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STATIC STRUCTURAL ANALYSIS OF BACKHOE LOADER CHASSIS

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ABSTRACT:

Backhoe Loader chassis is the skeleton of a commercial vehicles. The main function of the truck chassis is to support the different components like engine, cabin, transmission, front axle and rear axle. Static analysis is carried out for maximum reach condition in order to observed stress and deformation pattern.

Keywords: *Backhoe Loader chassis, maximum reach condition, stress and deformation pattern.*

[I] NTRODUCTION

In the era of globalization and tough competition the use of machines is increasing for the earth moving works, considerable attention has been focused on designing of the earthmoving equipments. Thus it is very much necessary for the designers to provide not only a equipment of maximum reliability but also of minimum weight and cost, keeping design safe under all loading conditions by careful stress analysis of the machines.

Backhoe Loaders are used primarily to excavate below the natural surface of the ground on which the machine rests and load it into trucks or tractor pulled wagons or onto conveyor belts. They are capable of excavating all classes of earth, except solid rock, without prior loosing. They are adapted to excavating trenches, pits for the basement, and general grading work, which require precious control of depths.

Chassis of commercial vehicles have almost same appearance since the model was developed. It indicates that there is very slow and stable improvement in the chassis [1].

The Backhoe Loader chassis used for the study has a gross weight of 743 Kg. It consists of 2 inside C-plate and has 1 chassis box members along the 2 inside C-plate. There are some additional members like End plate and chassis Front plate The material of the backhoe loader chassis is structural steel alloy. The properties of the material are listed below:

Modulus of Elasticity, E = 200 GPa

Mass Density, ρ = 7850kg/m^3

[II]STATIC FORCE CALCULATION

Maximum breakout force at the tip of bucket for given configuration is being calculated using given equation

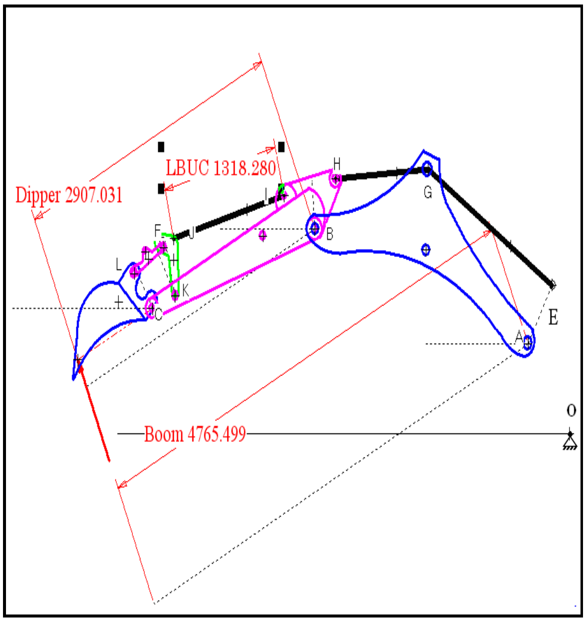
$$F_{brk} = \frac{Fbub \times A1 \times C1}{B1 \times D \times 9.81}$$

Where,

F_{bub} - Bucket cylinder force
A1 -Perpendicular distance bucket cylinder axis - lever pivot
B1 -Perpendicular distance connecting link axis - lever pivot
C1 -Perpendicular distance connecting link axis - bucket pivot
D -Radius bucket pivot-tooth lip

Distance A1, B1, C1 and D are being measured using DV file as shown in the fig.1 and fig.2

Figure1: Maximum reach condition



Distance A1, B1, C1 and D are being measured using DV file as shown in the fig.1.

Forces at each point are being calculated using Mathcad software. Forces at point A where boom is connected to swing post and point E where boom cylinder is connected to swing post are listed below for both load cases.

For maximum reach condition,

$$F_A = \begin{pmatrix} -316904.32 \\ 223034.996 \\ 0 \end{pmatrix} N$$

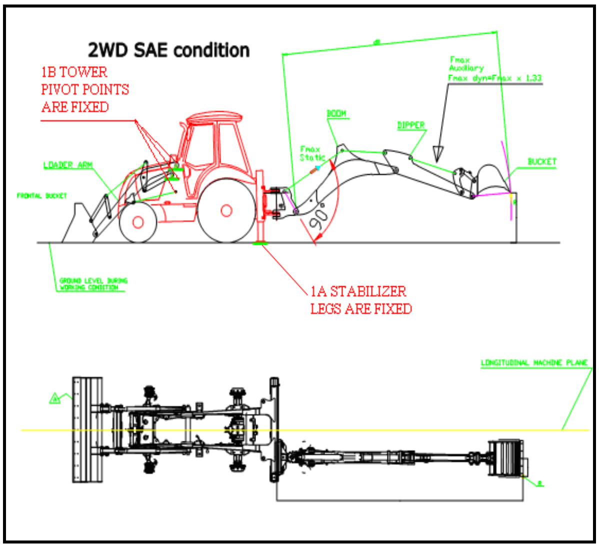
$$F_E = \begin{pmatrix} 300293.341 \\ -187274.224 \\ 0 \end{pmatrix} N$$

[III] FINITE ELEMENT MODEL

The Backhoe Loader chassis model was meshed by tetrahedron solid elements. For linear static analysis the chassis model was meshed with 109748 tetrahedron elements and 225025 nodes.

In above load case there are two different sub cases.

Figure 2: Constraint for both load cases



3.1. Stabilizer legs are fixed

When backhoe is in working condition and all the load is being transmitted through stabilizer legs as shown in fig.2.

3.2 Loader pivot points are fixed

When backhoes is in working condition and while digging bucket teeth struck some rigid obstacles then backhoe loader is resting on three pivot point of the loader as shown in fig.2.

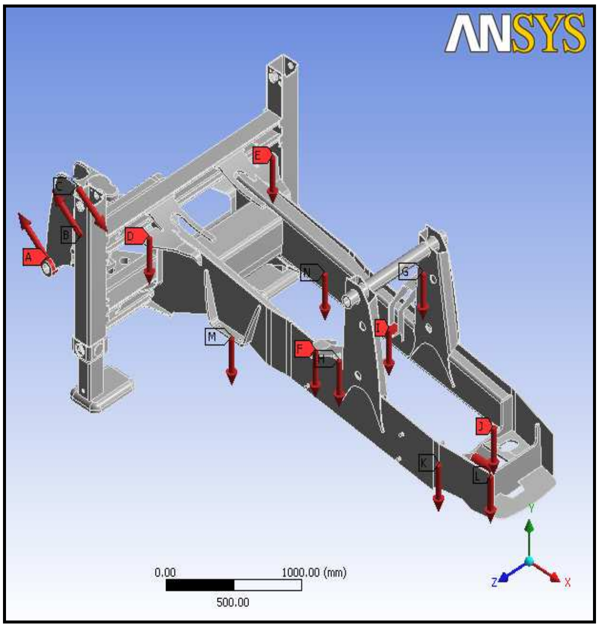
For practical calculation, it is recommended that the load on the chassis is concentrated at a small number of points [2]. Hence dead weight of different components mounted on chassis is applied at mounting points on the chassis along with breakout force. Dead weight of different components is listed in table 1.

[Table-1]

No.	Component	Weight(Kg)	Load(N)
1	Cabin	620	6082
2	Front axle	225	2207
3	Rear axle	410	4022
4	Transmission	215	2109
5	Engine	585	5739
6	Chassis	743	7289

Table1. Dead weight of different components

Figure 3: Different forces on chassis



[IV] RESULTS AND DISCUSSION

For load case 1A i.e. when stabilizer legs are fixed.

Figure 4: von- Mises stress for load case 1A

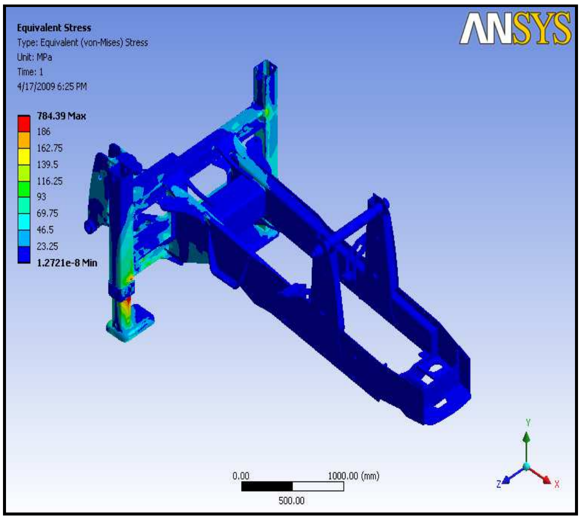
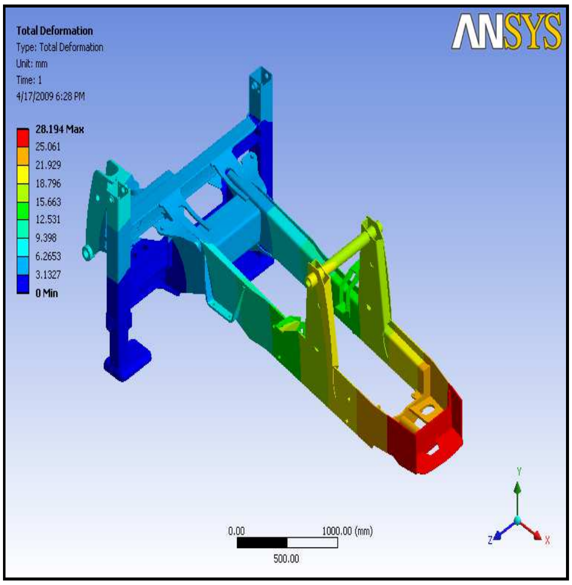


Figure 5: Deformation for load case 1A



For load case1A we can observed that stress generated are higher at stabilizer legs as compare to other part of the chassis. Also we can observe that deformation is higher at

front side of the chassis which has max value of 28.194mm.

For load case 1B i.e. when loader tower points are fixed

Figure 6: von- Mises stress for load case 1B

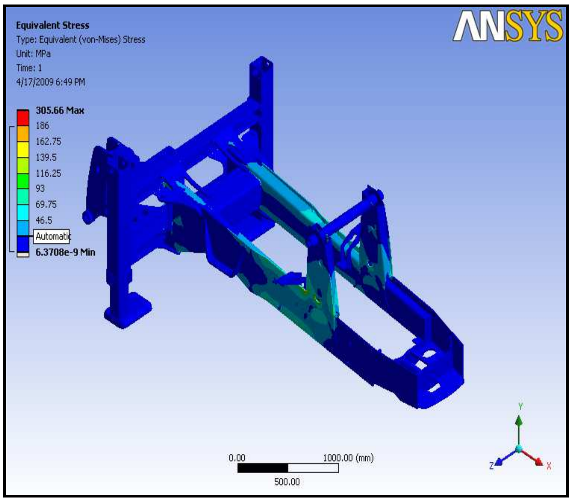
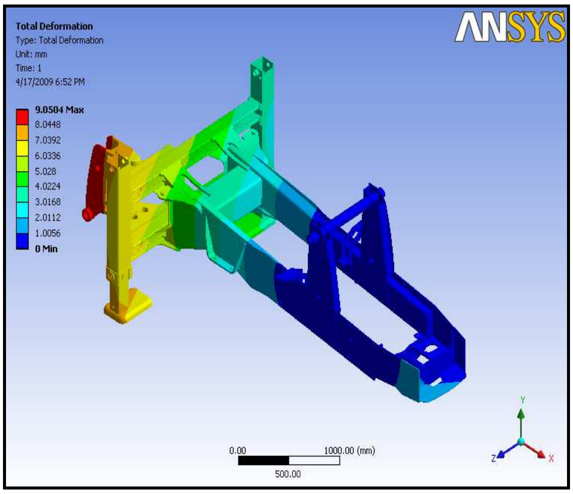


Figure 7: Deformation for load case 1B



For load case1B it can be observed that stress generated are higher at loader tower as compare to other part of the chassis. Also it can be observed that deformation is higher at front side of the chassis which has maximum value of 9.0504mm.

The static analysis shows concentration of stress at the sharp edges of the chassis. This concentration of stress can be reduced by smoothening the sharp corner. The sharp corner can be eliminated by introducing fillet in the design. Besides that, the welded joints are also one of the highest stress concentration areas. The imperfect welding during the fabricating process are the weak areas where failure of the chassis is likely to occur due to fatigue.

[V] CONCLUSION

In the linear static analysis, the stress distribution and deformation profile of the Backhoe Loader chassis is observed when backhoe is at maximum reach condition. For load case 1A maximum stress occurred at stabilizer legs while maximum deformation occurred at front side of the chassis. For load case 1B maximum stress occurred at loader tower while maximum deformation occurred at H-frame of the chassis. Here maximum stress is higher than permissible value due to sharp edges and corners. These can be minimizes by smoothening sharp edges and introducing fillet.

REFERENCES

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