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DESIGN AND STRUCTURAL ANALYSIS OF AUTO TILTING CAR

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ABSTRACT:

The use of a narrow / Auto tilting car instead of a large gasoline car should dramatically decrease traffic congestion, pollution and parking problem. This is the reason why most car companies are producing narrow track electrical car prototypes. These narrow track cars have an increased rolling tendency. The idea is to develop a tilting car of narrow track that seats two people in tandem. This can be operated on reduced lanes thereby increasing the effective capacity of highways. Narrow track cars are without doubt the future of urban mobility. This analysis is done by Ansys software. These cars have a very short wheel track in comparison to normal cars. Most of the international car companies have production models of narrow track cars. Such cars are mostly single seated or double seater with back to back seating configuration. Recently there had been some development in making three- wheeled tilting cars like the carver, but only design concept is to take development in the concepts of four-wheeled tilters. In this project, I need to develop a tilting mechanism for a narrow track car to give it the flexibility of a motor cycle. This feature enables the car to tilt in to the curve while negotiating it. Analysis shows that to increase the maximum curve at speed. The detailed calculations are enclosed within. The method we have used is a simple mechanical tilting system. This tilting mechanism if successful should dramatically increase the maximum speed in curves. This should also provide the advantages of increased passenger comfort and handling. These systems are done by modeling software's like CatiaV5, and analysis is done by Ansys software.

I.INTRODUCTION

Nowadays, automobile companies are involved in the design of more efficacious vehicles to improve the energetic efficiency. To this end and in order to improve the traffic in the cities, the design of smaller vehicles with a better weight/load ratio is widely reported. Narrow track cars are without doubt the future of urban mobility. These cars have a very short wheel track in comparison to normal cars. Most of the international car companies have production models and prototype of narrow track cars. Some examples are Nissan Land Glider, Nissan Pivo, Honda 3R-C, etc.

Such cars are mostly single seated or double seater with back to back seating configuration. These cars have several advantages:

1) Half the width means half the weight, more rigidity, more access to narrow roads, easier parking and much quicker transit times.
2) In an electric vehicle, the lighter weight of this much smaller vehicle will help to enhance torque power characteristics of an electric motor to achieve "linear acceleration".
3) At highway cruising speeds, such cars will be using half the frontal area and half the drag co

efficient, plus reduced running losses make for a very energy efficient vehicle.

All these advantages make the narrow track vehicle so appealing as an alternative to the car.

Such cars combine the comfort of a car with the functionality of a motor bike. But these cars have a very important and dangerous drawback. With a very comparatively narrow track and heights almost equal to normal cars, these cars are very susceptible to rolling. As of now all such narrow track cars are electrically driven and have a limited top speed and hence this drawback is comparatively negligible. But sooner or later these cars will have to get highway cruising speeds. Then this drawback will be of grave importance.

Our project took shape as an attempt to face this drawback. We thought so if the cars have the functionality of a motor cycle why not gives it the flexibility of a motor cycle. This gave use to the idea of an auto-tilting car. There have been many tilting body designs in rail but what we have done is not just a body tilting, in it the car tilts as a whole. Recently there had been some development in making three-wheeled tilting cars like the carver, but only prototypes or concepts exist in the field of four-wheeled tilters.

II - LITERATURE SURVEY

'Auto tilting cars' is not a new term. Several production models do exist and several prototypes are being tried out by major automobile companies. Some production models are Nissan Pivo, Honda 3R-C etc. Several automobile majors like Toyota, Mercedes, Nissan, Kia, Suzuki etc have prototypes for narrow track cars.

Fig.2.1: Auto tilting cars

A very successful product is a narrow car of the name NARRO. This car is expensive at $46000, but has managed to find a customer which stresses the acceptability of narrow cars for public.

This car is powered by two motors each driving one rear wheel. It has a maximum speed of 120 km/ph. But narro is a tall car, too tall for its track. It rolls tremendously on curves, the manufacturer have compensated for this by providing it a very stiff suspension. Since the car is only meant for urban road use the compromise made in suspension does minimum damage, but even with stiff suspension, the threshold velocity of this car in a curve is very low in comparison to a full track width car.

2.1 TILTING TRAIN

Tilting trains are today common in Europe and Japan. These trains are rail-running; they have very high curve velocities. In order to enable trains, to negotiate curves at high speeds, tracks are slightly banked (up to 11 degrees). But these trains are too fast, and it is not possible to tilt track beyond a limit because trains also pass along these curves really slowly at times.

 ISSN: 2320-1363

Tilting trains are an optimum solution for this problem. These types of train, tilts the body on the curve, this in a sort enables faster curve threshold speed and increased passenger comfort. The figure below shows two tilting mechanisms used in trains.

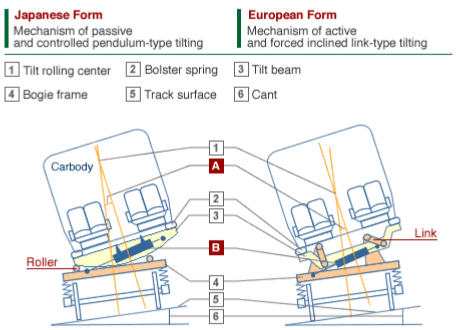

Fig.2.2: Auto tilting mechanism

2.2 THREE WHEELED TILTING CARS

These types of cars are a new species, but their number is fast increasing. These cars tilt about their rear wheels. Either there can be two wheels at the rear like the carver. Which has two wheels at the rear and the car body tilts about the rear wheels. Steering is done using front single wheel.

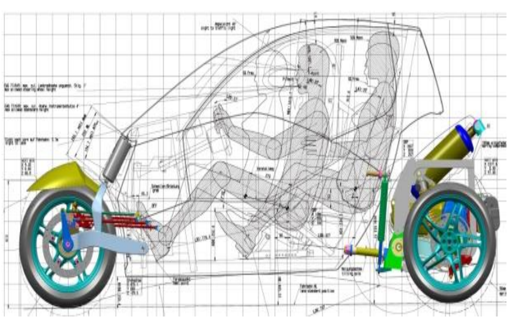

Fig.2.4: Auto tilting car in motion

III - OBJECTIVES AND METHODOLOGY

The objective of this project work is to successfully develop a design of a tilting mechanism for a Auto tilting car. The mechanism is to be reliable, simple, cost-effective and practically feasible. The aim of this tilting mechanism is to provide banking to the car on unbanked curves, so as to enable added threshold speed on curves in comparison to a narrow non-tilting car. This system is also supposed to enhance passenger comfort as the side force felt by passengers in a car taking a turn is comparatively less in a tilting car. Also in our purpose is the fabrication of a mini-prototype –a remote controlled toy car-to demonstrate the tilting in real world.

The methodology adopted to use standard and presently used components in design rather than to design all components from ground up. The advantage of this method is that, you do not have to spend ridiculous amount and time in testing the integrity of each part as they have already proved their worth in real world applications.

Initially the frame design was adopted from an already existing narrow car and minor changes were made to suite our purpose, the tilting mechanism first devised was based on using power screw driven by stepper motor lifting and lowering each wheel of the car. This mechanism was later dropped in testing phase due to following disadvantages.

1. It had a very large response time; this was not suitable for a car approaching curve at a very high speed.

2. Wear and tear of screw and contact nut bearing is too high to be satisfactorily used in a car.

3. The system used four high torque steppers; this along with controls could shoot up the cost of production.

Due to these disadvantages, the power screw design was dropped and a fully new design was defined. The prototype car also uses the same tilting mechanism

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setup. The software to be used in design is Catia V5 and testing of design is Ansys.

IV - WORKING MECHANISM

4.1 Vehicle Description

Initially spent some time brainstorming the basic configuration to use for the vehicle. Because of the desire for a vehicle that would ultimately be used by consumers we opted for a vehicle that could be stable when the vehicle was stopped. This required a three or four wheel configuration instead of two. With only two wheels, something needs to hold the vehicle upright at a stop. On motorcycles, this is the driver's legs. With three or four wheels, we have the option of using the side-by-side wheels to hold the vehicle up with direct tilt control. We decided on the three wheel configuration with a single rear wheel because this met several objectives.

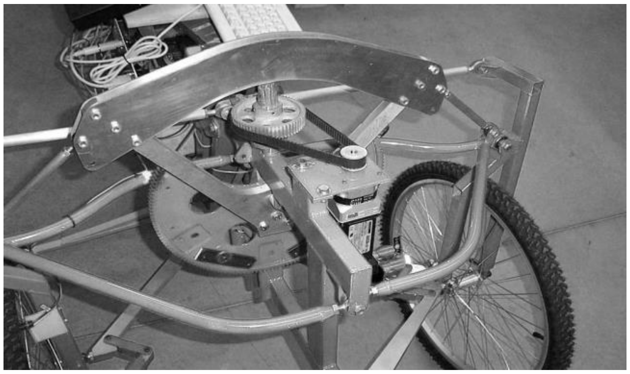

Fig: 4.2: Link mechanism of car

To link, we mounted a 14-inch pitch diameter ‡ex plate gear with 12-pitch. This is shown in the photos and is easily seen. If we were using "Direct Tilt Control", a torque, Mt, could be applied between links 1 (the vehicle body) and 5 (spring arm and gear) to lean the vehicle through the gear. For "Steering Tilt Control", we used this gear to measure the angle between links 1 and 5 as the vehicle's lean angle. The left side outrigger and castor wheel which were mounted directly behind the left front wheel. The upper limit of lean was about §15± due to these outriggers on each side. The outriggers were a safety precaution to catch the vehicle when it crashed and acted like training wheels on a child's bike.

V - DESIGN METHODLOGY OF AUTO TILTING CAR

5.1 Introduction to CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Dassault Systems. Written in the C++ programming language, CATIA is the cornerstone of the Dassault Systems product lifecycle management software suite. CATIA competes in the high-end CAD/CAM/CAE market with Cero Elements/Pro and NX (Unigraphics).

Sets of workbenches can be composed according to the user's preferences. Therefore Dassault Systems offers three different software installation versions. The platform P1 contains the basic features and is used for training courses or when reduced functionality is needed. For process orientated work the platform P2 is the appropriate one. It enables, apart from the basic design features, analysis tools and production related functions. P3 comprises specific advanced scopes such as the implementation of external software packages.

CATIA can be applied to a wide variety of industries, from aerospace and defense, automotive, and industrial equipment, to high tech, shipbuilding,

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consumer goods, plant design, consumer packaged goods, life sciences, architecture and construction, process power and petroleum, and services. CATIA V4, CATIA V5, Pro/ENGINEER, NX (formerly Unigraphics), and Solid Works are the dominant systems.

This **AUTO TILTING CAR** is designed using CATIA V5 software. This software used in automobile, aerospace, consumer goods, heavy engineering etc. it is very powerful software for designing complicated 3d models, applications of CATIA Version 5 like part design, assembly design.

The same CATIA V5 R20 3d model and 2d drawing model is shown below for reference. Dimensions are taken from. The design of 3d model is done in CATIA V5 software, and then to do test we are using below mentioned software's.

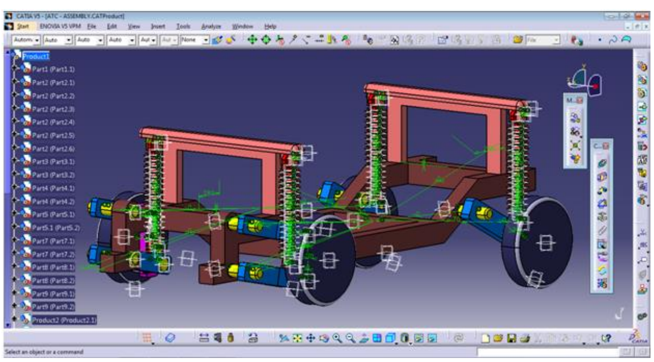

Fig: 5.2: Model design of ATC in CATIA-V5

VI - ANALYSIS OF AUTO TILTING CAR

6.1 Procedure for FE Analysis Using ANSYS:

The analysis of the Chassis, Suspension Clamp, Suspension clamp lock, hook, ring, rod, and wheel are done using ANSYS. For analysis is to carried out by applying moments at the rotation location along which axis we need to mention. Fixing location is bottom legs of the components.

6.2 Preprocessor

In this stage the following steps were executed:

- **Import file in ANSYS window**

File Menu > Import> STEP > Click ok for the popped up dialog box > Click

Browse" and choose the file saved from CATIAV5R20 > Click ok to import the file

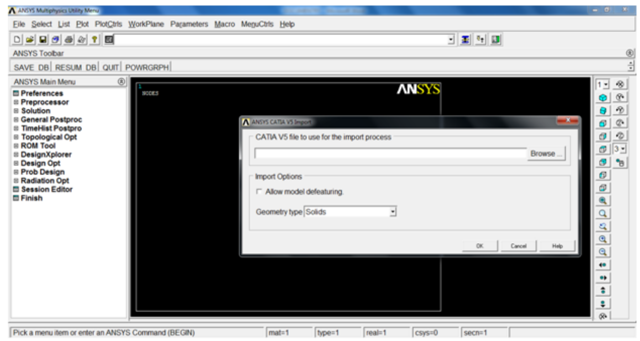

Fig.6.1: Import panel in Ansys.

6.2.1 Meshing:

Mesh generation is the practice of generating a polygonal or polyhedral mesh that approximates a geometric domain. The term "grid generation" is often used interchangeably. Typical uses are for rendering to a computer screen as finite element analysis or computational fluid dynamics. The input model form can vary greatly but common sources are CAD, NURBS, B-rep and STL (file format). The field is highly interdisciplinary, with contributions found in mathematics, computer science, and engineering.

Three-dimensional meshes created for finite element analysis need to consist of tetrahedral, pyramids, prisms or hexahedra. Those used for the finite volume method can consist of arbitrary polyhedral. Those used for finite difference methods usually need to consist of piecewise

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structured arrays of hexahedra known as multi-block structured meshes.

VII - DISCUSSION ON ANALYSYS RESULT

Fig: Displacement of CHASIS

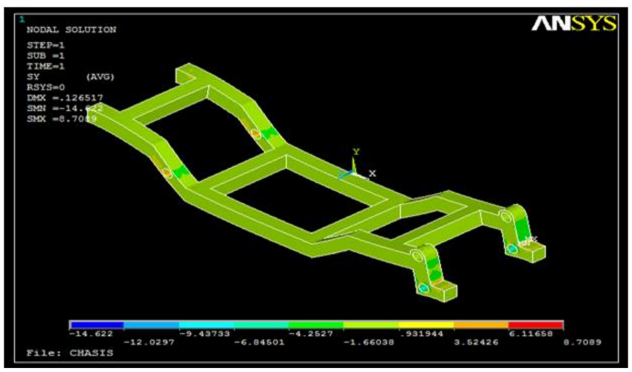

Fig: Stress Analysis of CHASIS

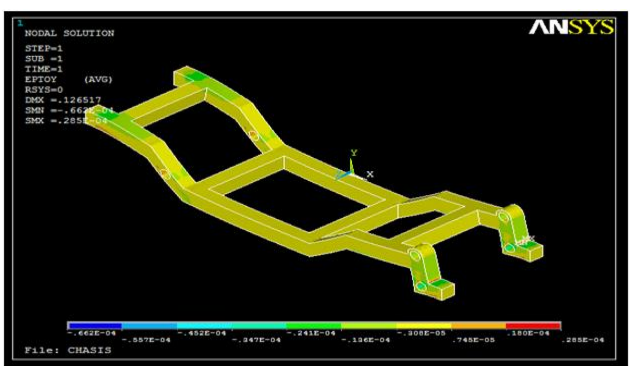

Fig: Strain Analysis of CHASIS

VII - CONCLUSION

It can be seen from the above result that, our objective 1to increase the threshold velocity of a narrow car in a curve has been successful. As shown above figures the displacement of the complete design assembly is meshed and solved using Ansys and displacement is 0.1265mm very less. This is showing us that clearly each component in assembly is having minor displacement.

Stress is at the fixing location (Minimum Stress which is acceptable). The value is 8.7089 MPa compared to yield value of Mild steel; this is below the yield point. The maximum stress is coming, this solution solving with the help of Ansys software so that the maximum stress is less .so we can conclude our design parameters are approximately correct. The design of the car and tilting mechanism is designed flawlessly in analysis as well. The design is to demonstrate tilting is also working successfully, all these facts point to the completion of our objective in high esteem.

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