Passenger Bus - Seat modification to avoid accident damages and for comfort level

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Abstract — A bus is a road vehicle designed to carry passengers.Buses can have a capacity as high as 300 passengers. The most common type of bus is the single-decker bus with larger loads carried by double-decker buses and articulated buses. Bus manufacturing is increasingly globalised, with the same design appearing around the world. Buses may be used for scheduled bus transport, scheduled coach transport, school transport, private hire, tourism etc.Buses generally run on internal combustion engine with diesel in it .The reason is that diesel can withstand heavy loads because of its high compression ratio.In addition cost of diesel is also less.But because of its high compression ratio and continuous detonation, the engine runs rough causing vibrations. The engine of the bus will generally be placed in the leading end without any proper casing and proper vibration dampers (generally viscous dampers).The seats in the bus are supported to the base by a pair of rigid fixed column (frame) which reduces the ease of movement of the passengers during turns and sudden braking. Lack of comfort of the passengers causes health difficulties and mental stresses for the individual and because of the rigid base, the load acts on the passenger causing body pain.

In addition to the lack of comfort, the seats are positioned in such a way that the passenger faces the driver's end (front facing).The reason is that ,if the seats are placed facing the trailing end, the objects outside the buses seems to be moving in the reverse direction that causes mental stress to the individual. But if the seats are placed facing the driver, the possibility for the death scale will be more during accidents because if the bus hit an object opposite to it, the passenger falls to the front seat because of the sudden impact. Due to this, the passenger first slides from the seat and passenger's neck portion hits the seat front to him and causes sudden shock load on his spinal cord causes major damages and injuries. Also during braking the impact makes the passenger to fall on the seat in front of them. Because of these difficulties the death scale possibility during accidents is more in seats facing front. In addition the night travel with front facing seats causes discomfort because the light rays from the vehicle in opposite lane falls on the individual's eye causing lack of sleep during nights.This paper aims in modifying the arrangement of seat with few additional designs to reduce the death scale possibility during accidents and for ease and comfort travel.

Index Terms—Air bag, Bus, Comfort level, Design, Passenger, Seat, Spring box.

1 INTRODUCTION

Accident is an specific , unpredictable , unusual , and unintended external action which occurs in a particular time and place , with no apparent and deliberate cause but with marked effects. It implies a generally negative outcome which may have been avoided or prevented had circumstances leading up to the accident been recognized, and acted upon, prior to its occurrence. Bus accidents are most frequent now- a- days. The main cause for bus accidents are due to the improper driving and lack of control during high speeds and during sharp turns.These types of accident s are reduced much and the main uncontrollable accidents are due to the sudden impact caused when the bus was hit by a vehicle coming opposite to it. These impacts are reduced in automobiles by installing "*air bags*" on to it. This new technology reduced the death possibilities in various cars and other automobiles. This new technology in turn didn't create any changes in buses and other heavy vehicles .The reason is that if air bags are installed for each seat in a bus, the maintenance and installation cost will be more and the productivity time will also be increased. In addition to this, the vibrations caused by the engine and surface terrain (road surface) cause additional discomfort to the passenger. The ease of motion of the passenger is reduced during turns because of rigid fixing of the seat to the base which arrests its degrees of motion. This results in body pain for the passengers because the load during the turning and braking will be acting on the passenger.

Due to this front facing and rigidly fixed seat arrangement, passengers do not prefer bus journey because of the lack of comfort and increased death scale possibility during accidents.

Fig.1: Passanger in seat during impact

1 MODIFICATIONS

1.1 Shock Absorbers (Spring Box)

The engine of a passenger bus will be generally with a high compression ratio for carrying heavy loads and for different environment and terrain conditions. The diesel engine with high compression ratio results in rough running of the engine even in the inclusion of the proper lubricating systems. This vibration causes the base of the vehicle to vibrate. In addition to this, the varying terrain causes additional vibration to the vehicle. This continuous vibration is transmitted to the passenger from the base by means of the seat. The seat skeleton generally consists of two column made of hardened steel or cast iron.

The vibration frequency will be transmitted to the passenger through the two columns of the seat. The seats are hinged to the base by these skeleton thereby arresting it degrees of motion completely. Due to complete arrest in degrees of motion, the passenger moves along the direction opposite to the force applied without the motion of the seats thereby inducing a partial shear stress in between them.

Fig. 2 : Spring skeleton with spring attached to it

These arrangement causes body pain and mental stress to the passengers because of the restricted motion of the bus seat and load acts on the passenger's body.The inconvenience caused is reduced by attaching a damping system and by restricting the transfer of frequency from the base. A spring box, generally a shock absorbing box can be attached which absorbs the shock from the seat and allows a tolerable degree of flexibility that results in additional comfort to the passengers.

The arrangement of springs are in series along the rows and columns inside the spring box. The purpose is to absorb all possible loads at the same time. A single spring can absorb only two loads at a time. But by arranging a number of springs various loads of different amount and on different direction can be absorbed. These springs also provides movement along the 360° angle and also on the upward and downward motion with respect to a specific tolerable value based on the stiffness of the material.

Placing a number of springs helps in distributing the load equally to all the springs reducing the failure because of sudden shock loads. The arrangement of the springs on the spring box and the deflection of the spring for a specific load is explained pictorially below.

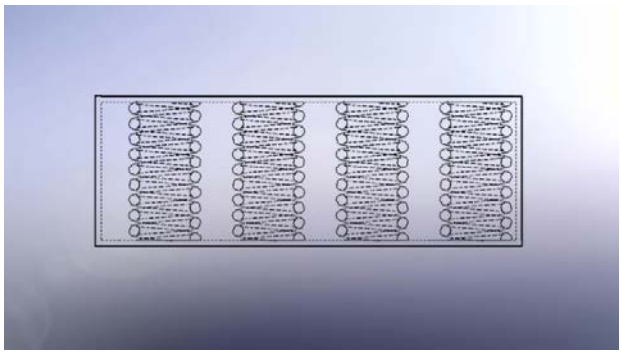


Fig. 3: Arrangement of springs in the Spring Box- Front view

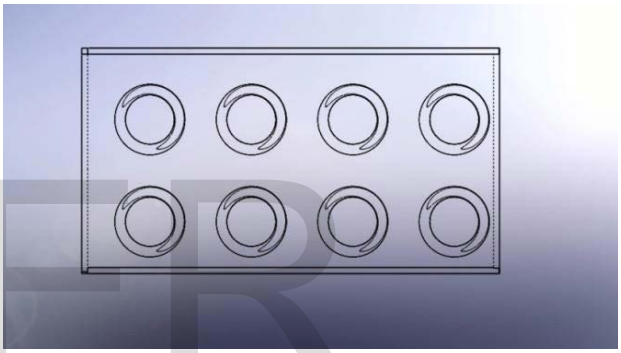


Fig. 4: Arrangement of springs in the Spring box- Top view

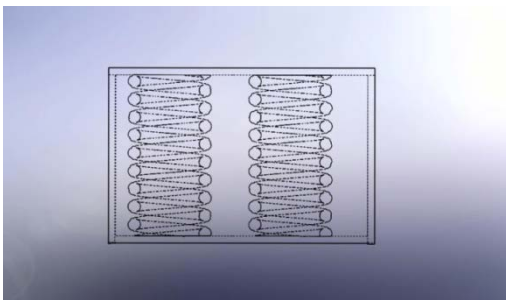


Fig. 5: Arrangement of spring in the spring box - Right View

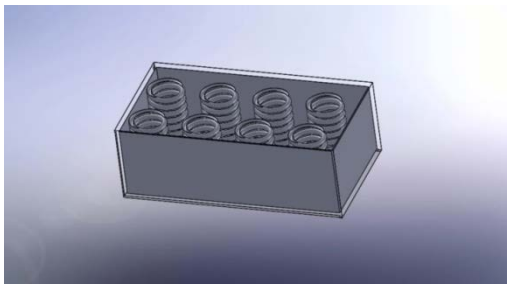


Fig. 6: Arrangement of spring in the spring box- Isometric view

The spring box is arranged with its bottom face fixed rigidly to the central column. The purpose of placing a single central column is to reduce the vibration transfer from the base to the passenger. The bottom portion of the spring is fixed rigidly to the bottom face of the spring box. The side faces also give support and absorbs minimal loads from the passengers. The top most face of the box is attached to the spring and it is not a rigidly fixed member. The purpose is for allowing ease of movement to the passenger during impacts. The cushion is attached at the top of the top face of the spring box. The bottom part of the spring is rigidly fixed and is subjected to static displacement load. The top portion experiences loads along all the three axes- two bending and one compression. The von-mises stress analysis on the spring along two axes when it is experienced by an impact load is shown pictorially below.

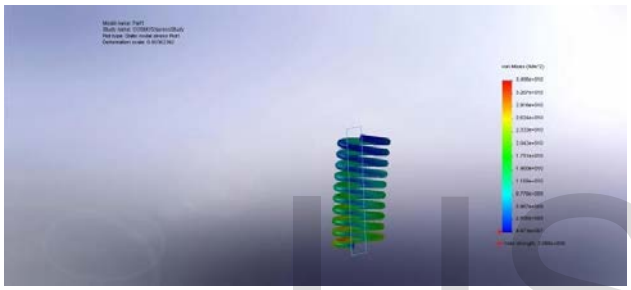


Fig. 7: Spring Stress Study- Plot 1

Fig. 8: Spring Stress Study- Plot 2

Fig. 9: Spring Stress Study- Plot 3

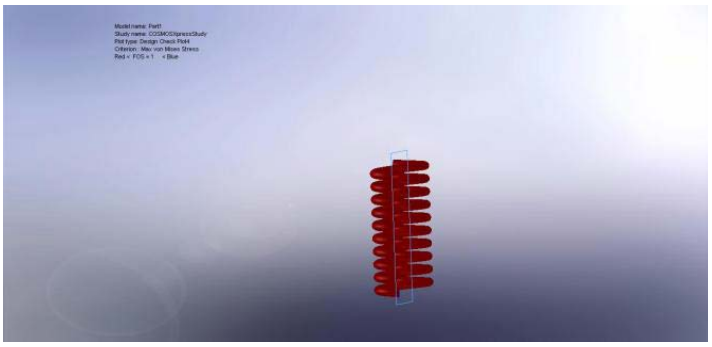


Fig. 10: Spring Stress Study- Plot 4

1.2 Seat Modification (with respect to arrangement position)

Bus seats are generally placed facing the forward .The effect of the forward facing seats are explained earlier in the paper. The passenger facing forward typically suffers for more severe neck and spinal injuries. Facing the rear pushes the passenger into the seat rather than flying off the bus. The injuries and pain on the body will be more during accidents in the forward facing seats than on the rear. The arrangement of the rear facing seat with a central column support on to it is described pictorially below.

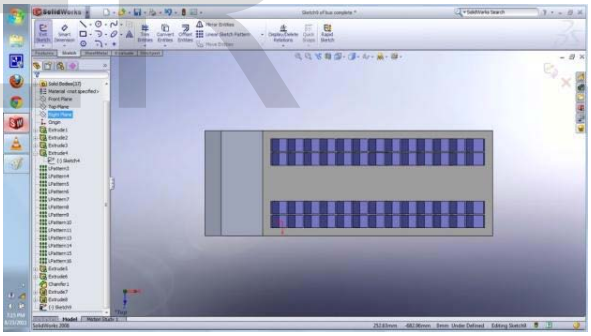


Fig.11: Modification of Seat Arrangement in Bus - Top View

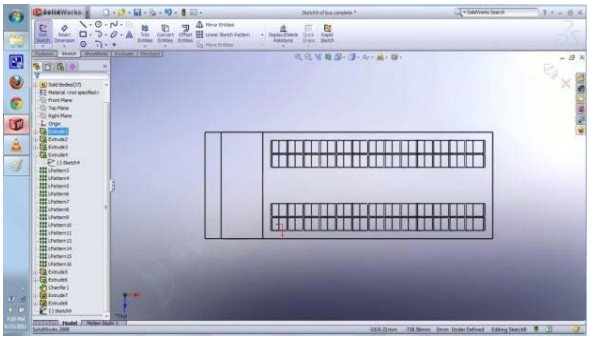
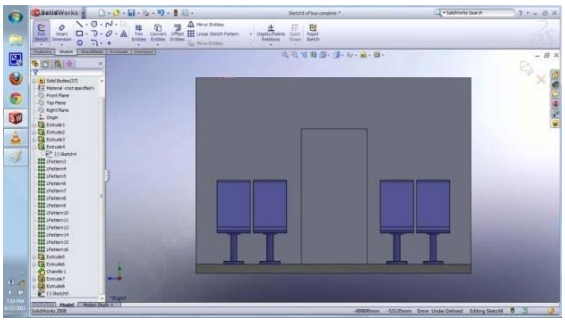


Fig. 12: Modification of Seat Arrangement in Bus -



Top View-Wire Frame.

Fig. 13: Modification of Seat Arrangement in Bus- Right view

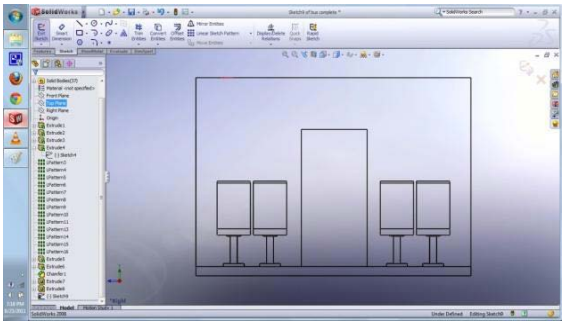


FIg. 14: Modification of Seat Arrangement in Bus - Right view - Wire Frame

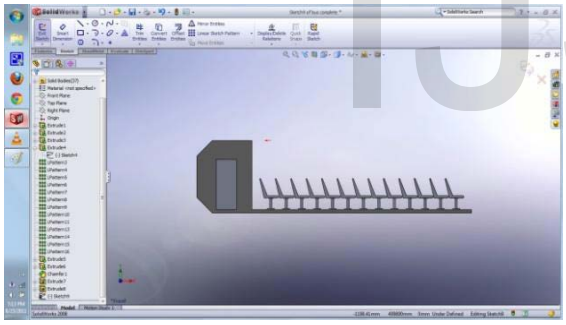


Fig. 15: Modification of Seat Arrangement in Bus - Front View

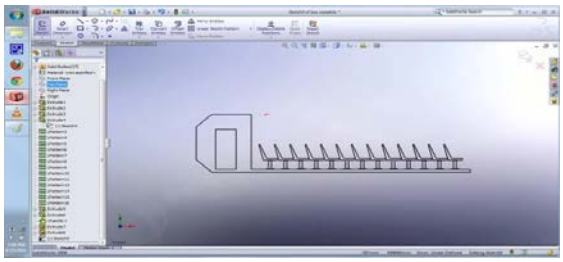


Fig. 16: Modification of Seat Arrangement in Bus - Front View- Wire Frame

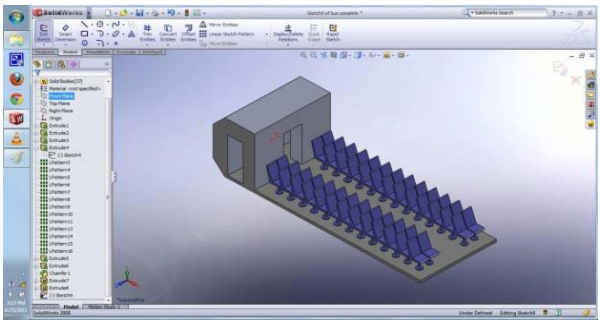


Fig. 17: Modification of Seat Arrangement in Bus- Isometric View

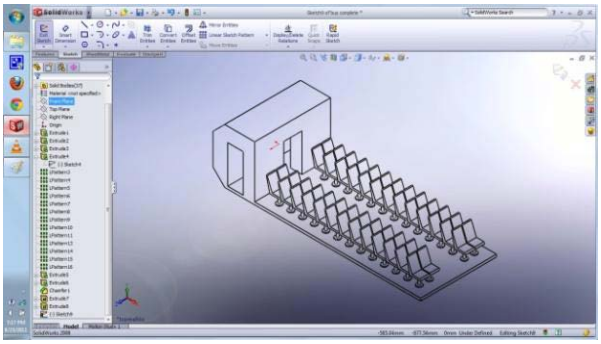


Fig. 18: Modification of Seat Arrangement in Bus- Isometric View- Wire Frame

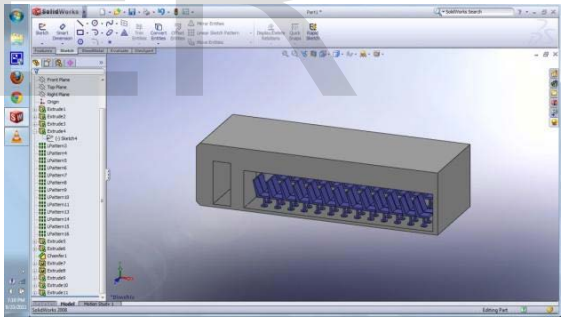


Fig. 19: Model Bus arrangement with modification in seat arrangement

The neck and spinal injuries caused to the passengers during accidents can be reduced by arranging the seats facing rear. The impact loads during accidents acted on the passengers will be transmitted to the seat . When the edge portion of the seat is made brittle, the seat results in fracture during impact loads. To avoid sudden fracture , the impact load withstand ability of the material should be more. Choosing the material with good ductile property first starts necking before leading to fracture. The von-mises stress analysis for a seat model with material having good ductile property - cast iron has been chosen for analysis. The base portion of the seat is subjected to static displacement.

The nodal results for structural analysis of the seat is as follows,

Fig. 20: Seat displacement study- Plot 1

Fig. 21: Seat displacement study- Plot 2

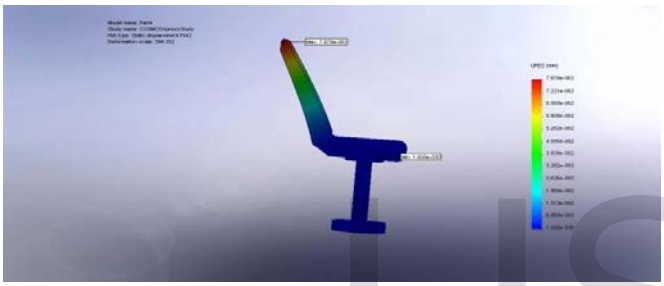


Fig. 22: Seat Displacement study- Plot 3

2 ADVANTAGES

- The above modification will not reduce the initial productivity time because the seat is just kept turned with 180° in position.
- The above implementation increases the comfort level to the passengers.
- The pain caused to the passenger during braking and turning is reduced by adding damping instruments- Spring Box.
- Reduction in death scale possibility during accidents because of the rear facing seats.
- Mental stress of the passenger is reduced and increased comfort level.

3 LIMITATIONS AND CONCLUSION

The rear facing seats are generally not preferred by the passengers because of their abnormal feel when they look for moving objects outside the window. In addition, the sprig box with exact stiffness value and proper arrangement of them in series will be difficult during installation. To avoid the damping difficulties of spring box, viscous dampers can be used. But the installation of viscous dampers will be even more costly and the viscosity of the fluid should be frequently monitored. The difficulty of the passengers facing rear can be reduced by their frequent travel by rear facing buses because frequent travel reduces their assumptions towards rear facing seats.

Further reduction of limitations are under process but on a whole, placing a damping system to all the seats reduces the vibrations and bumps passing to the passengers from the base. Further low frequency and high frequency sound damping systems can be installed for reducing the noise pollution caused by the engine and outside environment. Changing the position of the seat by facing the rear reduces the death scale possibilities during accidents and sudden impacts. On a whole by implementing the above modifications reduces the injuries during accidents and also increases the comfort during bus travel.

4 ADDITIONAL NOTE

The application used for above design is **SOLIDWORKS-2008 (with COSMOS- XPRESS with Von-Mises stress analysis) - DASSAULT SYSTEMS Limited.**

5 REFERENCES

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