So, in this task Aluminum Titanium is utilized in assembling gears. Composite materials can be improved in properties over steel compounds and cast iron and thus these can be utilized as a superior option for supplanting a metallic rigging. To plan the goad gear model utilizing structures programming and to examine the basic investigation for existing and composite materials. At last, looking at the outcomes for investigation and test trial of the composite apparatus with existing rigging.
Keyword- Gear, Aluminum, Titanium, Composite, Hardness, Strength to weight ratio, Structural analysis, Experimental test.

1. Introduction

To plan the goad apparatus to ponder the weight decrease and stress appropriation for existing and composite materials. Adapting is a standout amongst the most basic segments in a mechanical power transmission framework, and in most modern turning apparatus. It is conceivable that apparatuses will prevail as the best methods for transmitting power in future machines because of their high level of unwavering quality and conservativeness. Riggings are utilized for transmitting power starting with one piece of a machine then onto the next. Riggings can increment or lessening the speed of revolution and can without much of a stretch be utilized to invert the heading of pivot. Likewise, the quick move in the business from substantial ventures, for example, shipbuilding to enterprises, for example, car assembling and office robotization devices will require a refined use of rigging innovation. A gearbox as normally utilized in the transmission framework is additionally called a speed reducer, gear head, gear reducer and so on. which comprises of a lot of apparatuses, shafts and course that are industrial facility mounted in an encased greased up lodging. Speed reducers are accessible in a wide scope of sizes, limits and speed proportions. Their main responsibility is to change over the info given by a prime mover (for the most part an electric engine) into a yield with lower speed and correspondingly higher torque.

2. Metal Matrix Composites

An aluminum-based metal network composite ought to have the high pliability and break sturdiness of the aluminum framework and the high versatile modulus of the fortifying stage. Aluminum based metal framework composites containing particulate fortifications are normally restricted to encompassing temperature applications in view of the enormous crisscross in higher temperature quality between the aluminum Another issue with aluminum-based metal grid composites is the trouble of creating a bond between the lattice and the fortifying stage. To create such a bond, usually times important to vacuum hot press the material at temperatures higher than the nascent softening temperature of the framework. It has been recommended that this method be kept away from by precisely alloying the network with the expansion of the specific fortification. This technique, alluded to as strong state holding, allows the fortifying stage to be attached to the lattice without warming the material to a temperature over the solidus

of the framework. Earlier procedures in which aluminum-based combinations and additionally metal grid composites are precisely alloyed by methods for strong state holding. The low thickness and high explicit mechanical properties of aluminum metal framework composites (MMC) make these combinations a standout amongst the most fascinating material choices for the assembling of lightweight parts for some sorts of vehicles. With wear opposition and quality equivalent to cast iron, 67% lower thickness and multiple times the warm conductivity, aluminum MMC compounds are perfect materials for the assembling of lightweight car and other business parts.

2.1 Aluminum Alloy 7075:

Aluminum is a brilliant white metal, the thirteenth component in the occasional table. One astonishing certainty about aluminum is that it's the most far reaching metal on Earth, making up over 8% of the Earth's center mass. It's likewise the third most normal compound component on our planet after oxygen and silicon. It is one of the lightest metals on the planet: it's right around multiple times lighter than iron but at the same time it's solid, incredibly adaptable and erosion safe since its surface is constantly shrouded in an amazingly slim but extremely solid layer of oxide film. 7075 Aluminum combination is an aluminum compound with zinc as the essential alloying component. It is strong with a quality equivalent to steels and has great weariness quality and better consumption resistance. It is a creation of 5.6-6.1% Zinc 2.1-2.5% Magnesium, 1.2-1.6% Copper and not exactly a half percent of Silicon, Iron, manganese, Titanium, Chromium and Other materials

Atomic Number	13
Melting Point (°C)	660.2
Boiling Point (°C)	2480
Density (g/cm^3)	2.6898
Modulus of Elasticity (GPa)	68.3
Poisons Ratio	0.34

2.2 Titanium-Grade 12:

Titanium is a synthetic component with image Ti and nuclear number 22. It is a shiny change metal with a silver shading, low thickness, and high quality. Titanium is impervious to erosion in, ocean water district, and chlorine. Titanium can be alloyed with iron, aluminum, vanadium and molybdenum among different components, to create solid, light weight composites for aviation (stream motors rockets and shuttle, military, mechanical procedures (synthetic compounds and petrochemicals, desalination plants mash, and paper). It holds a great rating for its top-notch weld ability and exceptionally solid amalgam that gives a ton of solidarity at high temperatures Its synthesis of 0.08% Carbon 0.20-0.40% Manganese 0.60-0.90% Nickel,0.30% Iron and different metals.

PROPERTY	**VALUE**
Atomic Number	22
Melting Point (°C)	1650-1670
Boiling Point (°C)	3287
Density (g/cm^3)	4.50
Modulus of Elasticity (GPa)	116

Poisons Ratio	0.34

2.3 Proposed Material-Al (90%)-Ti (10%)

S.NO	MATERIAL PROPERTIES	VALUES
1	Density (g/cm3)	3.141
2	Young's Modulus (Mpa)	72800
3	Poisson ratio	0.3

3. Gear Dimensions details

Dedendum circle diameter = 156.86mm
Dedendum = 11.57mm
Addendum = 10 mm
Module = 10 mm
Fillet radius = 3.9 mm
Thickness of the tooth = 15.71mm
Face width (b) = 54 mm
Pitch circle diameter (p.c.d) = 180 mm

3.1 Design Calculation

TORQUE (T) = 13.8kg-m@2500rpm T = 13.8 kg-m; T = 13.8*10 N-m
T = 138 N-m; T = 138000 N-mm N = 2500 rpm.

POWER (P) = 2*3.14*2500*T/60

P = 2*3.14*2500*138/60; P = 36128 Watt
Power (P) = 36.128 K Watt. Torque (T) = F*(d/2)
Where,
F-load,

d- Pitch circle diameter (z*m=180mm) T= F*(d/2) F = T/ (d/2)

F = 138000/90

Load (F) = 1533.33N

Tangential load, F =b*y*pc*σb Pc = 3.14*module

Pc = 31.4mm

Y= Lewis form factor=0.134mm b = face width = 54mm

The maximum allowable stress= 8.7413N/mm2. Ultimate tensile strength for cast steel = 540mpa

Ultimate tensile strength for composite = 52mpa

Allowable stress for cast steel = ultimate tensile strength/3 = 540/3 = 180N/mm2> 8.7413N/mm2

Allowable stress for composite = ultimate tensile strength/3 = 52/3 = 17.33N/mm2>8.7413N/mm2

So, the design is safe.

GEAR TOOTH PARAMETERS

- Pitch circle diameter (p.c.d) = z*m = 18*10 = 180mm
- Base circle diameter (Db) = D cos α = 180*cos20 = 169.145mm
- Outside circle diameter = (z+2) *m= (18+2)*10 = 200mm
- Clearance = circular pitch/20 = 31.4/20 = 1.57mm
- Dedendum = Addendum + Clearance = 10+1.57 = 11.57mm

Module = D/Z = 180/18 = 10mm

- Dedendum circle diameter = P.C.D -2*dedendum
  = 80-2*11.57= 156.86mm
- Fillet radius = Circular pitch/8 = 31.4/8 = 3.9mm
- Pitch circle diameter (Pc) = m*z = 10*18 = 180mm

Hole depth = 2.25*m = 2.25*10 = 22.5mm

- Thickness of the tooth = 1.571*10 = 15.71mm

Face width (b) = 0.3*180= 54mm

- Center distance between two gears = 180mm

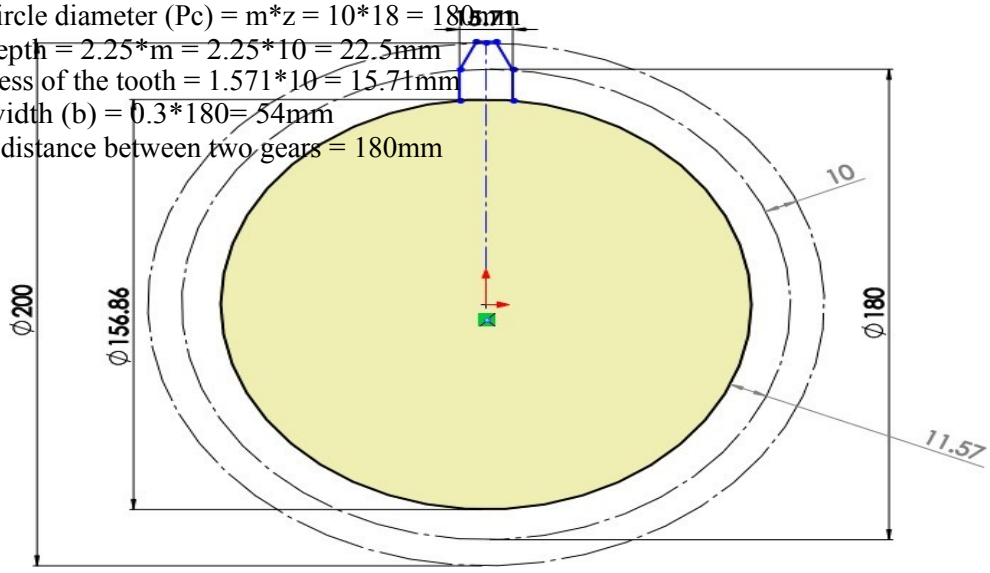

Fig.01 Gear calculation

4. Structural Analysis

A static auxiliary examination was done to break down the conduct of the structure under the relentless stacking conditions while overlooking idleness and damping impacts, for example, those conveyed by time changing burdens. A wide range of non-linearity are permitted, for example, huge disfigurements, pliancy, creep, stress solidifying, contact laments and so forth this outcome will decided if the structure will withstand for the connected outer burdens.

On the off chance that the pressure esteems acquired in this examination crosses the admissible qualities it will result in the disappointment of the structure in the static condition itself. To evade such a disappointment, this examination is vital. In this undertaking the FEA based investigation instrument were utilized to examine the auxiliary conduct of the distinctive composite material under the given limit conditions by deciding the absolute distortion.

Al (90%)-Ti (10%)-LOAD 12000N

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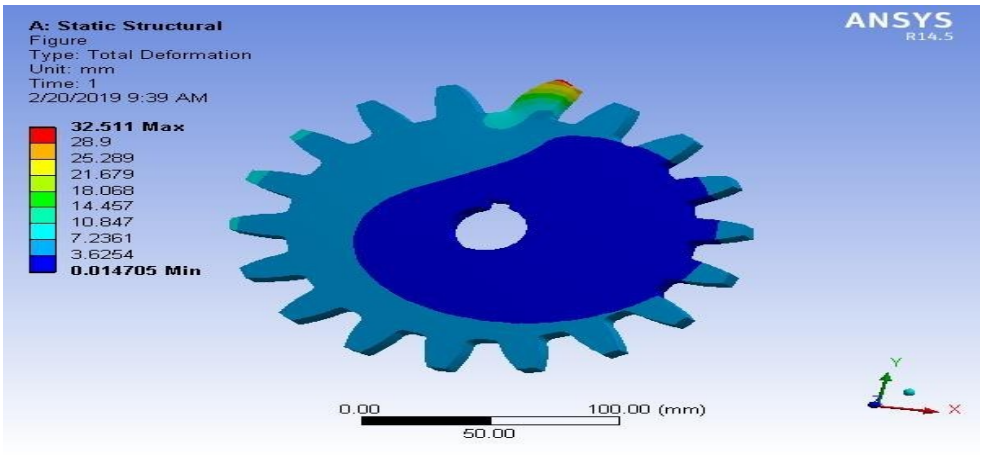

Fig.02: Deformation

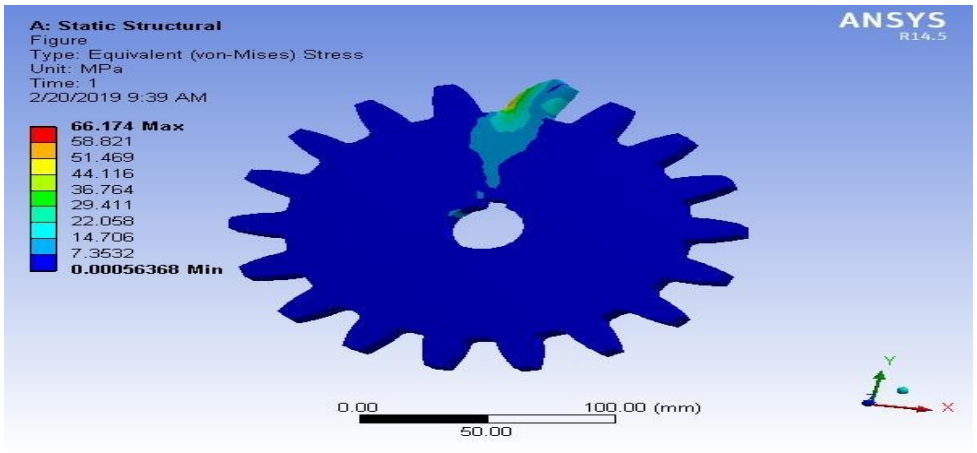

Fig.03: Stress

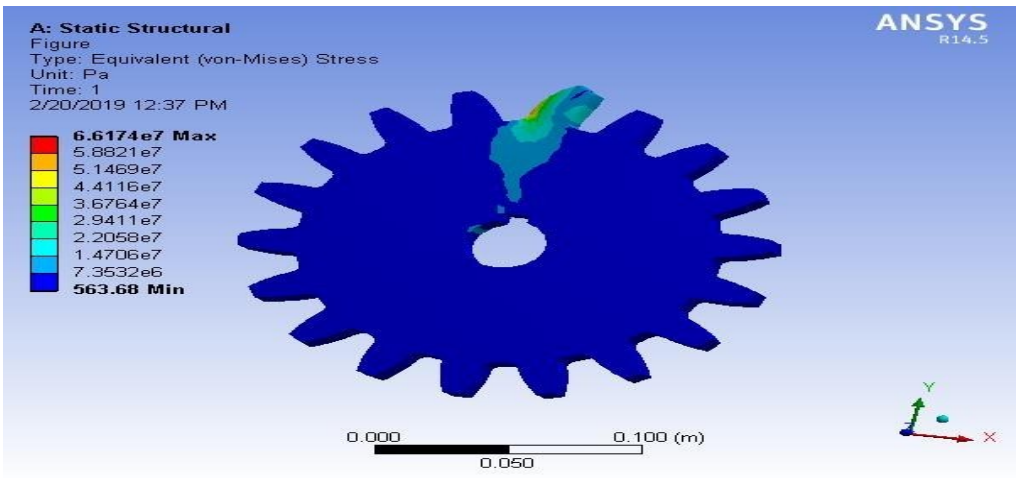

Fig.04: Deformation

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Al (90%)-Ti(10%)-LOAD 15000N

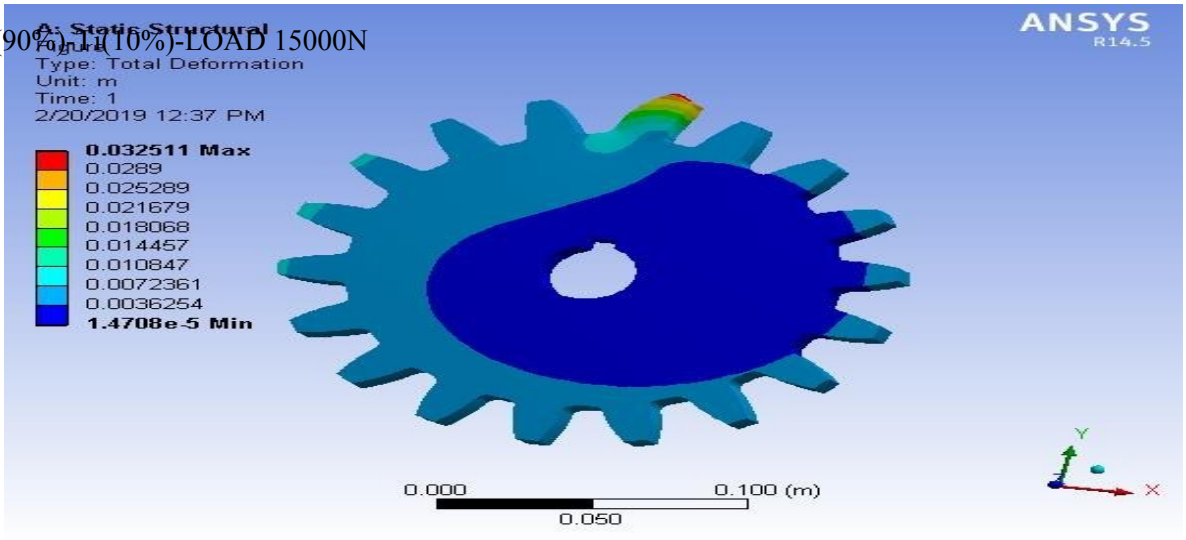

Fig.05: stress

5. Result

MATERIALS	PARAMETERS	LOAD 12000N	LOAD 15000N
Al (90%)-Ti(10%)	Deformation(mm)	32.511	0.0325
	Stress (N/mm^2)	66.174	$6.6174*10^7$

5.1. Fabrication Process Stir Casting Method

The stir casting is generally used to create the PRMMCs on the grounds that it demonstrated to be a promising for the production of close net shape composites in a basic and practical way. Right off the bat the metal network arrangement is to be included and afterward the stirrer is exchanged on. The mixing pace can be variable, the steady speed for all metal framework composite is around 600-800 m/s.The materials are included powder or particulate or thick structure. In this venture powder type of Aluminum and Titanium ingots are included. For achieving the wettability of the material borax powder is included. The measure of option is for each gram 2-3% is included. The Aluminum and Titanium are included the proportion of 90:10.

Aside from other throwing strategies, mix throwing defeats challenges of other throwing techniques. The liquid arrangement is then checked for any enormous particles of Titanium in Aluminum or it is completely broken up in the arrangement. After that the material is filled the example that is made in the mould.Then relying on the hardening time of the material utilized, the shape is left for quite a while to set. At that point the strong material is removed the shape and is machined. In this undertaking the example readiness is accomplished for hardness, sway, elastic tests. The given material is machined a role according to the models for specific tests.

5.2 Mechanical testing method

The mechanical test can be conducted by the following parameters.To know about the material elongation,strength,hardness,withstand load capacity.

- Tensile Test
- Impact Test
- Brinell hardness Test

MATERIALS	TENSILE TEST		BRINELL HARDNESS TEST	IMPACT TEST (Joules)
	Ultimate Tensile load (KN)	Ultimate Tensile strength (N/mm^2)		
Al (90%) and Ti(10%)	19.46	120	81.3	58

6. Conclusion

In this undertaking Aluminum Titanium metal network composite material is proposed for the production of goad gears. The MMC is arranged and tried by both precisely and scientifically. The outcomes demonstrate that this MMC has properties that can supplant the current material that is utilized ordinarily. In this way giving less weight, more life and withstand more burden than customary gears. It has better solidarity to weight ratio, better hardness than ordinary gears. These riggings can almost certainly transmit up to 40kW power. These riggings can be utilized in cars and other apparatus where goad gears discover an application.

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