A Review on: Notch Shaft used in All Terrain Vehicles

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Abstract— Notched shaft is that the most vital part to any power transmission application; automotive notch Shaft is one in every of this. A notch shaft may be a mechanical half that transmits the torsion generated by a vehicle's engine into usable driving force to propel the vehicle. Substituting composite structures for traditional steel structures has several benefits as a result of the strength and higher specific stiffness of composite materials. 2013TRX400X model of ATV is used for the study. This paper focuses on study of notch and notch shaft also known as drive shaft of ATV. Previously, the axle shafts were manufactured in Mild Steel and were straight tapering shapes. Later, they were modified into notched shapes for high power ATVs. This study will show the effect of notch on shaft that where the stress concentration can be more. To increase the strength conventionally used steel material can be replaced with composite material.

Key words: Notch, Notch shaft, Bending & Tortional Load, and ATV

I. INTRODUCTION

An all-terrain vehicle (ATV), additionally called a quad, quad bike, hackney carriage or three-wheeler, is outlined by the American National Standards Institute (ANSI) as a vehicle that travels on nonaggressive tires, with a seat that's represented by the operator, together with handlebars for steering management. because the name suggested, it's designed to control a wider kind of terrain than almost all alternative vehicles. though it's a street-legal vehicle in several countries, it's not street-legal inside most states and region of Australia, the United States or North American nation.

Rapid technological advances in engineering design field lead to finding the alternate answer for the traditional materials. The design engineers dropped at a degree to finding the materials that square measure a lot of reliable than standard materials. Researchers and designers area unit perpetually searching for the solutions to produce stronger and sturdy materials which can answer the requirement of fellow engineers. Notched shafts area unit used as power transmission. Within the design of metallic shaft, knowing the torsion and also the allowable shear stress for the fabric, the dimensions of the shaft's cross section will be determined. within the today's days there's an important demand for lightweight materials vehicle.

There is combined cyclic tension, bending and Tortional masses throughout operations in commission. These complicated cyclic loadings are outlined as multiaxial loadings, wherever principal stresses rotate and alter their magnitudes non proportionally throughout a loading cycle. Additionally, several of machine elements consist of notches and geometrical randomness due to style necessities. These geometric irregularities cause vital stress concentrations. Multiaxial loading method turn out advanced stress and strain states close to notches & may cause a fatigue failure even with none evident large scale plastic deformation. Unfortunately, the mixture of multiaxial loading strategies & compound geometries of mechanical elements is inevitable in observe & carry out durability test are frequently not practicable by reason of time and price concern.

A. Importance of Notch shaft:

Failure nearly always start at an imposed or accidental discontinuity, such as a notch or hole. a tiny "notch" is frequently a potential nucleus of failure which may lead to serious damage. The term "notch" in a broad sense is used to refer to any discontinuity in shape or non-uniformity in material. A notch is frequently called a "stress raiser" because it develops localized stresses that may serve to initiate a crack (or reduce the load-carrying capacity).Notches are hardly avoidable in engineering practice; they may occur as(a) a metallurgical notch, which is inherent in the material due to metallurgical processes (as inclusions, blowholes, laminations, quenching cracks, etc.); (b) a mechanical notch, of some geometrical type which usually results from a machining process (as grooves, holes, threads, keyways, fillets, serrations, surface indentations); (c) a service notch, which is formed during use (as chemical or corrosion pits, scuffing, chafing or fretting, impact indentations, and so on). Hence the potential load-carrying capacity of a material under repeated stress can seldom be attained in actual machine parts because of the presence of these imposed or accidental notches. Notches, is therefore an important consideration in almost every branch of machine design.

From results of static tension tests, it has been seen that for ductile steels the ultimate strength and yield strength increase with notch depth and sharpness of the notch angle; the breaking stress (load per unit of actual area at fracture) also increases, moderately or remains approximately constant. For brittle metals such as cast iron, cast brass, and magnesium alloys (which may have many internal defects or high residual stresses but little capacity for plastic flow) there often is little difference between the strength values of notched and un-notched bars.

In general, the higher the tensile strength the greater is the notch-sensitivity. The increased strength reduction for the stronger metals may be due mainly to their lowered capacity for the minute plastic flow which results in localized work-hardening.

For steels of the same tensile strength the notch-sensitivity is altered somewhat by differences in metallurgical structure produced by different heat treatments. It was found that for the same tensile strength drastically quenched-and-tempered steel was less notch-sensitive than the same steel in a slowly quenched-and-tempered or normalized condition.

1) Understanding the behaviour of stress distribution in stepped/notched shaft:

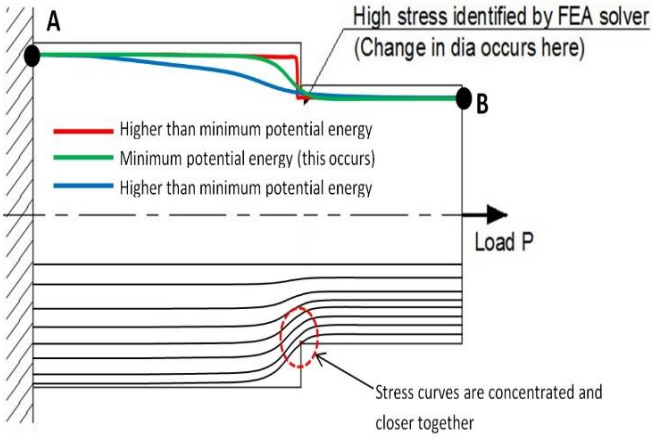


Fig. 1:

1) Stress must distribute from point A to point B. The distribution path that requires the minimum amount of strain energy is the green path. The red and blue paths would never occur because they would require more than this minimum amount of energy.
2) The reason higher stresses form at the shaft step is because there is a higher concentration of stress curves that pivot around the corner. Refer to the black stress curves in the bottom half of the image below.

In other words, the space between two adjacent stress curves is smaller closer to the shaft step. This is because various stress curves must pivot around the shaft step to get from the left side of the shaft to the right side.

This means that the material at the shaft step is subject to more force than other areas.

3) So to summarize, the minimum strain energy concept forces stress curves to pivot around the shaft step.

This increases the concentration of stress curves in this location, which then increases the value of stress

B. Functions of Notch Shaft:

- First, it should transmit force from the transmission to the rear wheels.
- The notched shafts should even be efficient of rotation at the terribly high speeds needed by the vehicle.
- It is necessary to transmit most low-gear torque during the operation which is developed by the engine.
- As the rear wheels roll over bumps within the road, it should be capable of handling the shaft move up and down
- Due to fatigue the shaft usually breaks, notched shaft is employed for prime power atv's to enhance the fatigue strengths

C. Problem Statement:

- It is more prone to failure as it carries various loads during bump, cornering etc.
- If the shaft fails, driver will face problem during turning.
- Another problem is the weight. Suitable material must be found to lower the weight of the shaft because world is moving towards using optimized components only.

II. LITERATURE STUDY

The result of notches on multiaxial fatigue behavior was examined exploitation thin-walled hollow 2024-T3 aluminum specimens with a circular transversal hole. Continuous magnitude totally invert axial, torsion, and in-phase and 90_ out-of-phase axial–torsion tests were carried out in load control[1].

Next, a numerical model was given to estimate notch strains of a notched specimen underneath proportional and non proportional cycling tension–compression–torsion loadings. The projected model uses elastically calculated notch stresses and a notch stress–strain curve to explain material hardening at the notch root[2].

Results of the proposed multiaxial fatigue analysis methodology area unit compared to sets of experimental knowledge revealed within the literature to verify the prediction capability of the elastic-plastic stress/strain model and also the multiaxial fatigue damage parameter. supported the comparison between calculated results and experimental knowledge, it's found that the multiaxial elastic-plastic stress/strain model correlates well with experimental strain knowledge for SAE 1070 steel notched shafts subjected to many non-proportional load paths[3].

A notch analysis methodology employing a finite element basis is integrated with two crucial plane multiaxial fatigue criteria to simulate combined bending–torsion fatigue of SAE 1045 notched specimen[4].

This work describes the development and mechanical characterization of recent polymer composites consisting of glass fiber reinforcement, epoxy resin and filler materials like TiO2 and ZnS. The new developed composites are characterised for their mechanical properties[5]. torsional and vibration analysis is done on conventional SM45C steel drive shaft, carbon epoxy and glass epoxy composite drive shaft[6]. the High Strength Carbon/Epoxy and High Modulus Carbon/Epoxy Composite drive shafts have been designed and analyzed to increase its strength[7,8].

1) Concluding Remarks from literature survey:

- By using above case studies, we can determine the working and design of notch shaft that transmits the torsion generated by a vehicle's engine into usable driving force to propel the vehicle. Modeling are often done on 3D computer code (software).
- Based upon studies, we can apply boundary conditions to the model and carry out analysis.
- Analysis can be done on FEA software's to determine the nature of failure caused due to stresses developed.
- Based on analysis modification in design will be recommended.

2) Loads Acting on Shaft of ATV:

- Bending load: Bending load acts due to suspension.
  Below figure shows geometric stress concentration factor for bending loads:

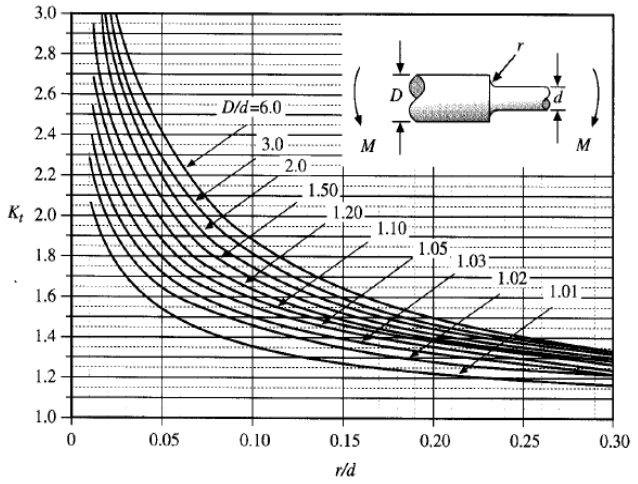
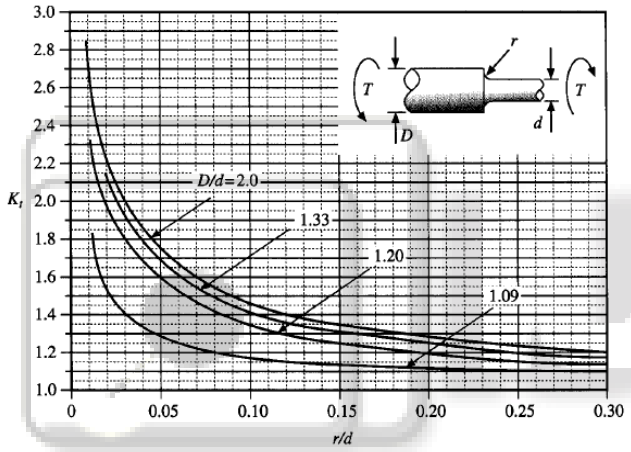


Fig. 2:

1) Tortional load**:** Tortional load acts due to torque transferred from differential to wheel side.

Below figure shows geometric stress concentration factor for torsion loads:



III. Conclusion & Future Scope

Various aspects of a notch shaft have been studied. Forces acting on shaft are known which can be further used for applying boundary condition during simulation. Future work will include analysis and testing of notch shaft with bending and torsional load and its optimization using composite material.

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