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Analysis on the stretcher frame of an ambulance by the Arduino UNO-R3 code and Ansys work bench for the vibration optimization

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Abstract- It is an experimental project to improve the stabilization of the stretcher in an ambulance, instability caused by emergency braking and steering during ambulance operation would easily lead to a sharp rise of blood pressure in patient's head, which would further cause a secondary injury to the patient. Furthermore, the vibration generated by uneven road would result in patient's nausea and deterioration of patient's condition. To reduce induced vibrations experienced in the patient-care compartment of an ambulance. Measures must be taken against such vibration. Vibrations in medical environments can pose significant challenges to patient comfort, safety, and healthcare professionals. Stretcher design plays a crucial role in mitigating these effects and providing a stable and comfortable platform for patients during transportation. The proposed stretcher design represents a significant advancement in vibration control for medical transportation. By minimizing vibrations and providing a stable and comfortable platform, this design has the potential to improve patient outcomes, reduce discomfort, and enhance the overall quality of care. Further research and testing are required to validate the effectiveness of this design in real-world medical environments.

Keywords- Stretcher, Vibration, Medical, Optimization, Arduino

INTRODUCTION

This Ambulance transportation poses a significant risk to seriously injured patients, with a notable occurrence of patient deterioration during journeys. To mitigate this risk, ambulance speeds are often reduced, but this approach can also introduce potential dangers. This abstract highlights the importance of vibration control in ambulance transport to ensure patient safety and proposes potential solutions to address this issue. The high-speed nature of ambulance transport can subject patients to significant vibrations, which can exacerbate injuries, cause discomfort, and potentially lead to patient deterioration. However, reducing ambulance speed excessively may compromise timely medical intervention and increase the risk of adverse outcomes. To strike a balance between patient safety and timely transport, effective vibration control mechanisms should be implemented. This abstract presents potential strategies to address this challenge.

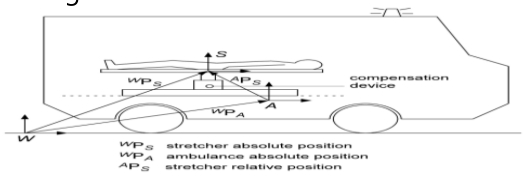

Figure 1: Stretcher suspension device [1].

Ambulance suspension systems incorporating advanced suspension systems into ambulances can help absorb and dampen vibrations caused by uneven road surfaces. These systems utilize shock absorbents, pneumatic elements, or adaptive damping technologies to enhance ride comfort and minimize the transmission of vibrations to the patient. Patient stabilization techniques implementing secure and adjustable patient stabilization techniques within the ambulance can minimize movement and reduce the effects of vibrations. This may involve the use of specialized stretchers with integrated restraint systems or adjustable support mechanisms to ensure patients are securely positioned during transport.

Vibration isolation technologies employing vibration isolation technologies within the ambulance can effectively isolate the patient compartment from external vibrations. This may include the use of vibration-absorbing materials, isolation mounts, or active vibration control systems that actively counteract external vibrations. Ergonomic design considerations designing the patient compartment with ergonomic considerations can contribute to vibration control.

Soft padding, adjustable headrests, and side supports can help reduce patient discomfort and minimize the impact of vibrations during transport. Implementing these vibration control strategies in ambulance design and operation can help mitigate the risks associated with patient deterioration during transport. However, further research, testing, and collaboration between medical professionals, engineers, and ambulance manufacturers are essential to develop and validate effective vibration control solutions that ensure both patient safety and timely delivery of medical care.

Problem Definition

a. Ambulances:

- Government ambulances are not well equipped.
- Private ambulances are like the corporate ambulances.
- These are used on-call basis and are used for intercity and for long distance, transport depending on the call.

b. Causes of vibration on the patient

- Delay in the transport of the patient.
- Risk of causing more injuries.
- The decrease in patient comfort

Objectives

The aim of the system is to minimize the acceleration experienced by the patient. Once the acceleration is reduced, the vibration effects on the patient will be reduced as well.

a. Better stabilization of patients.
b. Better ride conditions.
c. Faster transportation

II.METHODOLOGY

- The course of our work begins with the planning phase involving initial research, literature survey and background study.
- It is followed by concept generation phase that includes evaluating existing ambulance stretcher, user comfort requirements and concept designs.
- Designing and CAD modeling with reference to previous literature review and working ambulance stretcher model with modifying in to stabilized stretcher bed arrangement.
- Optimizing the modeling and selecting the components and assembly material for fabrication.
- Market research for most optimum material and cost efficient for fabricating this model in minimum cost that can be achieved.
- Material purchase after having different comparative study.
- Collection of all the equipment's and materials required for overall stabilized ambulance stretcher bed enhancement setup.
- Forming of a light weight ambulance stretcher bed structure which would carry up to 80-100 kg.
- Fabricating the assembly with trial and error method with resolving multiple issues.

Hardware Requirements

a. Helical spring
b. Angular bar
c. Arduino (for testing purpose)
d. Accelerometer (for testing purpose)

Design and testing

Figure 2: Isometric View of the Stretcher base

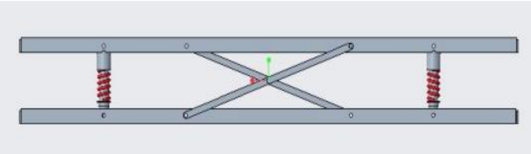

Figure 3: Front View of the Stretcher base

The design of the frame was made by using the Solid Edge St4, and the Figure.2 and Figure. 3 are the Isometric view and Front view of the Stretcher base. The material used for the fabrication purpose is the MS L angle frames with cross section thickness 3 mm. The frame mainly consisting of two rectangular frames of dimensions 6 X 2 feet. These two frames are connected by the 4 links as shown in the figure. Mainly the frames are then supported by the four suspension springs.

Figure 4: Suspension spring

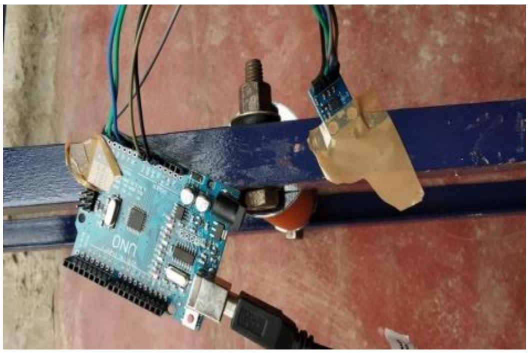

Figure 5: Accelerometer attached frame

The springs are commercially manufactured with metals like vanadium chromium steel or different grades of spring steels due to its high strain energy. Springs are supposed to support axial as well as torsion loads which cause bending and shear stresses in the compression coil spring respectively. Open coiled springs can be used as tension or compression elements due to the presence of large helix angles and large pitch. The open coil springs have a wide range of applications as in brake drums, vehicle suspension system or sometimes used as tension element.

Arduino UNO Code for Dumping

```
int xpin = A3;
int ypin = A2;
int zpin= A1;
int xvalue;
int yvalue;
int zvalue;
void setup()
{
Serial.begin(9600);//initialize the serial communications;
}
void loop()
{
xvalue = analogRead(xpin);//reads value from x-pin & measures acceleration in X direction
int x = map(xvalue,267,400,-100,100);//maps the extreme ends analog values form -100 to 100 for our understanding
you need to repalce the 267&400 value with your form calibration flot xg = (float)x/(-100.00);//converts the mapped value into acceleration in terms of “g”
Serial.print(xg);//prints value of accelaration in X direction serial print(“g”);
//prints “g”
yvalue = analogRead(ypin);
int y = map(yvalue,272,406,-100,100);
float yg = (float)y/(-100.00);
Serial.print(“\t”);
Serial.print(yg);
Serial.print(“g”);
zvalue = analogRead(zpin);
Int z = map(zvalue,277,410,-100,100);
float zg = (float)z/(100.00);
Serial.print(“\t”);
Serial.print(zg);
Serial.println(“g”);
delay(100);
}
```

Designing of helical spring

Wire daimeter = 5 mm
ID of spring = 30 mm
OD of spring = 40 mm Mean daimeter
= 40+30/2 = 35 mm
Spring index C =D/d = 35/5 = 7.00
Length of spring = 180 mm
No. of Rounds = 10 with variable pitch
No. of Active turns = 10.2 = 8
No. of Inactive turns = 10.8=2
Thickness of supporting cap for the element = 30 mm
Deflection in the spring = 8PD^3N/Gd^4
=8*343.35*(35)^3*8/75.68*(30)^4=15.36 mm
Stiffness k = P/delta = 343.35/15.36 = 22.35 N/mm
Wahl factor K = 4C-1/4C-4+0.615/C
=(5.66*7.1)/(5.66*7.4)+0.615/7.00
=27/24+0.087=1.212
Final Deflection=Delta*K=15.36*1.212 =18.61632 mm
During Calculation load on the element is =343.354 N

Figure 6: Model of stretcher base

III.RESULTS AND CONCLUSION

It's not an easy task to manage an ambulance stretcher and patients on them without hurting them transport or move them to the nearest hospitals, with safety and care. The main objective of this product is to make the life easy and to make sure the patient is not hurt during the process of treatment.

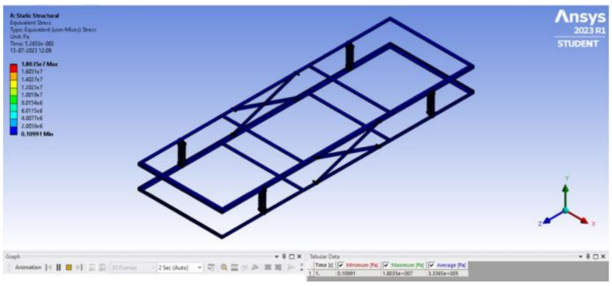

Figure 7: Load analysis for the stretcher

The deflection of the frame with respect to the spring dimension for different load is shown in the Table 1, the maximum deflection is with in the limit for the patient safety.

Table 1: Deflection of the stretcher for varying load

Sl no	Load (N)	Deflection (m)	
		Minimum	Maximum
1	1000	3.148e-003	1.823e+009
2	1500	3.718e-003	2.153e+009
3	2000	4.326e-003	2.788e+009

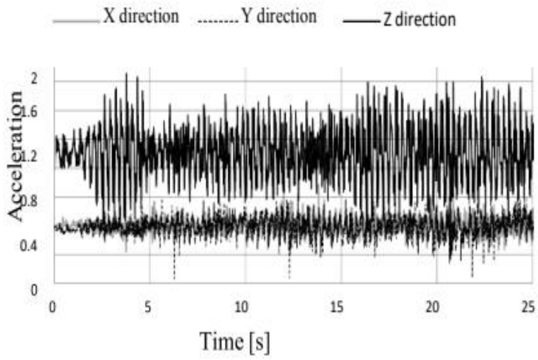

Figure 8: Without vibration isolation

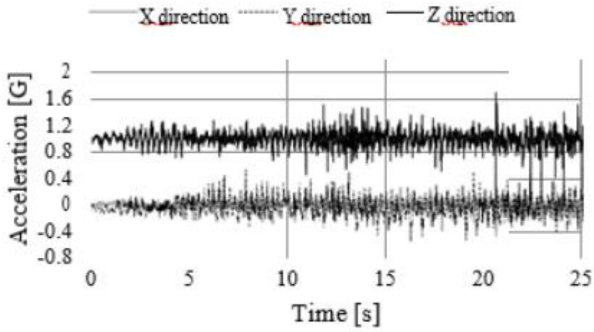

Figure 9**:** With vibration isolation

This product eliminates the step of shifting patient from bed or stretcher to wheelchair and vice versa as handling of old age people is very difficult. It makes the patient comfortable when sitting for a long time. This will reduce the effort of the caretaker and provide a safer transfer for the patients in hospitals. We have fabricate this project with manual system not having any automatic technology in order to keep our model cost effective and easy to operate. As we know using automation technology will also increase the maintenance cost as our project only consist mechanical assembly only lubrication is required from time to time.

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