

Structural Stability Analysis of the Radiator in General Four Wheeler Vehicles

Manoj Taipalle¹, Shivaprasad Patil², Dr.S.N.Kurbet³

P.G. Student, Department of Mechanical Engineering, Basaveshwar Engineering College Bagalkot, India^{1,2}

Professor, Department of Mechanical Engineering, Basaveshwar Engineering College, Bagalkot, India³

ABSTRACT: The Design of the radiator is based on the three main engineering demands such as Thermal, design point of view and fabrication. The current scope of project is based on the structural design of the radiator. When the radiator is mounted on the moving vehicle, during the operation the radiator is subjected to the various loads such as bumping and breaking. These loads tend to create the stress at the weld zone area in radiator structure. So in the current project work the analysis is carried out and the stress are compared with the yield strength of the material thus finding the appropriate FOS as required by the standards.

KEYWORDS: Bumping, Breaking and FOS.

I.INTRODUCTION

Radiators are those heat exchangers used to transfer the thermal energy from one medium to another medium for the purpose of cooling and heating. But in automobile radiators were fitted as cooling device they maintain the heat or temperature at optimum level. Radiators are considered as the source of heat i.e radiator is used for the purpose of heating and the cooling environment using suitable coolants, coolants may be air or liquid. 80years ago most of the radiators were made from cast-iron but in now days radiators were manufacturing by using the pressed steels and aluminium. And few radiators are manufacturing by using copper- brass and plastic.

Different types of radiators in different vehicles are found example in car, laurry and bus etc... but In car it is very important component for the purpose of cooling because sometimes leakage of heat and blockage may cause the car to be over heat then that leads major problem or leads to major damages and expensive repairs for the cooling system. As mentioned above in automobiles radiators used for the purpose of cooling and temperature maintaining at optimum level along with radiator also results in to the problems like knocking, cylinder deformation and piston deformation but sometimes radiators fail to control the knocking, cylinder deformation and piston deformation may happened. If radiators work properly and efficiently then cooling system automatically works well in order to that engine performance will increases vice- versa.



Fig.1.1 commonly used radiators in vehicle

Functions of radiators

Two main functions of the radiators are as follows

1. Cooling and Heating.
2. To maintain temperature level.

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II. LITERATURE REVIEW

1) **P. Mounik, Rajesh K Sharma and P. S. Kishore (2016):** In this literature they studied, the analysis of the radiator at different speed of air striking when radiator change its position from rest to certain speed. Heat transfer process usually takes from coolant to tube and later from tube to air through fins. After analysis, air heat transfer coefficient, ethylene glycol estimated and heat transfer coefficient is to be calculated. Finally they concluded that the heat transfer coefficient increases when air striking of the radiator changes and also noticed that radiator with higher the velocity of air striking the Reynolds number will be higher and it also results in reducing the efficiency of the fins.

2) **R. K. Jayakumar and Dr. K. S. Amirthagadeshwaran (2016):** In this literature they discussed that the development of the engine system in order to improve the engine performance and heat transfer coefficient. By experimental method here they studied the copper radiator actions with the different velocities. They noticed the changes in between experimental and simulation method. At lastly they concluded that the increase of air velocity results in increasing the engine parameter performance i.e heat transfer coefficient, surface pressure drop and heat transfer ratio some times in results changes may occurs due to quality of mesh and friction loss.

3) **Shaolin Mao, Changrui cheng and Xianchang Li et.al (2010):** In this paper they discussed about the radiator thermal performance and radiator thermal stress in heavy duty vehicles. Used the FEA tool and simulation method to analyse the displacement and strain on the basis of radiator tube wall temperature, pressure drop and heat transfer coefficient. From analysis they predicted the spots in the radiator from that improve of the weak spot in the radiator are to be done. Finally concluded that using of such thermal coupling and DPZ method is very useful to improve the product useful life, durability and also warranty.

4) **Chavan D K and Tasgaonkar G S (2013):** In this paper they discussed, the various shape and designs of the radiator which are using in vehicles. In vehicles most of the peoples are using rectangular shape, square shape and circular shape radiator. With the help of CAD drawing they started to develop the various design of radiator model and finally they concluded that the circular shape and design of radiator is better than the rectangular shape and square shape radiator because these circular shape of radiator gives maximum efficiency, less material required to manufacture, design is compact and more efficient.

5) **JP. Yadav and Bharat Raj Singh (2015):** In this paper they studied the numerical parameters of the radiators. The radiator design has been explained by using finite element method and thermal concept. Before evaluation of radiator performance radiator is kept under test setup, various parameters like mass flow rate – inlet coolant temperature are varied. Here they did analysis between two different coolants i.e water another one is mixture of propylene glycol. Concluded that still water is the best coolant for the radiator but disadvantage of water is that it is corrosive in nature and contains dissolve salt that degrade the coolant flow passage.

III. RESULT AND DISCUSSIONS

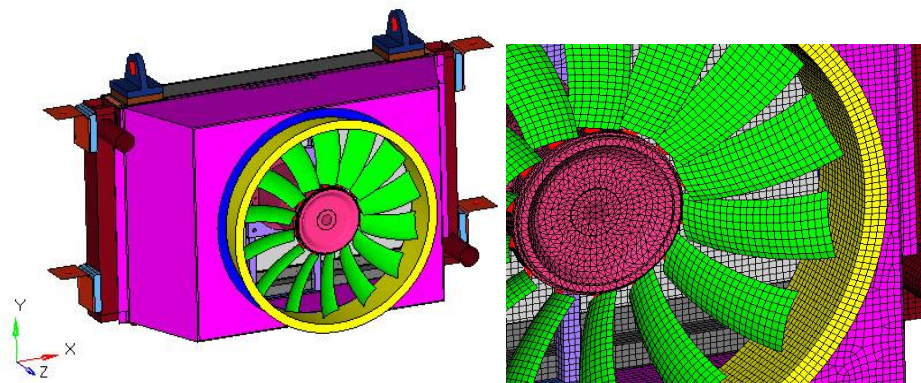


Fig.3.1 CAD Geometry and FE Model of Radiator

The space for the radiator to mount on the vehicle requires the length, breadth and width to be 1.6m x 0.8m x 0.7m respectively. The three dimensional model of radiator is generated in the CAD software as per the customer

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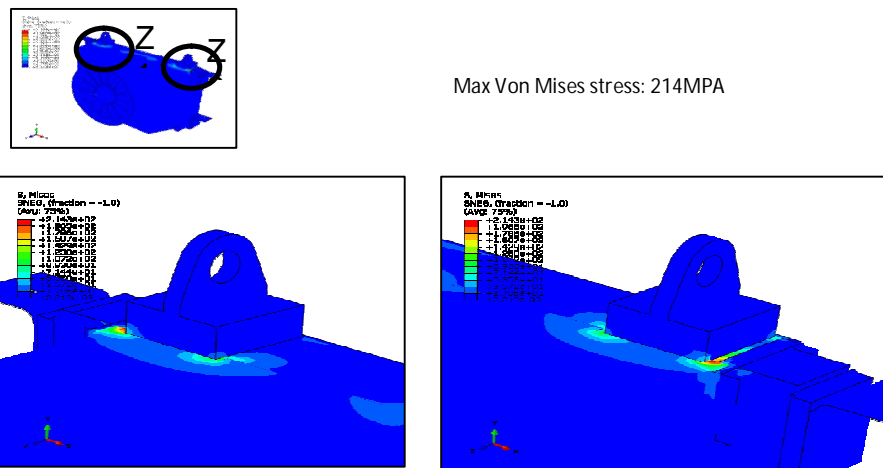
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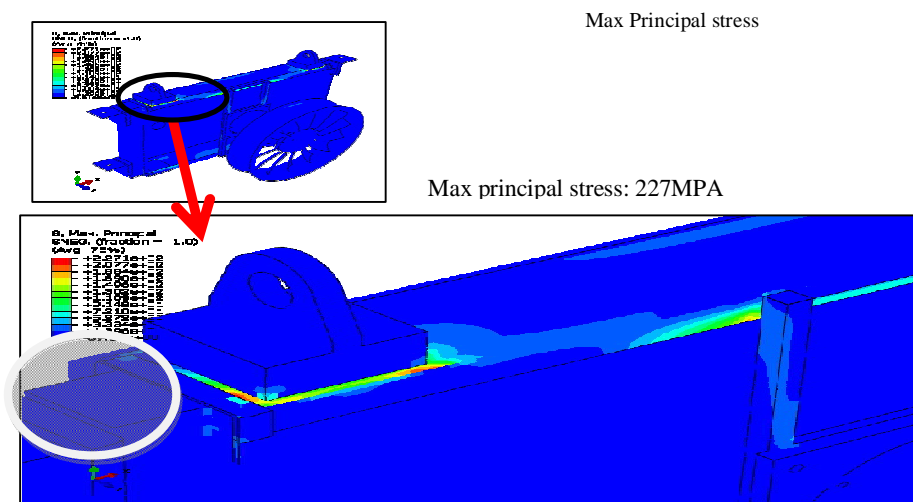
required specifications. The 3D model can be generated by Unigraphics, CATIA or any CAD software's. The reference model is generated in the IGES file format as it can be support the various software's available in the market. In this work the IGES file is imported into the Hypermesh software for further analysis.

1st order shell 4 nodes and shell 3 nodes elements are used for sheet metal parts and 3 dimensional tetra elements are used for solid parts like hub of the fan. Size of the elements plays a vital role in finite element analysis because accuracy of the result depends on element size. Therefore elements size has to be selected lot of care. If elements size is small, the expected final solution is to be more accurate. Depending on cross section and region where stress concentration is more the element size varies.

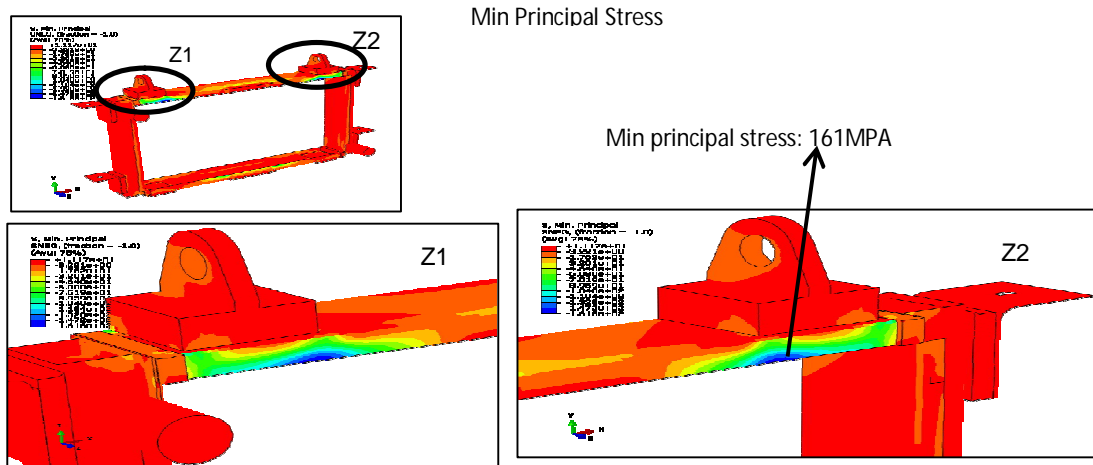
I. LOAD CASE 1: LIFTING LOAD IN VERTICAL DIRECTION



The Fig.3.2 shows the maximum von mises stress on the radiator structure when the lifting load is applied on the radiator structure. The lift load considered here is three times of that static gravity load in vertical upward axis. The maximum von mises stress observed at the hook during lifting condition is 227Mpa.

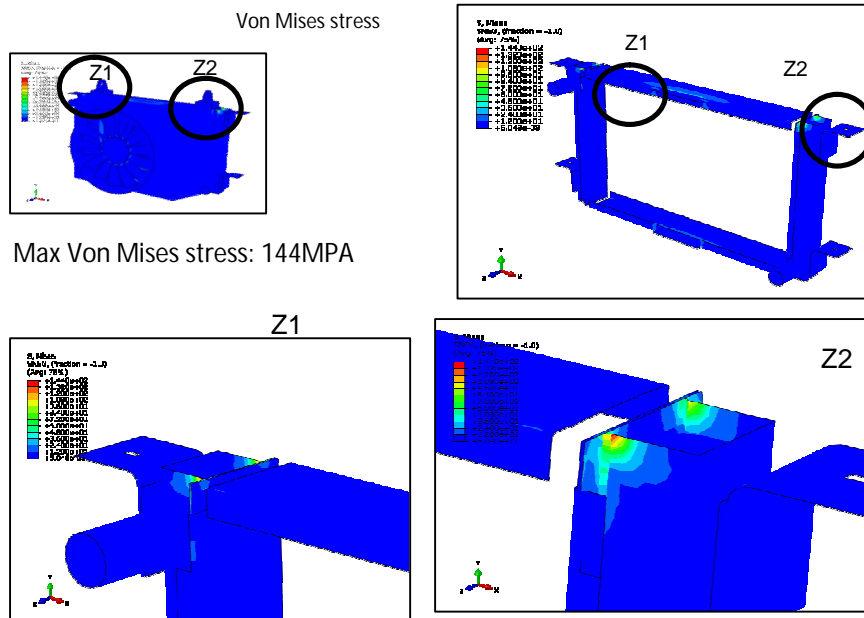


The Fig.3.3 shows the maximum principal stress on the radiator structure when the lifting load is applied on the radiator structure. The lift load considered here is three times of that static gravity load in vertical upward axis. The maximum principal stress observed at the hook during lifting condition is 227Mpa.



The Fig.3.4 shows the minimum principal stress on the radiator structure when the lifting load is applied on the radiator structure. The lift load considered here is three times of that static gravity load in vertical upward axis. The minimum principal stress observed at the hook during lifting condition is 161Mpa.

Load case 2: Breaking load in longitudinal direction



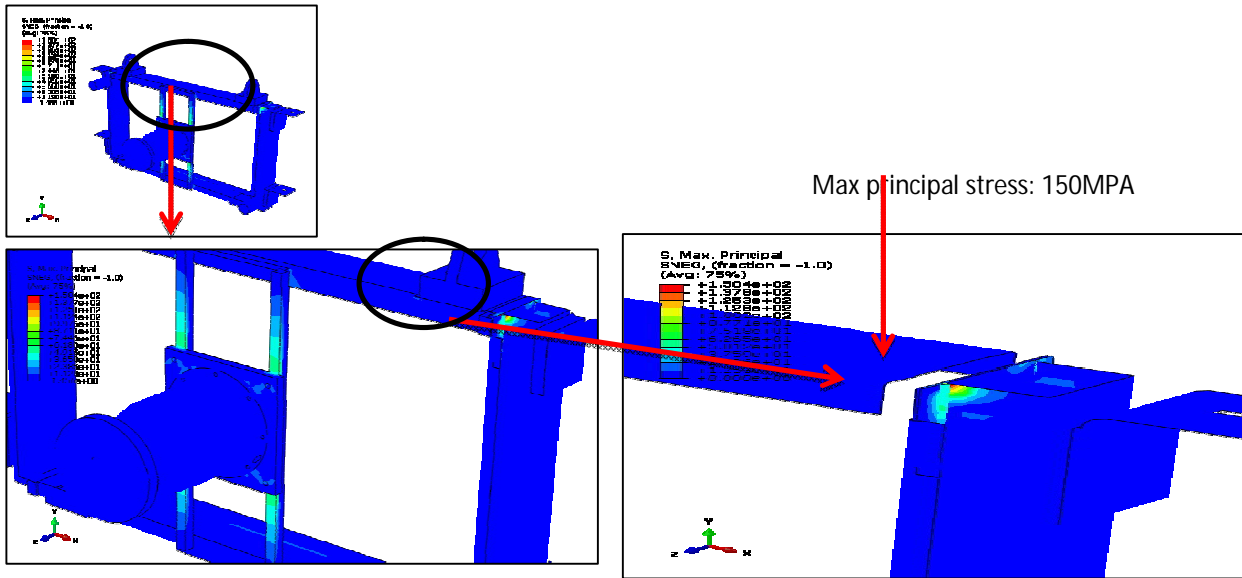
The Fig.3.5 shows the maximum von mises stress on the radiator structure when the breaking load is applied on the radiator structure. The break load considered here is three times of that static gravity load in vertical upward axis. The maximum von mises stress observed at the hook during breaking condition is 144Mpa.

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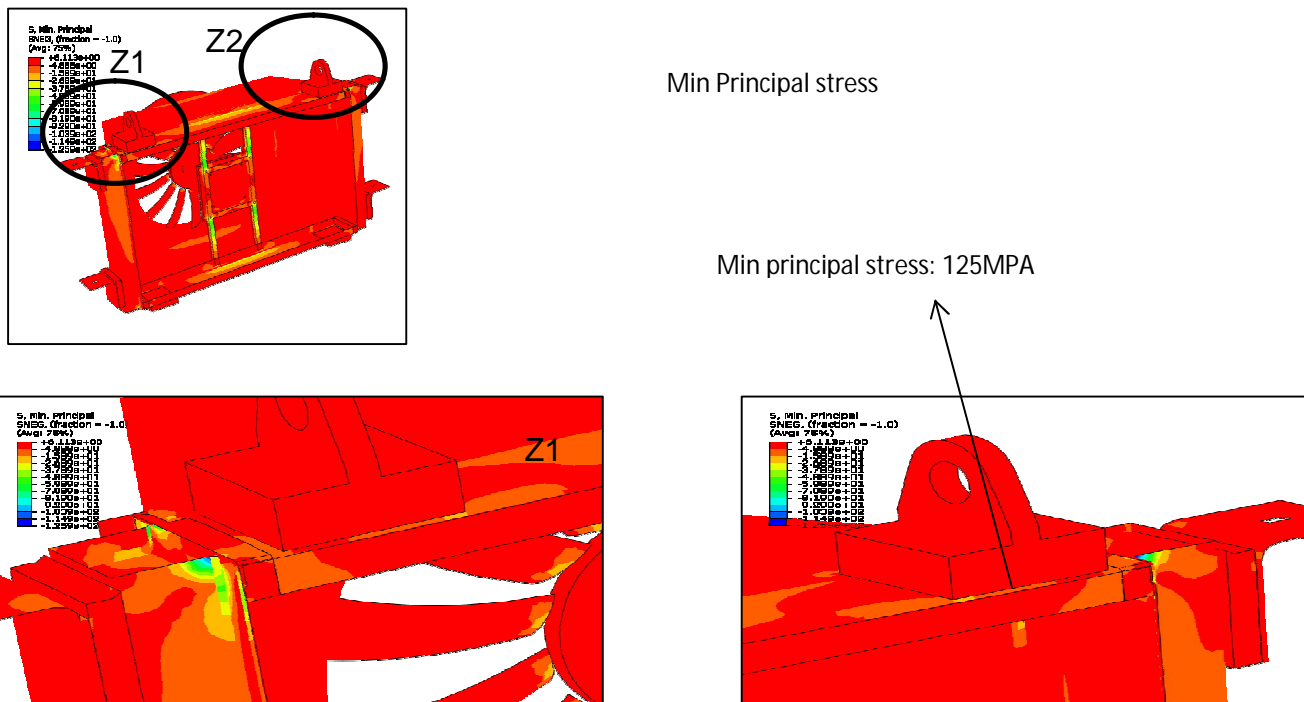
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The Fig.3.6 shows the maximum principal stress on the radiator structure when the breaking load is applied on the radiator structure. The break load considered here is three times of that static gravity load in vertical upward axis. The maximum principal stress observed at the hook during breaking condition is 150Mpa.



The Fig.3.7 shows the minimum principal stress on the radiator structure when the breaking load is applied on the radiator structure. The break load considered here is three times of that static gravity load in vertical upward axis. The minimum principal stress observed at the hook during breaking condition is 125Mpa.

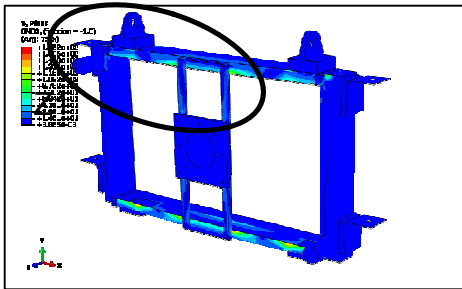
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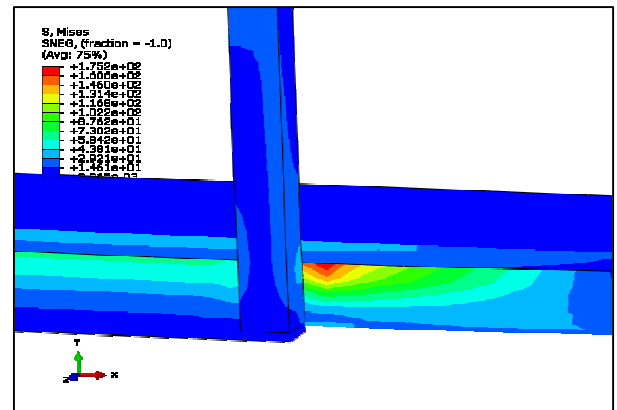
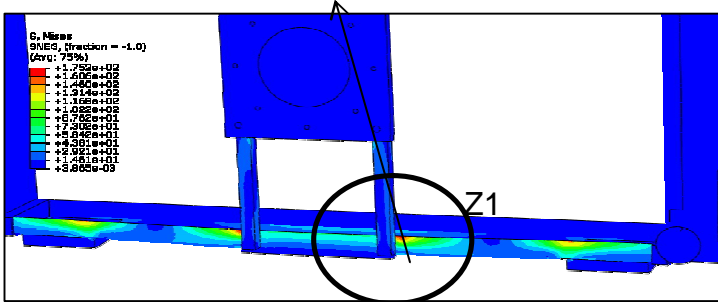
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Load case 3: Bumping load in Vertical direction

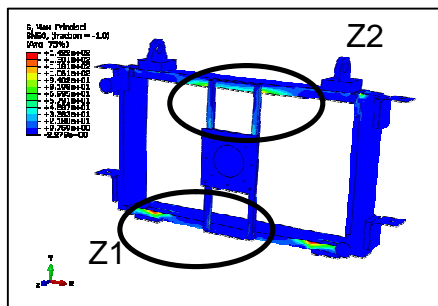


Von Mises stress

Max Von Mises stress: 175MPa

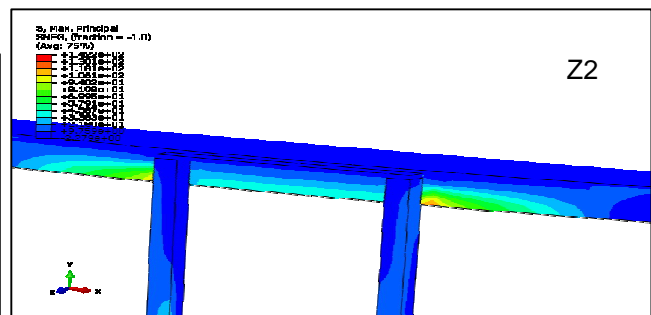
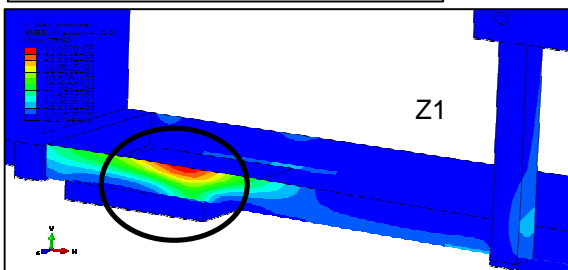


The Fig.3.8 shows the maximum von mises stress on the radiator structure when the bumping load is applied on the radiator structure. The bump load considered here is three times of that static gravity load in vertical upward axis. The maximum von mises stress observed at the hook during bumping condition is 175Mpa.



Max Principal stress

Max principal stress: 142MPa



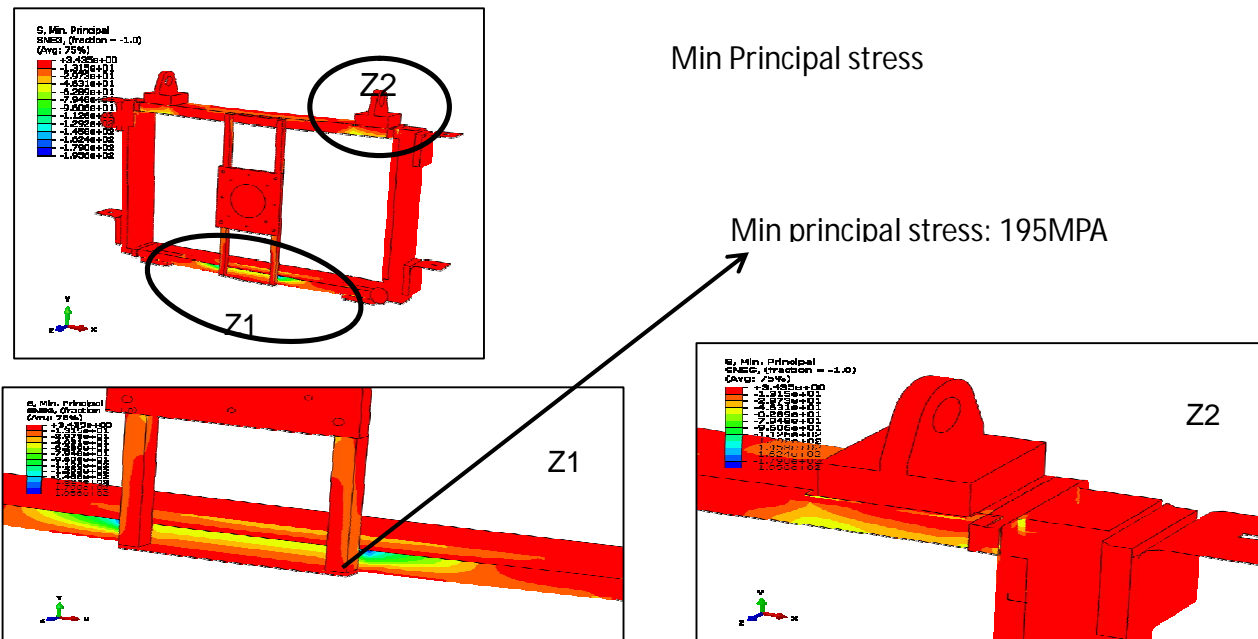
The Fig.3.9 shows the maximum principal stress on the radiator structure when the bumping load is applied on the radiator structure. The bump load considered here is three times of that static gravity load in vertical upward axis. The maximum principal stress observed at the hook during bumping condition is 142Mpa.

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The Fig.3.10 shows the minimum principal stress on the radiator structure when the bumping load is applied on the radiator structure. The bump load considered here is three times of that static gravity load in vertical upward axis. The minimum principal stress observed at the hook during bumping condition is 195Mpa.

Result and Summary table

Strength analysis report													
Sl.No	Mass of structure(tons)	G Load	Applied Loads on the structure			Reaction force at fixed points			YS (MPA)	Max Principal	Min Principal	Max von mises	FOS
			x	y	z	x	y	z					
LC1 (Lift)	0.2868	3	0	-8441		0	8441		369	227	161	214	1.6
LC2 (Breaking)	0.2868	3	0	0	8441	0	0	-8441	369	150	125	144	2.5
LC3 (Bumping)	0.2868	3	0	-8441	0	8441	0		369	142	195	175	1.9

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IV. CONCLUSION

After conducting all the three load cases for the radiator the stress plots are tabulated as shown in the table 4.1. From the result summary table the maximum stress observed in the radiator is 227Mpa which occur during lifting condition. The maximum stress 227Mpa is less than the yield strength of the steel material i.e yield strength of the steel material is 369 N/mm. hence the structure is with respect to a strength and the least factor safety among three loading condition is 1.6, hence the structural design is safe and the radiator should be designed based on the lifting case.

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