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Optimization of Hand Brake Lever using FEA & Experimental Stress Analysis Technique

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***Abstract*— Hand brake levers are widely used in all automotive, which acts as a linkage between occupant and brake mechanism. Existing design seems to be overdesigned. Solid modelling of same is done using CATIA V5 software. Finite element analysis is used to apply cantilever load. Topology Optimization solver is used to perform topology optimization. Existing design is then machined as per topological optimization results and tested using strain gauge technique at tensile loading using UTM machine. Comparative analysis is done with FEA and Experimental results.**

***Keywords*— Hand Brake, UTM, CATIA, Optimization**

I. INTRODUCTION

In the system of road vehicles, the parking brake, also known as the hand brake, emergency brake or e-brake, is used to keep the vehicle stationary and in many cases an emergency stop is also performed. Parking brakes operation system on older vehicles often consist of a cable connected to two wheel brakes at one end and the other end to a pulling mechanism which is operated with the driver's hand or foot. The mechanism may be a hand-operated lever, at floor level beside the driver, or a straight pull handle located near the steering column, or a (foot-operated) pedal located beside the drivers leg. In most automobiles the parking brake system process operates only on the rear wheels, which have reduced traction while braking. Some cars have the parking brake on the front wheels, such as most Citroens manufactured since the end of the Second World War and early models Saab 900. The most common use process system for a parking brake is to keep a vehicle motionless when it is parked. The parking system brake has a ratchet or other locking mechanism that will keep it engaged until manually released. On vehicles with automatic transmissions process system, this is usually used in concert with a parking pawl in the transmission. A recent variation is the electric parking brake. First installed in the 2001 BMW 7 Series (E65), electric parking brakes have since appeared in a number of vehicles. Two variations process system are available: In the more-traditional "cable-pulling" type, an electric motor simply pulls the parking brake cable on the push or pull of a button rather In the cabin, as a mechanical pedal or handle. A more complex unit (first seen on the 2003 Audi A8) uses a computer-controlled motor attached to each of the two rear brake calipers referred to as the Motor on Caliper(MoC) system. Hand brake levers are cantilever structure used for transferring motion from occupant to brake mechanism. Existing design needs to be investigated for mass optimization, hence reducing overall cost of brake levers. The objectives of this project is to achieve topology optimized model for hand brake lever using FEA and experimental stress analysis technique. To draw 3 D model using CATIA and to analyse hand brake using ANSYS. To validate the results.

Amit B. Maske et al. [1] The parking brake won't work without pulling or pushing the lever. We humans also often forget to use parking brakes because of negligence or in emergency conditions. This may result in vehicle rolling in the parking area in the event of slopes and collision with other vehicles. Sometimes parking brakes are used as an emergency brake to stop the vehicle when the service brake fails. This project offers a new design of the parking brake system with simple and low-cost features. This paper examines the design, analysis and manufacture of new car parking braking systems. This new parking brake system, also known as the by-wire brake, replaces the conventional parking brake handle with an electronic switch. This is done by replacing conventional connections with electric motor units. High-performance DC motors and gear reduction directly generate the braking force by applying the parking brake [2]. M.R. Mansor et al. Because of the recent trend and increasing awareness of sustainable product design, natural fiber materials are gaining popularity to replace synthetic based fiber in composite formulation, particularly for structural and semi-structural applications in automotive applications. The Analytical Hierarchy Process (AHP) method was used in this paper to select the most suitable natural fiber to be hybridized with glass fiber reinforced polymer composites for the design of the parking brake component of a passenger vehicle center lever lever. Thirteen candidates were selected and analyzed for the hybridization process to determine their overall scores in three main performance indices in accordance with the specifications of the component product design. Using the AHP method, the kenaf bast fiber yields the highest scores and was chosen as the best candidate material for formulating the hybrid polymer composites for the construction of automotive components. Sensitivity analysis has also been carried out and results show that kenaf bast fiber has emerged as the best candidate material in two out of three simulated scenarios, further validating the results obtained by the AHP method. Chunyan Wang et. al. [3] This paper discusses the consistency strategy of braking sense from two aspects of multi-objective optimization and control of compensation. Under multiple targets and multiple constraints, an optimized method of braking force allocation is explored to find the optimal distribution ratios of front and rear axles as well as Hydraulic braking and regenerative braking. The braking sense

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consistency controller is further designed to make up the braking force difference and keep the rate of change in the braking force unchanged. Daogao Wei et. Al. [4] This study sets up a dynamic model of a new two-layer brake system to explore the vibration and noise reduction mechanism of a brake pad with a new structure. The model is used to analyze the effects of double-layer pad parameters on the brake system's stability characteristics and stick-slip vibration.

II. METHODOLOGY

CAD model of existing Hand break lever is done using CATIA software. The meshing of CAD model is carried out using Hypermesh software. Loading and boundary conditions are applied for the analysis of Stress- starin results. For topology optimization of hand break lever, Optistruct solver is used. With the help UTM, stress analysis of optimized mode is carried out. Comparative analysis of FEA and experimental results is done.

III. CAD MODELLING

Computer-aided design (CAD) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. The term CADD (for Computer Aided Design and Drafting) is also used. For modelling of Hand Break Lever CATIA software is used.

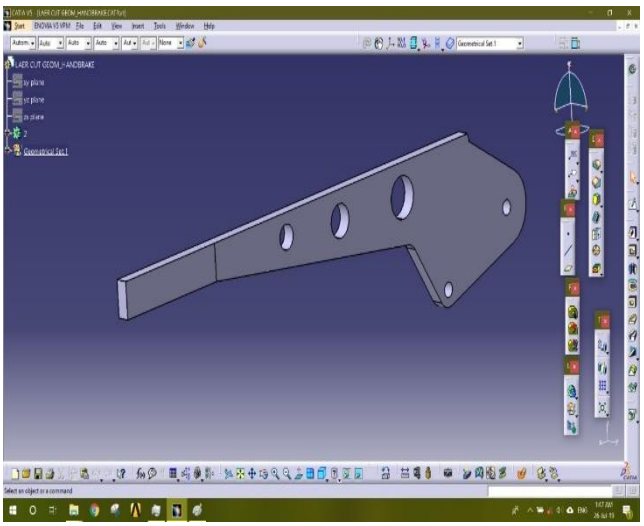

Fig. 1 CAD model

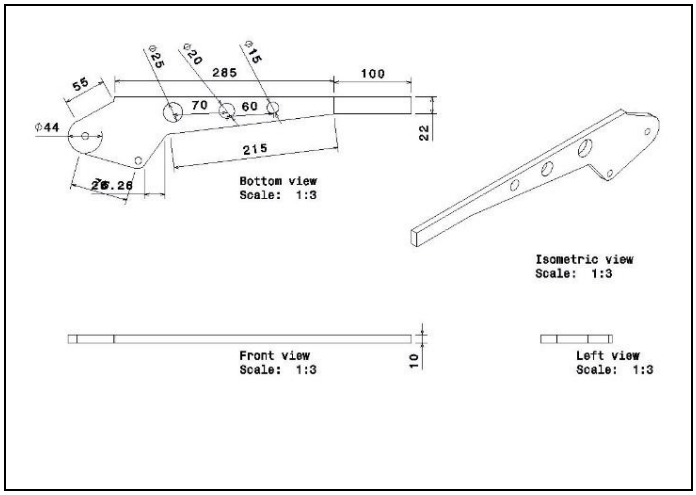

Fig. 2 Drafting of CAD Model

2. Finite Element Analysis:

MESHING

ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient Multiphysics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.

The solid tetrahedron elements are used to generate the meshing of the Hand Brake lever. The node population count is 20751 and element population count is 12387.

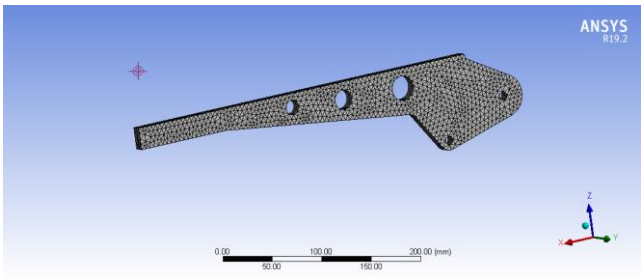

Fig. 3 Meshing of CAD Model

Properties of Outline Row 3: ACRYLIC

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	1.18	g cm^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulu...	
6	Young's Modulus	2760	MPa
7	Poisson's Ratio	0.37	
8	Bulk Modulus	3538.5	MPa
9	Shear Modulus	1007.3	MPa

Fig.4 Properties of Acrylic

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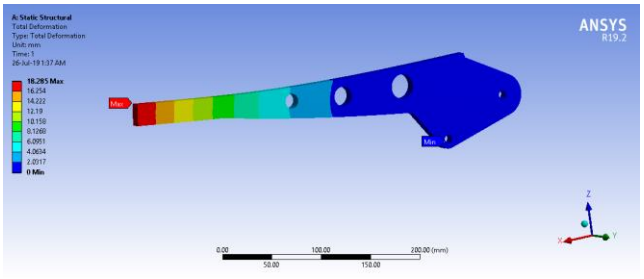

Fig. 5 Results Obtained

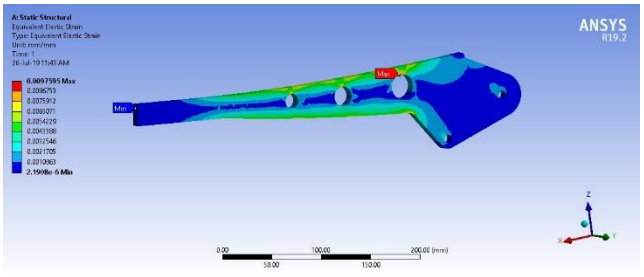

Fig. 6 Maximum Principle Strain

IV. RESULTS AND DISCUSSIONS

By assigning material properties to hand brake lever static structural analysis is carried out. From this analysis deformation and maximum principle strain are obtained 18.25mm and 0.0097 respectively.

V. EXPERIMENTAL SETUP

A universal testing machine (UTM), also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile strength and compressive strength of materials. An earlier name for a tensile testing machine is a tensometer. The "universal" part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures (in other words, that it is versatile). The set-up and usage are detailed in a test method, often published by a standards organization. This specifies the sample preparation, fixturing, gauge length (the length which is under study or observation), analysis, etc.

The specimen is placed in the machine between the grips and an extensometer if required can automatically record the change in gauge length during the test. If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held. However, this method not only records the change in length of the specimen but also all other extending/elastic components of the testing machine and its drive systems including any slipping of the specimen in the grips.

Once the machine is started it begins to apply an increasing load on specimen. Throughout the tests the control system and its associated software record the load and extension or compression of the specimen.

Fig. 7 Experimental Setup

VI. CONCLUSION

It is seen that with use of computer aided design and FEA the results can be obtained very close to the actual testing results which saves our time and cost for the production. It also allows us to get different methods to optimize the product within less time with best results. The optimization done using acrylic material shows the results obtained for the hand break lever are maximum principle strain after the analysis 975microstrain and that for the testing maximum principle strain value is 897.56microstrain. These results obtained from both the methods are useful to validate the work as they are very close to each other with the variation of 8%. As compared to the previous use of material for hand break lever the acrylic shows better results with less mass and good strength for the hand breaks and can be used for the mechanism after actual implementing the hand break and testing it in the real time scenario.

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