Prajwal V. Gedam, et. al. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 13, Issue 4, April 2023, pp. 54-59

RESEARCH ARTICLE OPEN ACCESS

Investigation and Analysis of Spur Gear Using Different Composite Materials - review paper

Prajwal V. Gedam[1], Dr.Anil Kumar[2], Dr.Nitin A. Wankhade[3]
(PhD Scholer,,SJJT,University, Rajasthan)
(Associate Professor,SJJT, University, Rajasthan)
(Associate Professor PRMIT&R,Badnera)

Abstract—
When it studies to the spur gear, gear is a mechanical power transmits and works a lot of industrial rotating equipment; gearing is one of the most important components. Due to their high dependability and compactness, gears may become the dominant method of power transmission in future machinery. In addition, a more nuanced application of gear technology is required due to the fast transition from shipyards and other heavy sectors to car production and workplace automation tools. But there is still a need to extend the gear's lifespan, consequently the spur gear can be analyzed via books and composed studies. For that we have to study the weight reduction, stress distribution and vibration reduction for using Epoxy resin and silicon carbide materials. Finally, comparing and analyzing composite gear with existing Epoxy resin and silicon carbide is to be done
Keywords—Spur Gear, Aluminum, Epoxy Resin and Silicon Carbide**.**

Date of Submission: 01-04-2023 Date of acceptance: 11-04-2023

I. INTRODUCTION

To design and fabricate the spur gear to study the Weight reduction, vibration reduction and pressure sustainability for aluminum (AI) and composite materials. Gearing is one of the most critical components in a mechanical power transmission system, and in most industrial rotating machinery.

Apple Peeler machine is a device spur gear in a proposed project Usually the spur gear material is structural steel and alloy steel has used. But here in the project we finding some new material for the spur gear which reduces weight, vibration reduction and more pressure sustain. Automation tools used to necessitate a refined application of gear technology, to design the spur gear model using designs software, to study the impact analysis for aluminum (AI) and composite materials and to study the torque loading for aluminum (AI) and composite materials. Finally, comparing and analyzing of the composite gear with existing aluminum (AI) gear is carried out.

II. LITERITURE REVIEW

Journal papers and patents explored here are related directly or indirectly to the proposed area of work that is modeling and development of space saving seating arrangements. These papers are to support and enlighten the whole process of design in the specific area.

The literature review mainly focuses on replacement of aluminum (AI) with the epoxy resin and silicon carbide within the application of apple peeler machine.

Mohammad afnan bin mohammad kamarizaman,et.al (2008) Introduced the designing and fabrication of apple peeler machine. Apple peelers are basically kitchen utensils used to peel any kind of vegetable or fruit that needs peeling and their use is not restricted to apple. In this project we have to develop and improving it performance as well so that there has no doubt about the design and concept. This design much more portable because it easy to carry Together when to slice the apple. In this project, use (AutoCAD), Solid Works 2005 software, using the Disc Cutter, Drilling and welding process. An apple peeler is certainly an indispensable tool in the kitchen. So, this design would through many processes before It gets into prototype from in order to achieve the objective and customer need as well. (1)

Mrs. C.M. Meenakshi, Akash Kumar, Apoorva Priyadarshi, Digant Kumar Dash and Hare Krishna et.al (2012) introduced the study the various stress state of spur gear. We calculated the tangential and radial forces which acts on various point upon that basis we can analyze by applying the forces. By using Ansys software bending stress and contact stress on the tooth of spur gear drive is found Gears are machine elements used to transmit power between rotating shafts by means of engagement of projection called teeth. Gears are most common means of transmitting power in the wooden mechanical world. They vary from a tiny size used in watches to larger gears used in massive speed reducers, bridge lifting mechanism and rail road turn table drive. The gears are vital elements of main and auxiliary mechanism in many machines such as automobiles, tractors, metal cutting machine tools rolling mills hosting and transmitting and transporting machinery, massive engines etc. (2)

V. Siva Prasad, Syed Altaf Hussain, V.Pandurangadu, K.Palani Kumar et.al (2012) Introduced the design and analysis of Spur gear. In the present work, it is proposed to substitute the metallic gear of sugarcane juice machine with plastic gears to reduce the weight and noise For the purpose of two different types of plastic materials were considered namely Nylon and Polycarbonate and their viability are checked with their counterpart metallic gear (Cast iron). Static analysis of a 3-D model has been performed using ANSYS 10.0. Compared to Cast iron spur gears Nylon gears are suitable for the application of sugarcane juice machine application under limited load conditions. (3)

Prajwal V.Gedam, Pavan J.Bhadange et.al(2015) Introduced the focuses on replacement of metallic gear of Alloy Steel is Replaced by the composite gear of cast steel, carbon fiber and cast iron. The literature survey of composite spur gear was performed. Then the study in weight reduction and stress Distribution and noise reduction of spur gear for cast steel and composite materials has been done. On the basis of that study, the analysis of both cast steel and composite materials are analyzed in the application of gear box which is used in automobile vehicles. So, Composite materials are capable of using in automobile vehicle gear boxes in the application of model instead Kinetic Luna TFR of existing cast steel gears with better results**. (4)**

Anuj Nath, A.R. Nayak et.al (2015) To design the spur gear to study the weight reduction and stress distribution of cast steel and composited material. Gearing is one of the most critical components in the mechanical power transmission system and in the most industrial rotating machinery. It is possible that gears will predominate as the most effective means of transmitting power in future machines due to their high degree of reliability and compactness. In addition, the rapid shift in industry from heavy industry such as ship building to industries such as auto mobile manufacture and auto machine tools will necessitate a refined application of gear technology. To design the spur gear model using the PRO-E software. To study the impact analysis for cast steel and composite materials. To study the torque loading for cast steel and composite materials. Finally, comparing and analyzing the composite gears with existing cast steel gear is to be done by using ANSYS R1. (5)

III. METHODOLOGY

In this study read near about 150 research paper then studied their properties and composition finally compared Aluminum spur gear as replaced to composite material spur gear

Flow on methodology

- Study of research material.
- Literature review.
- Material selection.
- Study and Comparisons with Aluminum (AI) and composite material gear

i) SPUR GEAR

The spur gear is simplest type of gear manufactured and is generally used for transmission of rotary motion between parallel shafts. The spur gear is the first-choice option for gears except when high speeds, loads, and ratios direct towards other options. Other gear types may also be preferred to provide more silent low-vibration operation. A single spur gear is generally selected to have a ratio range of between 1:1 and 1:6 with a pitch line velocity up to 25 m/s. The spur gear has an operating efficiency of 98-99%. The pinion is made from a harder material than the wheel. A gear pair should be selected to have the highest number of teeth consistent with a suitable safety margin in strength and wear. The minimum number of teeth on a gear with a normal pressure angle of 20 degrees is 18.

Fig.1-spur gear

Description of project: This project is for manufacturing composite gear using several materials. Gears are generally used in power and motion transmission work under different loads and speeds. Due to advantages of noiseless running, light weight, resistance to corrosion, ease of mass production, lower coefficients of friction, and the ability to run without external lubrication, the use of composite gears is continually increasing. These gears are especially preferred and successfully used in office machines, household utensils, in the food and automotive industries, and in textile machinery because of the above- mentioned advantages. Gearing is an essential component of many machines, and the defect of gear is the important factor causing machinery failure. According to statistics, 80% of transmission machinery failure was caused by the gear, and gear failure was about 10% of rotating machinery failure, so gearbox monitoring for fault detection and diagnosis is one of the important tasks in industrial maintenance.

In this work, a metallic gear of Alloy Steel is replaced by the composite gear of cast steel, carbon fiber and cast iron. Such Composites material provides much improved mechanical properties such as better strength to weight ratio, more hardness, and hence less chances of failure. In this work, an analysis is made with replacing gear material with composite material such as cast steel, carbon fiber and cast iron so as to increase the working life of the gears to improve overall performance of machine. Finally, the Modeling of spur gear is carried out using SOLID WORK and bending stress analysis of spur gear is carried out using ANSYS V14.

ii) COMPOSITE GEAR

Gears made from composite materials are widely used in many power and motion transmission applications. Due to lower weight to stiffness ratio, composite gears may be replaced by conventional material gears in power transmission systems. Present day plastics have attracted the attention as gear material for use in such facilities. These composite gears are usually manufactured by process of injection molding, which are reinforced by carbon, short glass fibers, or fillers. Geometrical accuracy of an injection-molded component is decided by many parameters such as material shrinkage characteristics, molding parameters, gating and cooling systems. Complex geometry of gear causes different flow and shrinkage rates and affects the gear accuracy. Polymeric composite gears materials suffer from poor mechanical strength and thermal resistance compared with metals. Reinforced polymers offer high mechanical strength and thermal resistance and are suitable for structural load bearing applications. The basic weakness of plastic spur gear teeth is tooth fracture brought on by the accumulation of stress at the root of the tooth and by the geometry of the tooth. Polymer composite gears can fail in two ways: one by fatigue, the other by wear. Fatigue can be measured directly by life tests, but wear needs to be continuously recorded. According to the recent works it has been reported that short glass fiber- reinforced gears also show unacceptable wear under power transmission conditions, and only carbon fiber reinforced gears have efficient capacity for high torque. Carbon fiber-reinforced material has been used in an application for the flexspline of harmonic drive gears. However, the problem is that carbon fiber-reinforced gears are expensive. Gear rotational speed influences the performance of composite gears. Increasing the rotational speed considerably increases the loading frequency and increases the surface temperature of gears,which leads to the reduction of gear life.

iii) COMPOSITE MATERIAL

A composite material can be defined as a combination of two or more materials that results in better properties than those of the individual components used alone. In contrast to metallic alloys, each material retains its separate chemical, physical, and mechanical properties. The two constituents are reinforcement and a matrix. The main advantages of composite materials are their high strength and stiffness, combined with low density, when compared

with bulk materials, allowing for a weight reduction in the finished part. The reinforcing phase provides the strength and stiffness. In most cases, the reinforcement is harder, stronger, and stiffer than the matrix. The reinforcement is usually a fiber or a particulate. Particulate composites have dimensions that are approximately equal in all directions. They may be spherical, platelets, or any other regular or irregular geometry. Particulate composites tend to be much weaker and less stiff than continuous fiber composites, but they are usually much less expensive. Particulate reinforced composites usually contain less reinforcement (up to 40 to 50 volume percent) due to processing difficulties and brittleness. A fiber has a length that is much greater than its diameter. The length-to-diameter ratio is known as the aspect ratio and can vary greatly. Continuous fibers have long aspect ratios, while discontinuous fibers have short aspect ratios. Continuous-fiber composites normally have a preferred orientation, while discontinuous fibers generally have a random orientation. Fibers produce high-strength composites because of their small diameter; they contain far fewer defects (normally surface defects) compared to the material produced in bulk. As a general rule, the smaller the diameter of the fiber, the higher its strength, but often the cost increases as the diameter becomes smaller. In addition, smaller-diameter high-strength fibres have greater flexibility and are more amenable to fabrication processes such as weaving or forming over radii. Typical fibres include glass, aramid, and carbon, which may be continuous or discontinuous. The continuous phase is the matrix, which is a polymer, metal, or ceramic. Polymers have low strength and stiffness, metals have intermediate strength and stiffness but high ductility, and ceramics have high strength and stiffness but are brittle. The matrix (continuous phase) performs several critical functions, including maintaining the fibers in the proper orientation and spacing and protecting them from abrasion and the environment. In polymer and metal matrix composites that form a strong bond between the fiber and the matrix, the matrix transmits loads from the matrix to the fibers through shear loading at the interface. In ceramic matrix composites, the objective is often to increase the toughness rather than the strength and stiffness; therefore, a low interfacial strength bond is desirable. There is a practical limit of about 70 volume percent reinforcement that can be added to form a composite. At higher percentages, there is too little matrix to support the fibers effectively. Common fiber reinforced composites are composed of fibers and a matrix. Fibers are the reinforcement and the main source of strength while the matrix which glues all the fibers together in shape and transfers stresses between the reinforcing fibers. Sometimes, fillers or modifiers might be added to smooth manufacturing process, impart special properties, and/or reduce product cost. Primary functions of the matrix are to transfer stresses between the reinforcing fibers (hold fibers together) and protect the fibers from mechanical and/or environmental damages. A basic requirement for a matrix material is that its strain at break must be larger than the fibers it is holding. The primary functions of the additives (modifiers, fillers) are to reduce cost, improve workability, and/or impart desired properties. Design choices, especially the complex shape and hollow cross-section parts.

IV. Outcome of Literature review

Here near about 150 researches paper has been studied from which following information get in the satisfactory progression of my research work.

Material Selection

A) Aluminum

The unique combinations of properties provided by aluminum and its alloys make aluminum one of the most versatile, economical, and attractive metallic materials for a broad range of uses—from soft, highly ductile wrapping foil to the most demanding engineering applications. Aluminum alloys are second only to steels in use as structural metals. Aluminum has a density of only 2.7 g/cm3, approximately one-third as much as steel (7.83 g/cm3). One cubic foot of steel weighs about 490 lb; a cubic foot of aluminum, only about 170 lb. Such light weight, coupled with the high strength of some aluminum alloys (exceeding that of structural steel), permits design and construction of strong, lightweight structures that are particularly advantageous for anything that moves—space vehicles and aircraft as well as all types of land- and water-borne vehicles. Aluminum resists the kind of progressive oxidization that causes steel to rust away. The exposed surface of aluminum combines with oxygen to form an inert aluminum oxide film only a few ten-millionths of an inch thick, which blocks further oxidation. And, unlike iron rust, the aluminum oxide film does not flake off to expose a fresh surface to further oxidation. If the protective layer of aluminum is scratched, it will instantly reseal itself. The thin oxide layer itself clings tightly to the metal and is

colorless and transparent—invisible to the naked eye. The discoloration and flaking of iron and steel rust do not occur on aluminum.

B) Epoxy Resins

Epoxy resins are widely used in filament-wound composites and are suitable for molding prepress. They are reasonably stable to chemical attacks and are excellent adherents having slow shrinkage during curing and no emission of volatile gases. These advantages, however, make the use of epoxies rather expensive. Also, they cannot be expected beyond a temperature of 140ºC. Their use in high technology areas where service temperatures are higher, as a result, is ruled out. Epoxy-reinforced concrete and glass-reinforced and carbon-reinforced epoxy structures are used in building and bridge structures. The applications for epoxy-based materials are extensive and include coatings, adhesives and composite materials such as those using carbon fiber and fiberglass reinforcements. The chemistry of epoxies and the range of commercially available variations allow cure polymers to be produced with a very broad range of properties. In general, epoxies are known for their excellent adhesion, chemical and heat resistance, good-to-excellent mechanical properties and very good electrical insulating properties. Epoxy is a copolymer that is; it is formed from two different chemicals. These are referred to as the resin‖ or compound‖ and the hardener or activator the resin consists of monomers or short chain polymers with an epoxide group at either end. Most common epoxy resins are produced from a reaction between epichlorohydrin and bisphenol-A. Two part epoxy coatings were developed for heavy duty service on metal substrates and use less energy than heat-cured powder coatings. Their low volatility and water cleanup makes them useful for factory cast iron, cast steel, cast aluminums applications and reduces exposure and flammability issues associated with solvent-borne coatings. They are usually used in industrial and automotive applications since they are more heat resistant than latex-based and alkyd-based paints. The large family of epoxy resins represents some of the highest performance resins of those available at this time. Epoxies generally out-perform most other resin types in terms of mechanical properties and resistance to environmental degradation, which leads to their almost exclusive use in aircraft components.

C) Silicon Carbide

Silicon carbide (SiC) is a hard chemical compound containing silicon and carbon. Grains of silicon carbide can be bonded together by sintering to form very hard ceramics that are widely used in applications requiring high endurance, such as car brakes, car clutches and ceramic plates in bulletproof vests. Large single crystals of silicon carbide can be grown by the Lely method and they can be cut into gems known as synthetic moissanite.

Electronic applications of silicon carbide such as light-emitting diodes (LEDs) and detectors in early radios were first demonstrated around 1907. SiC is used in semiconductor electronics devices that operate at high temperatures or high voltages, or both. Silicon carbide is used as an abrasive, as well as a semiconductor and diamond simulant of gem quality.

The material formed in the Acheson furnace varies in purity, according to its distance from the graphite resistor heat source. Colorless, pale yellow and green crystals have the highest purity and are found closest to the resistor. The color changes to blue and black at greater distance from the resistor and these darker crystals are less pure. Nitrogen and aluminum are common impurities, and they affect the electrical conductivity of SiC.

Mechanical Properties of Aluminum (Ai) & Composite material gear

	Aluminum (Ai)	**Epoxy resin / Silicon carbide (Sic)**
Density	2700 kg/m3	2150 kg/m3
Young modulus	5 GPA	226 GPA
Poisson's ratio	0.3	0.3
Tensile strength	125 MPa	157Mpa
Modulus of Elasticity	70.3 GPA	193 A

V. CONCLUSION

The review mainly focuses on replacement of Aluminum is Replaced by the composite gear of Epoxy resin and silicon carbide.

The literature survey of composite spur gear was performed. Then the study in weight reduction, stress distribution, Pressure sustainability and vibration reduction of spur gear for composite gear of Epoxy resin and

silicon carbide has been done.

On the basis of that study, the analysis of Epoxy resin and silicon carbide are analyzed in the application of spur gear which is used in apple peeler machine.

So, Composite materials are capable of using in automobile and other mechanical parts in the application of model instead apple peeler machine of Epoxy resin and silicon carbide with better results.

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