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WHEEL CHOCK ANALYSIS BY DEVELOPING FINITE ELEMENT MODEL USING ANSYS

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Abstract

Effective utilization of hand brakes for parking the vehicle on an inclined plane is well established. In addition to hand brakes are the wheel chocks which are the wedges made up of different suitable materials that are placed very close to the wheels to avoid the vehicle to move accidently over a slope when stationary. Wheel chocks are placed as added safety measures along with the parking brakes to prevent the vehicles from rolling when parked over an inclined street. Wheel chocks widely used are made up of steel, aluminum, concrete or even a high quality plastic can also be used to manufacture it. Since use of plastics for wheel chocks makes it light weighted, handy and cost effective, wheel chocks made of steel has been converted to wheel chocks that are made in plastics. The main aim of this project is the cost reduction and weight reduction which makes the chock both handy and economical. To find out the maximum displacement when any external force is applied on wheel chock, stress analysis has been carried out using ansys software.

Introduction

Wheel chock is a device that is manufactured to prevent the vehicles from rolling over the slope when parked. Automobile vehicles have the parking brakes installed on the rear side of the vehicle. If the vehicle is controlled by the parking brakes only on the rear side, there are chances that the vehicle may roll on the front wheels. It can be hence hazardous to park the vehicles over a slope for longer hours at one place, since there are chances that the vehicle might roll over the slope. It can also cause accidents with the employees working on or near the vehicles if it starts rolling over the slope accidently. To avoid such mishaps the use of wheel chocks is necessary as a safety precaution along with the hand brakes. Wheel chocks can be used as the backup measure to prevent the vehicle from rolling down over a slope in the situation when the vehicles parking brake system fails. The side facing the wheel of the wheel chock has a concave profile to configure the shape of the wheel and hence increase the force required by the wheel to overrun the chock. Wheel chocks must be placed in a proper direction to prevent the vehicle from rolling. If the vehicle is parked in the downhill direction, the chocks are placed at the front side of the tire. While if the vehicle is parked in the upward direction, the chocks are placed at the rear side of the vehicle. If the vehicle is parked at the ground level, the chocks are placed on both sides of the tires. Thus depending upon the inclination of the road where the vehicle is parked, the chocks are installed on the side of the wheel which faces downward. If the roads are flat and difficult to identify the slope direction, it is better to place the chocks on both front and rear side of the wheels. Occupational Safety and Hazard Administration (OSHA) recommends installing chocks on rear side of the vehicle. Misapplication of chocks can lead to serious personal injuries to the surrounding people or things. The bottom surface of these chocks can be coated with rubber to obtain a firm grip with the ground. Wheel chocks are manufactured in yellow or orange color due to which it is clearly visible to the eyes. The physical phenomenon of friction, keeps the bottom of the tires pressed firmly against the ground. These chocks provide ramp to the wheels to slide over the chocks to continue revolving. Apart from doing, other functions of the wheel chocks are also considered before selecting them for any vehicle. Since the weight and gravity combines together to roll the vehicle over the slope, the wheel chock should be verified if it can sustain the weight of the vehicle it is going to be used for. It is necessary to identify them for the effective utilization of chocks.

Analysis using ansys

To find out the position where maximum displacement occurs, a model of wheel chock is made in Unigraphics, as shown below. The model is made considering the outer dimensions of the wheel chock made of steel (Fig 1) which is then converted into wheel chocks in plastic (Fig 2). Keeping the outer dimensions same, the internal features of the existing design is changed to provide greater strength to the wheel chock. Minimum wall thickness of 3.5 mm is required to provide proper strength to the wheel chock. Later ribs are also added to the design which adds to the strength of the chocks. Serration lines are added to the model to provide friction to the wheel chocks with respect to the ground as well as the wheel resting on it. Handle is provided to lift the chock and carry along. To obtain weight reduction, cost reduction and to provide the required strength, the material used is high density polyethylene (HDPE).

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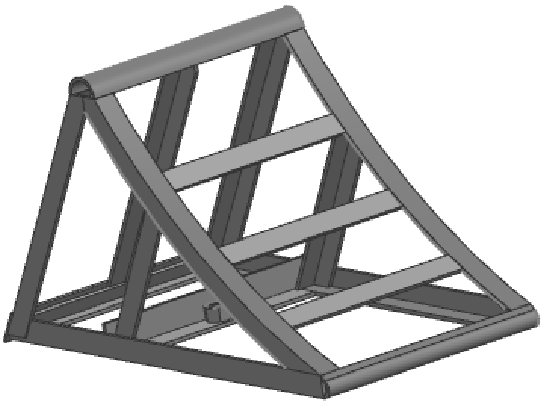

Fig.1 Wheel chocks in Steel

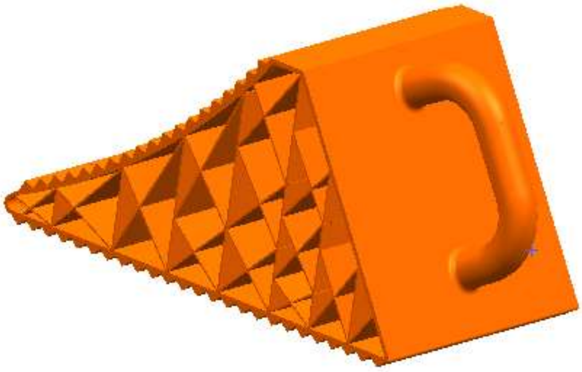

Fig.2 Wheel chocks in plastic

Ansys observations

The model is then analyzed on the ansys software and following results are obtained when the assumed weights are provided to the model. Load applied is of 6500 Kg as shown on yellow color area (Fig. 3). Assuming the mentioned load the following result is obtained. When the wheel chock model is analyzed on the ansys software it is observed that maximum displacement is obtained at the red colored area of around 30.288 mm which reduces at different areas (Fig. 4). The range of displacement is indicated by different colors. The part shown in dark blue color indicates zero displacement which means the weight is not going to cause any impact in that area.

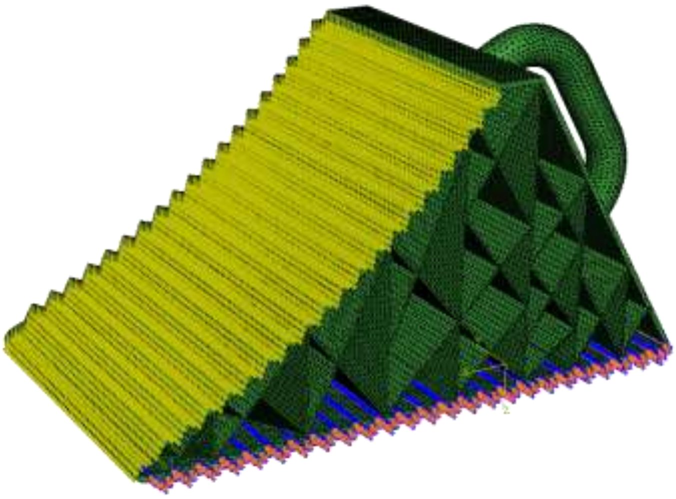

Fig.3

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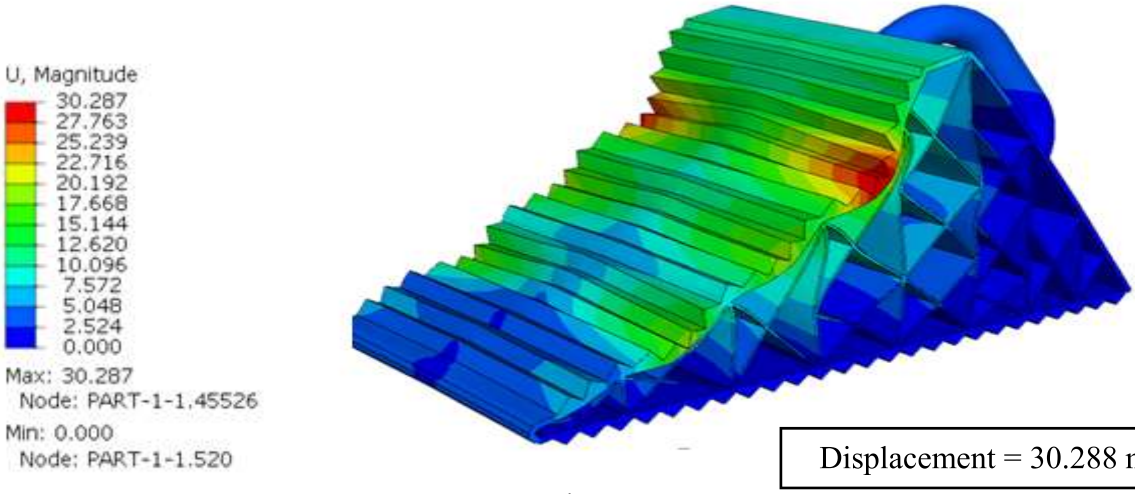

Displacement = 30.288 mm

Fig.4

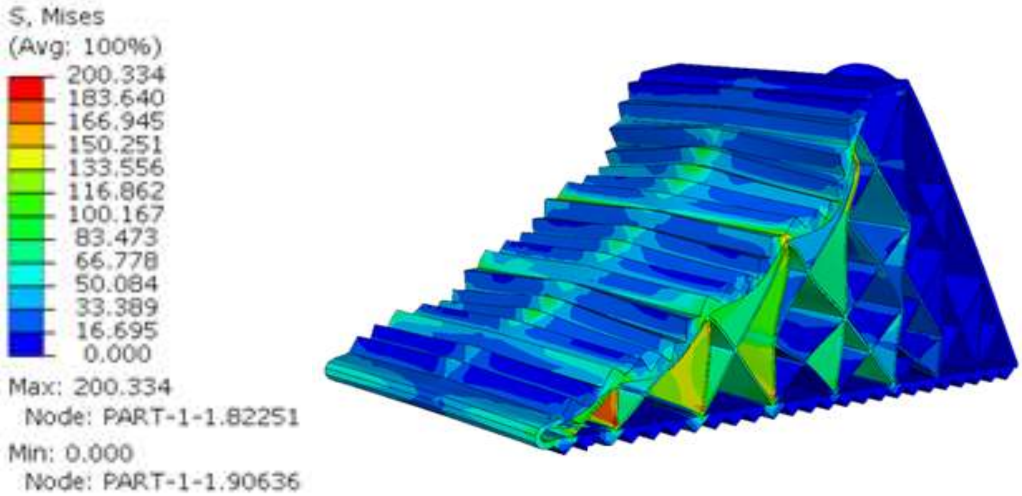

Fig.5

Obtained Von Misses Stress = 200.334 N/mm^2
Yield Stress Limit = 34.5 N/mm^2

The Von misses stress when calculated is obtained to be 200.334 N/mm2 and the yield strength obtained is 34.5 N/mm2 (Fig. 5). When the Von Misses stress reaches the value given in yield strength, the plastic material begins to yield. The yield strength is the stress value at which the plastic material begins to deform. Hence the stress needs to be reduced and the displacement value also needs to be reduced in the above given model. Further changes are to be made in the model to pass the analysis.

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Fig.6

To reduce the stress and displacement value, certain modifications are made in the design of the wheel chock. The handle is removed and the shown arrangement is made to lift the chock (Fig. 6). Since the handle made the part heavy and there is risk that the chock might break during handling. To reduce these risks, the design is modified as shown. When the analysis is made on the modified model of wheel chock by applying a weight of 6500 kg on it which is highlighted in yellow color (Fig 7), following results are obtained.

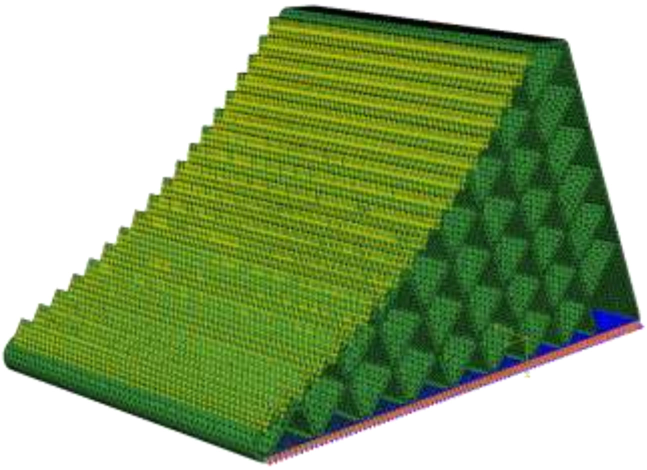

Fig.7

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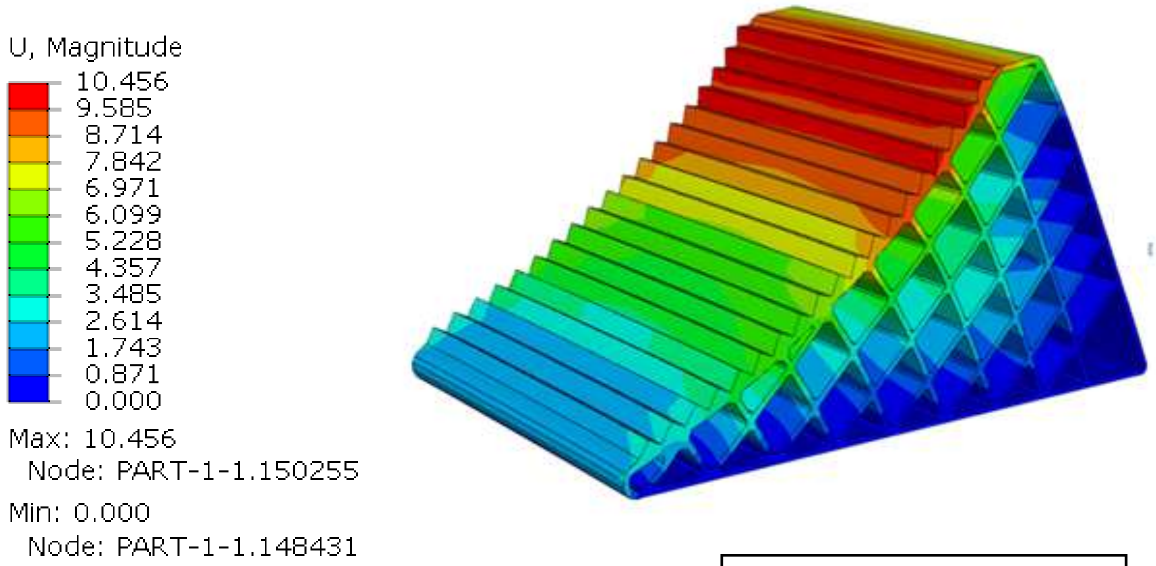

Displacement = 10.456 mm

Fig.8

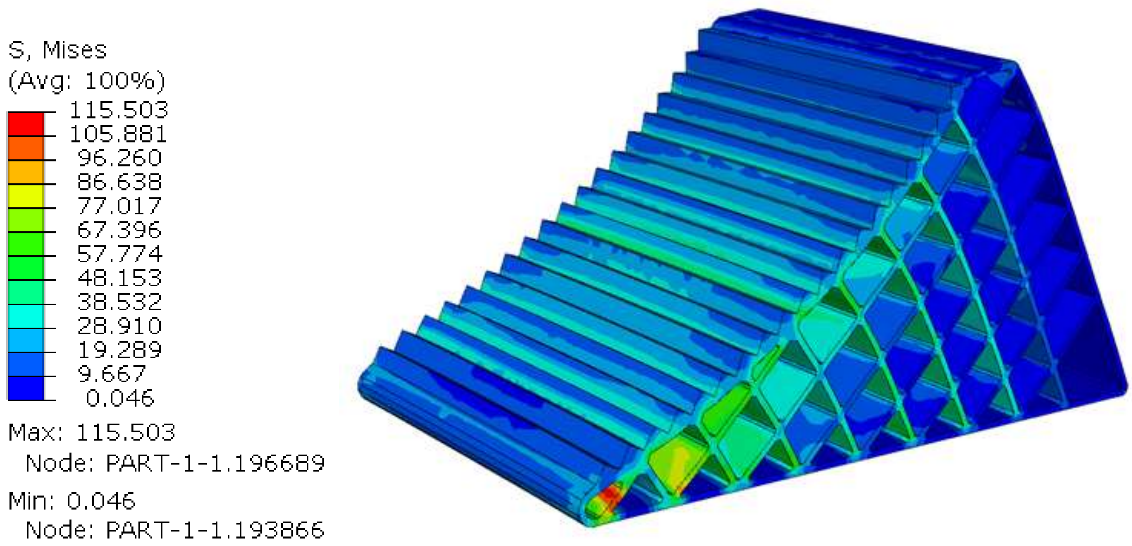

Fig.9

Obtained Von Mises Stress = 115.503 N/mm^2
Yield Stress Limit = 34.5 N/mm^2

Conclusion

It is concluded that the displacement is reduced from 30.288 mm to 10.456 mm (Fig. 8). There is an improvement in the displacement level. Lesser the displacement greater will be the strength of the chock. The Von Misses stress is also reduced from 200 N/mm2 to 115.503 N/mm2 while maintaining the yield stress limit as 34.5 N/mm2 (Fig. 9). The wheel chock can be processed further for manufacturing since it has satisfied the DIN standard test data conditions. According to DIN standard test data, the chocks need to be tested on vehicle parked at 18% slope. Load used for the same should be 6500 kg as prescribed in DIN. Since the required tests are passed by the model, the model can be manufactured.

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References

1. *Franziska Dieke, Meier, "Expectations from a steering control transfer to cockpit crews for aircraft pushback", Department of Air Transport Technology and Logistics, Dresden, Germany, May 29-31, 2012.*
2. *Automotive Research Association of India, "Automotive Vehicles- Starting Grade ability- Method of Measurement and Requirements, AIS 003/1999, Amendment No 2/ September 2000*
3. *ICAO Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual, ICAO Doc. 9830, 1st ed., International Civil Aviation Organization, 2004.*
4. *Zöbel, D., Trajectory Segmentation for Autonomous Control of Backward Motion for Truck and Trailer, IEEE Transaction on intelligent transportation systems, Vol. 4, No. 2, 2003.*
5. *Dell, G., Pushback Accidents Reviewed To Identify Causes and Prevention, Flight Safety Foundation, Vol. 20 No. 3 | No. 4, 1994.*