Performance Check and Relevant Design Modifications of RUPD under Impact Loading

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Abstract

Under-running of passenger vehicles is one of the important parameters to be considered during design and development of truck chassis. Rear under run protection device (RUPD) is used to offer safety in case of rear impact and rear under-running of the passenger vehicles to the heavy and medium duty trucks. As per ECE regulation 58 RUPD is statically analyzed but we have performed its dynamic analysis in order to have the knowledge of the damage caused by rear impact in real life situation. Here we have suggested a modification in existing RUPD design. Maximum deflection and stresses in both existing and modified design are compared using FEA in LS-Dyna. Comparison clearly shows the necessity of improving the design.
Keywords- RUPD, Hypermesh, LS-Dyna, Dynamic, Impact analysis

I. INTRODUCTION

Many people get injured during under ride accidents. Under ride occurs when a small passenger vehicle goes beneath the heavy goods vehicle either from the front or rear or side. During such accidents the passenger compartment of the small vehicle strikes the chassis of the heavy vehicle causing severe injuries to passenger in the smaller vehicle. Under ride accident are of three different types namely front, rear and side under run accidents. To avoid such accidents an under run device has to be installed on the heavy good vehicle which would prevent the passenger of the small vehicle from getting fatal injuries. In this paper we are going to increase the load bearing capacity of the RUPD (Rear Under-Run Protection Device). Without the installation of the RUPD the entire energy will be on the pillars of the car structure which in turn would not be able take such impact. Figure 1 shows damage caused to small passenger vehicle during a rear under ride accident. The entire vehicle has gone underneath the truck and the entire structure of the car has got crumbled due to the sudden impact load[1].

It is very much clear that in case of crash without the RUPD the impact of the truck is on the passenger compartment due to the under running of the car under the truck.

Fig. 1: The passenger vehicle impact with Rear end of Truck[1]

Static analysis of RUPD is often performed but it doesn't give any idea of actual damage caused by the rear impact which naturally is the dynamic case. So we are presenting the dynamic analysis of RUPD using FEA and suggesting the modification in existing design.

II. METHOD

Detailed 3D FE model of RUPD assembly and chassis were developed using Hypermesh13.The complete simulation was developed using LS-Dyna explicit solver. Meshed model is shown in the fig 3.While modeling it was considered to be comprised of two parts namely a bracket and tubes. Both the components were modeled using 2D shell elements. Holes provided on RUPD for bolting were constrained in all the directions. Vehicle bumper was modeled as a rigid part and meshed using 2D shell elements.MATL24 is used to define a material property which is for deformable materials.MATL20 is used to define material properties of vehicle bumper which is for rigid materials.MATL24 allows users to define stress-strain data.

Fig. 2: Meshed model of RUPD in Hypermesh 13[2,3]

Table below shows the details of material used and corresponding properties.

Table 1: Mechanical Properties of the RUPD tube and brackets

Component	*Bracket and Tubes*
Material Type	*Hot rolled steel*
Yield stress(MPa)	*255*
Ultimate Tensile Stress(MPa)	*410*
% Elongation	*24*
Elastic modulus(MPa)	*2.10E+05*

III. DYNAMIC ANALYSIS OF EXISTING RUPD MODEL

Initialvel card in LS-Dyna allows users to input initial velocity. Using this we input the initial velocity of 20Kmph.Vehicle bumper was made to impact on the RUPD. Post processing was done and results were noted. Results include maximum deformation, its location and maximum stress by Von-Mises theory of failure. The figure below shows the maximum stress and the node at which it is observed.

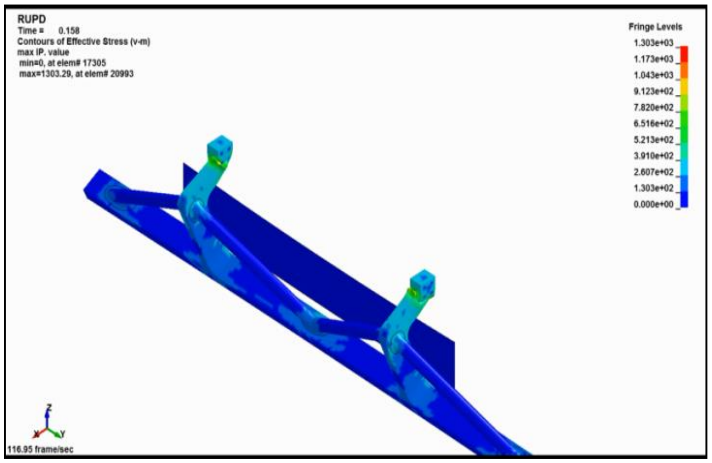

Fig. 3: Dynamic analysis of existing RUPD.

Maximum deformation observed was 730mm.Maximum stress was 1303Mpa.

IV. MODIFIED DESIGN

Results above clearly show the necessity of improving the existing RUPD design. Additional reinforcement was provided at the top. Material reinforcement increases section modulus and stiffness of the structure. The reinforcement was carried out by welding the plates of same material as that of RUPD having thickness 5mm.
The Dynamic analysis was again carried out on the
Structure having reinforcement .The results obtained are shown by the figures below.
Dynamic analysis was performed keeping all other parameters same.

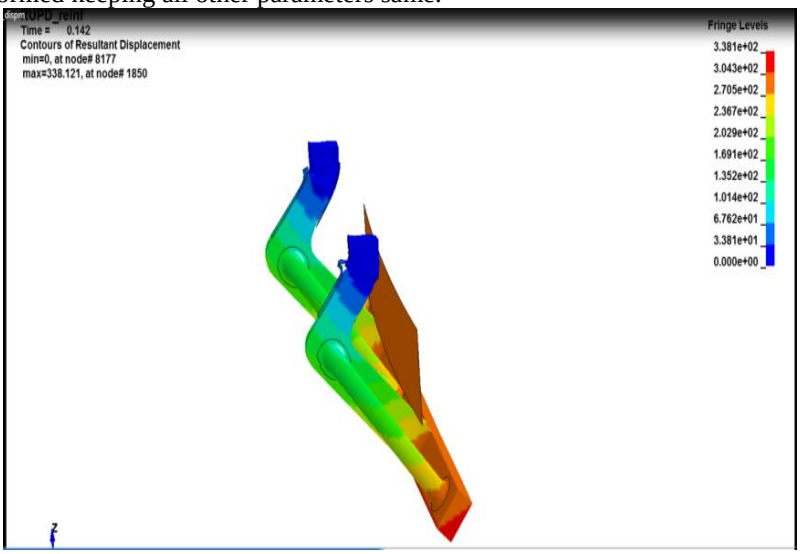

Fig. 4: Dynamic analysis of reinforced RUPD (Resultant displacement)

The maximum displacement observed was 338.121mm.

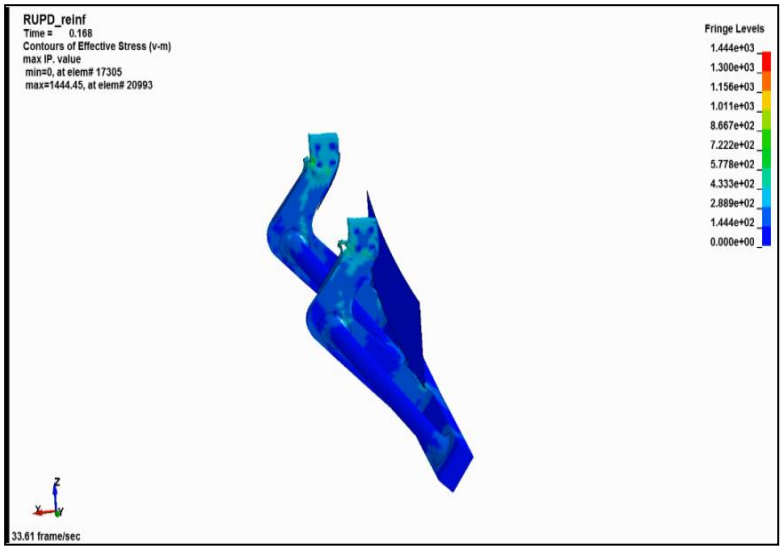

Fig. 5: Dynamic analysis of reinforced RUPD (Maximum stress)

The maximum stress observed was 1445.45MPa.

V. CONCLUSIONS

1) From the comparison above it can be concluded that reinforcement reduces maximum deformation
2) Reinforcement increases ability to withstand higher stresses.
3) Material reinforcement increases section modulus and stiffness of the structure with negligible increase in weight of the vehicle.

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Basic

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