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Design and Development of Tractor Tubular Tow Pin using Ahss

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Abstract: ***An automobile industry focuses to reduce the fuel losses by replacing solid components into a hollow without compromise the performance, strength and leads to decreases the total weight of the vehicle. There byreduce the manufacturing difficulty, cost and fewer yields during manufacturing of solid components. Theaim of this paper is to design and develop a new Tubular Tow pin instead of solid tow pin which is used in truck. The strength and pulling load of new design are matched with the existing design. Structural properties are determined and compared using ANSYS. The high strength can be achieved by using advance high strength steel material with the same material tubular Tow pin were developed without compromising the mechanical and metallurgicalproperties.Hence by changing the solid pin to tubular tow pin the weight reduction up to 62% compared to existing. Similarly the cost savings up to 40% and the yield strength is increased 60 to 85% compared solid pin. In overall due weight reduction the fuel consumption by the truck is reduced.***

Keywords: Tubular Tow pin, Solid tow pin, Tractor, ANSYS.

I. INTRODUCTION OF TOW PIN

Towing is the process of coupling one componentinto another, there by pulling takes place with one another. The coupling may consist of a chain, or some other means of keeping the two objects together while in motion.The towing pin is used in the tractor as shown in Fig.1. This study is carried out particularly for a person with disability to gain an in depth understanding of how the guidelines are implemented in a modified vehicle for the safer driving [4]. Route optimization technique gives a clear picture about to plan vehicle route based on available traffic data and surrounding environment which will solve the vehicle route planning problem. This work proposes a novel extended vehicle route planning problem to improve fuel economy by optimize vehicle route and speed simultaneously using both traffic data and vehicle characteristics for a given expected trip time [2].

Fig.1 Tow Pin Assembly

In recent years many researchers trying to reduce energy consumption of a vehicle by means of a concerted effort to promote energy efficiency. In this work an increase in energy efficiency leads to a decrease in the consumption of the good or service rendered efficient [10]. The main objective is to design the automobile radiator with surface area with increased heat transfer coefficient, rate of Heat transfer, reduced cost and reduced weight using CFD. Suitable modifications are to be incorporated depending on the requirements [7]. The total heat gained to vehicle cabin mainly through glass windows as well as Heat flow from the roof with radiation. When a vehicle is parked in direct sun light leads to a quick rise of cabin temperature that may damage property and harm to the children or pets left in the vehicle [5]. The exhaust manifold is provided in the vehicle to collect and dispose the waste toxic gases through a single pipe. During that time exhaust manifold leads to thermal stresses causes blowholes on the manifold. In this study, to prevent the defects of the exhaust manifold, a different coating is applied using ceramic materials [8].In automobile industry to boost engine performance and improve efficiency is the latest trend. In this one the important inevitable phenomenon is engine wear. It is the biggest challenging task for the automotive industry to reduce the wear rate to get higher mean time operation. This work deals with preventive steps in IC engines to maximize wear resistance [1]. The cooling system of the engine decides the performance of an engine, to improve the cooling system addition of nano particles to changes their properties of any coolant. The radiator heat removalrate is increased by nano particle mixed coolant and quantity of coolant is decreased [9].This article studies about on heat transfer and flow characteristics of nanofluidwith different concentrations of SiO_2as nano particles used in a shell and tube exchanger.

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The results reveals that heat transfer coefficient of nano fluid is higher than that of the base fluid at same inlet temperature and mass flow rate[7]. The usage of biodiesel in diesel engines to improve the performance methyl ester is added to the diesel. Two different feed stocks of karanja oil methyl esters were selected to evaluate the performance [3]. The small modifications in the vehicle leads to reduce the overall weight of the vehicle thereby reduce the fuel consumption.

II. MATERIALS AND METHODS

This paper support weight reduction and cost benefits to customer. It involves process time savings comparing to existing version. Tubular tow pin eliminates the welding process & machining process. Comparing to existing version tubular tow pin offers maximum yield. This paper involves FE model using ANSYS software and modeling with solid works software and experimental results.The high strength tubular tow pin is made up of Induction Heat treatment process. Mechanical properties are coming under advanced high strength steel category. Low carbon high manganese steel is taken for this application & the strength will be matched with equal to the solid version by heat treatment process. The mechanical properties, hardness and pulling loads are verified.Currently in a tractor solid rod is using with a rod diameter of 35 mm, weight of the solid rod is 1.07 kg per component and the cost of the product is Rs.135 per piece. Without disturbing the outer geometry of the current version, tubular version is designed in such a way that it has to withstand the pulling load of 10 Tons. The main Parameter to be Consider while designing a Tubular Tow Pins is the Stiffness of solid rod design to match with Tubular design and stress level from rod to tube to be compensated with increased Yield strength of Tubular Design. Process wise time saving is very high for tubular version. Comparing to solid version end cap welding is eliminated in tubular version. End cap is achieved through forming. Process time saving is also there in hole drilling in tubular version comparing to solid version.New proposal drawings details compared with existing drawings shown in Fig.2. Advanced high-strength steels (AHSS) include DUAL-TEN (dual phase) steel and transformation induced plasticity (TRIP) steels. The minimum tensile strengths range from 500 to 800 MPa. These steels are gaining popularity in automotive applications because they are easier to form than HSLA grades with similar initial yield strengths, but have much higher final part strength. The unique characteristics of advanced high-strength steels are developed by a continuous heat treating process that creates martensite in the steel microstructure. The amount of martensite, together with the amount of carbon, will determine the strength level of the steel. When compared to other grades, specifically high-strength, low-alloy steels, the classification for advanced high-strength steels are based on minimum tensile strength and all the phases as shown in Fig.2.

III. ANALYSIS OF TOW-PIN

FEA is one of the simplest numerical methods which will deconstruct a complex system into very small pieces to refine the exact solution. These results then can be presented in graphical formscomparison between solid pin to tubular tow pin.

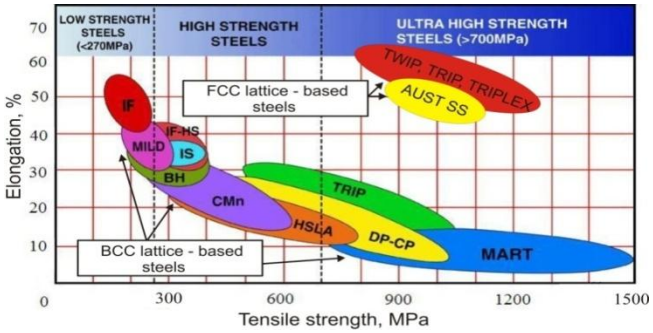

Fig.3 Stress variation of Solid Pin

Tubular version shows higher stress compared the solid

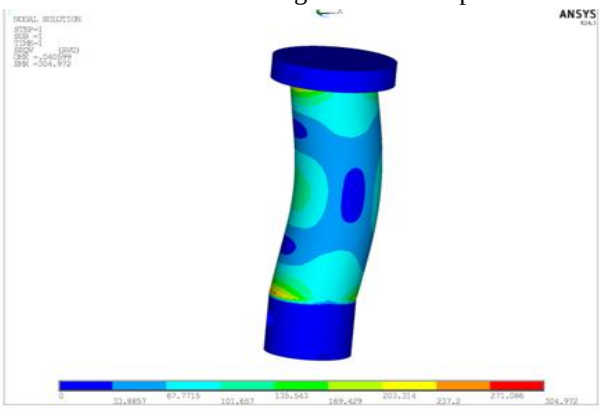

Fig 2: Advanced High Strength Steel Graph

version which is compensated by doing heat treatment of Tubular Tow pin by raising the yield strength twice the strength. The tow pin leads to only pulling load and pulling test has been carried out. The stress comparison between the solid pin to tubular Tow pin as shown in Fig.3 and Fig.4.

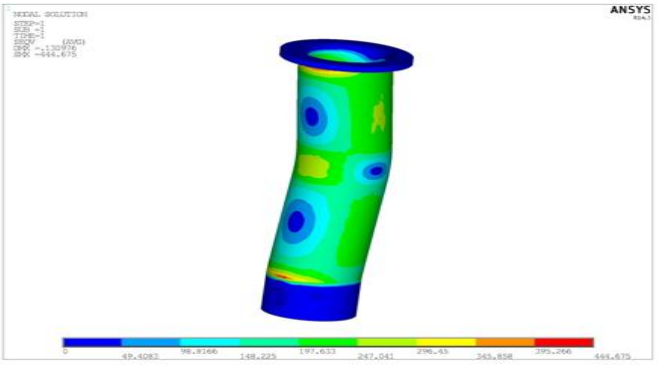

Fig.4 Stress variationof Tubular Tow Pin

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IV. RESULT AND DISCUSSION

The solid and tubular tow pin are fabricated and carried out various test eddy current, heat treatment, hardness and pull load test are presented one by one.

A. Eddy Current Testing

To detect the flaws in fabricated materials eddy-current test has been carried out and its shows that the signals were normal hence the material is good condition as shown in Fig.5.

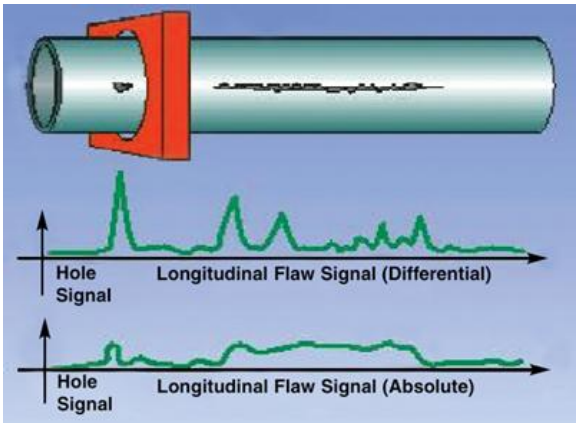

Fig.5 Eddy Current Test Flaws Signals

B. Heat Treatment

Induction heating is the process of heating an electrically conducting object by electromagnetic induction, where Eddy currents are generated within in the metal and resistance lead to Joule heating of Metal. This ability can be used in hardening to produce parts with various properties. The most common hardening process is to produce a localized surface hardening of an area that need ware resistance, while retaining the toughness of the original structure as needed elsewhere. The depth of induction hardening patterns can be controlled through choice of Induction frequency, Power density and interaction time. Heat treatment line diagram as shown in Fig.6.

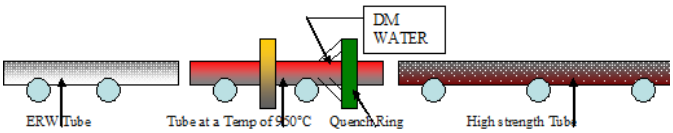

Fig.6 Induction hardening concept drawing

Tubular Tow pin is developed from electric resistance welding tube. Later it passé through certain chain series of processes like annealing, straightening, wet process and cutting & chamfering, which is normal processes in electric resistance welding tube making. In tubular Tow pin development forming and heat treatment are the most critical processes.

C.Forming Trial

Forming is done by using 100Ton hydraulic press. Here the tools are manufactured by our own design. Forming is conducted in two stages. Flaring and flattening. In initial stage of trial we faced issues like achieving dimensional requirement and material friction issues because of over pressure applied during the forming. The thickness variation in the end flat region and corner forming issues of the samples as shown in Fig.7.

Fig.7 Rejected samples

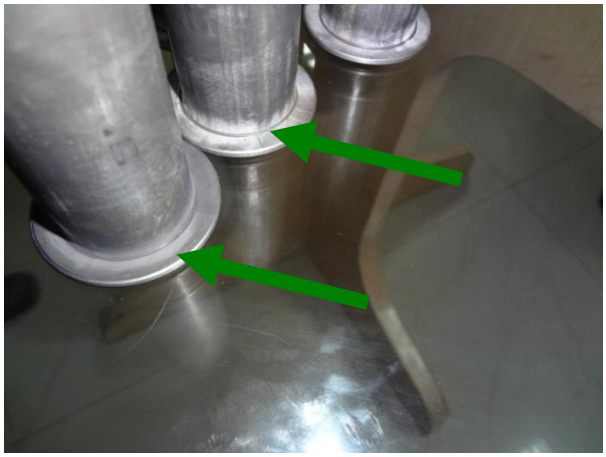

Fig.8 Accepted samples

By providing stopper system optimum hydraulic pressure is derived for the forming operation. These issues are sorted out. Accepted samples image shown in Fig.8

D.Heat Treatment

Here low carbon high manganese steel is heated to a temperature of 950° C by induction heating and it is rapidly quenched by water to attain the full martensite microstructure which is the hardest phase in steel.

Later it is tempered for ductility and we maintain hardness 32 – 37 HRC which meets the customer requirement. This category of microstructure steel comes under advanced high strength steel. The design of experiment is done by the heat treatment process to attain the optimum power and speed for the tempering process. The DOE results of the heat treatment trial in shown in Table.1.

Table.1 Heat Treatment DOE Results

POWER (kW)	TIME (sec)	HARDNESS (HRC)
65	8	**31.05**
65	16	32.65
75	**8**	**34.08**
75	16	35.06
85	8	36.02
85	16	**37.09**

E. Microstructure ofthe Tube after Heat Treatment

The SEM images of the tow pin tube are shown in Fig.9 and Fig.10. Fig.9shows that after hardening process of the microstructure is fine martensite and Fig.10 shows that after tempering process of the microstructure of tempered martensite.

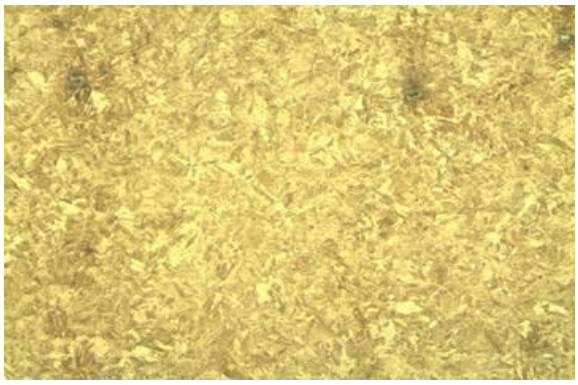

Fig.9 500x Etched (4%Nital) – As IH

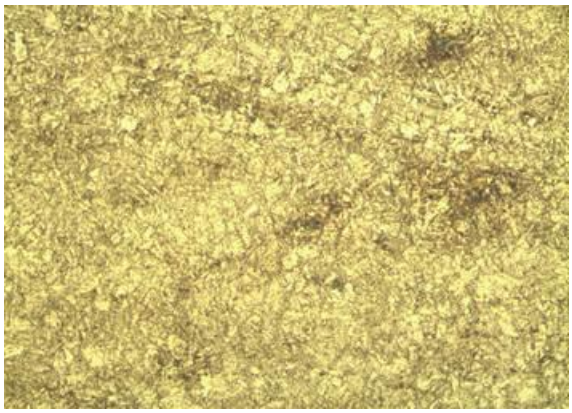

Fig.10 500x Etched (4%Nital) As IH+IT

F.Mechanical Properties

Customers specific requirement is pull load testing. We design the special fixture for pull load testing as shown in Fig.11. This fixture is fixed Universal Testing Machine (UTM).

Fig.11 Pull load testing fixture

Universal Testing Machine is used to test the tensile stress of the soft tube. The 50mm length of soft tube is placed in the machine between the grips and an extensometer. If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held.UTS is the maximum stress that a material can withstand while being stretched or pulled before necking

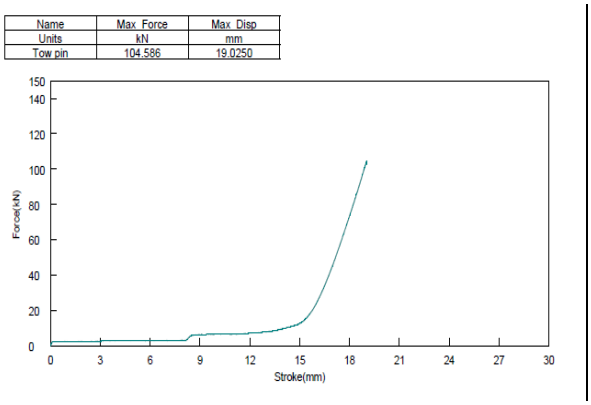

Fig.12 Pull load testing

The yield point in the stress-strain curve at which the curve the levels off and plastic deformation begins to occur.The load Vs Displacement graph is plotted as shown in the Fig.12.

G. Hardness

Hardness test is carried out to check the variation of solidmatterwhen a force is applied is to various kinds of permanent shape change. Hardness is dependent on ductility, elasticstiffness, plasticity, strain, strength, toughness and viscosity. It is tested in hardness testing machine shown in Fig.13.

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Fig.13 Hardness Machine

V. CONCLUSION

The design of tubular tow pin changed from the solid version and analysis was done by mechanical and metallurgical aspects. In tubular tow pin withstand the pulling load of the existing solid pin. Hence by changing the tubular tow pin the weight reduction up to 62% and the cost benefits up to 40% and the yield will be the 55 – 60 % to 85%. This successful result gives us the confident of horizontal deployment of this kind of design in various solid tow pin, steering parts such as conversion of High strength drag link from forged rod and also Center links etc. This paper is helped in learning more about value addition and scope for value addition of present Scenario in auto industries.

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