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## To improve the comfort to the tractor operator by using gravity tractor seat frame

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### ABSTRACT

*Tractor is the major machine used in agriculture aspects for various purposes. The operator wants more comfort while operating at various situations. Generally due to sudden shocks and vibrations it effects in various parts of an operator. A large number of studies have been conducted and researchers have suggested several criteria for evaluating discomfort and the suitability of a tractor seat in a given working condition. The studies have led to various parameters, viz. the body pressure distributed under and supporting both the buttocks, thighs and the back of an operator, control of posture in static or dynamic condition, ride vibration, exposure time on task and other factors. But in the absence of a more definitive and the most logical criteria particularly from biomechanical viewpoint, the researchers will continue to design conditions and procedures to understand the seat dynamics and evaluate the seating discomfort. By introducing sliding mechanism in a curved frame by using roller bearings the sudden shocks and vibrations are absorbed by this mechanism and it enhance the feeling of comfort, safety, convenience, and results in higher work output from the operator. Therefore, this paper reviews the research and development information available in this regard and attempts to set the most appropriate procedure for assessment of seating discomfort during tractor driving.*

**Keywords:** Agriculture Tractor, Seat Suspension, Vibration Reduction, Control System, Comfort

### 1. INTRODUCTION

India is one of the largest manufacturers of farm equipment like tractor, harvester and tiller. It accounts for one third of total global tractor production. Tractor sale in the country is expected to increase 11-13 per cent in the financial year 2019-2020 while the tractor industry is expected to grow at 8-10 per cent during 2019- 23 . In the country, the agricultural tractors are mainly used for tillage operations, seeding and planting operation, spraying and fertilizing operation and transportation of agricultural goods as well as people in the country. The tractor operated machines and equipment used in farming generate vibrations which are more detrimental than the physical work to generate fatigue and discomfort in operators . These vibrations, generated from the engine and ground surface, are transmitted to the operator through seat suspension system attached in tractors . The modern days' high power agricultural tractors are equipped with suspension at front axle, rear axle, and cabin and at seat . However, in most of the Indian tractors due to its lower rated power (less than 55 hp), fitted with passive type seat suspension system which is less costly as compared to other off-road vehicle seat suspensions. This type of seat suspension has two springs attached in parallel and a damper in series. It is a vertical type suspension system and its effectiveness to reduce vibration depends on operator weight and spring stiffness adjustment . The vibration in the frequency range of 2-6 Hz was reported to be most harmful for the operator due to resonance of different body parts. Hence, the seat must be designed to lower the vibration within these ranges . A study was conducted to analyze the SEAT (Seat Effective Amplitude Transmissibility) value of different tractor seats with discomfort value when a subject was exposed to vibration in the frequency range of 0-50 Hz. The result confirmed that corresponding frequency for highest SEAT value was observed to be 2.5-6 Hz. Exposure of occupational whole body vibration for longer duration resulted in low back pain and other degenerative pathologies among the tractor operators .

The ergonomic design of tractor operator seat and workplaces is an effective method for improving operator comfort (Lehmann, 1958 and Pheasant, 1986). These at design characteristics comprise of static and dynamic characteristics. The static characteristic of the tractor seat refers to the relation of comfort to seat construction type' and its geometric parameters and the physiological

features. Therefore, there is need to design the tractor seat considering anthropometric data of tractor operators in India.

**2. RELATED WORK**

Gravity tractor seat frame is generally recognized that to minimize discomfort, fatigue and the possibility of damage to the back whilst seated, the spinal column should maintain its normal curvature as found in the standing position (Keegan and Radke, 1964)' The main body support is provided by the seat pan, taking between 65 and 75 % of the body weight (Branton, 1969), which is transferred via the ischial tuberosities and to a lesser extent the surrounding tissues. The linear dimensions of tractor seat must fit those of the most likely user population. This by now is axiomatic. Therefore, seat characteristics such as seat pan length, width and tilt, backrest height' angle and slope need to be designed considering anthropometric data of most likely user population of tractor operators.

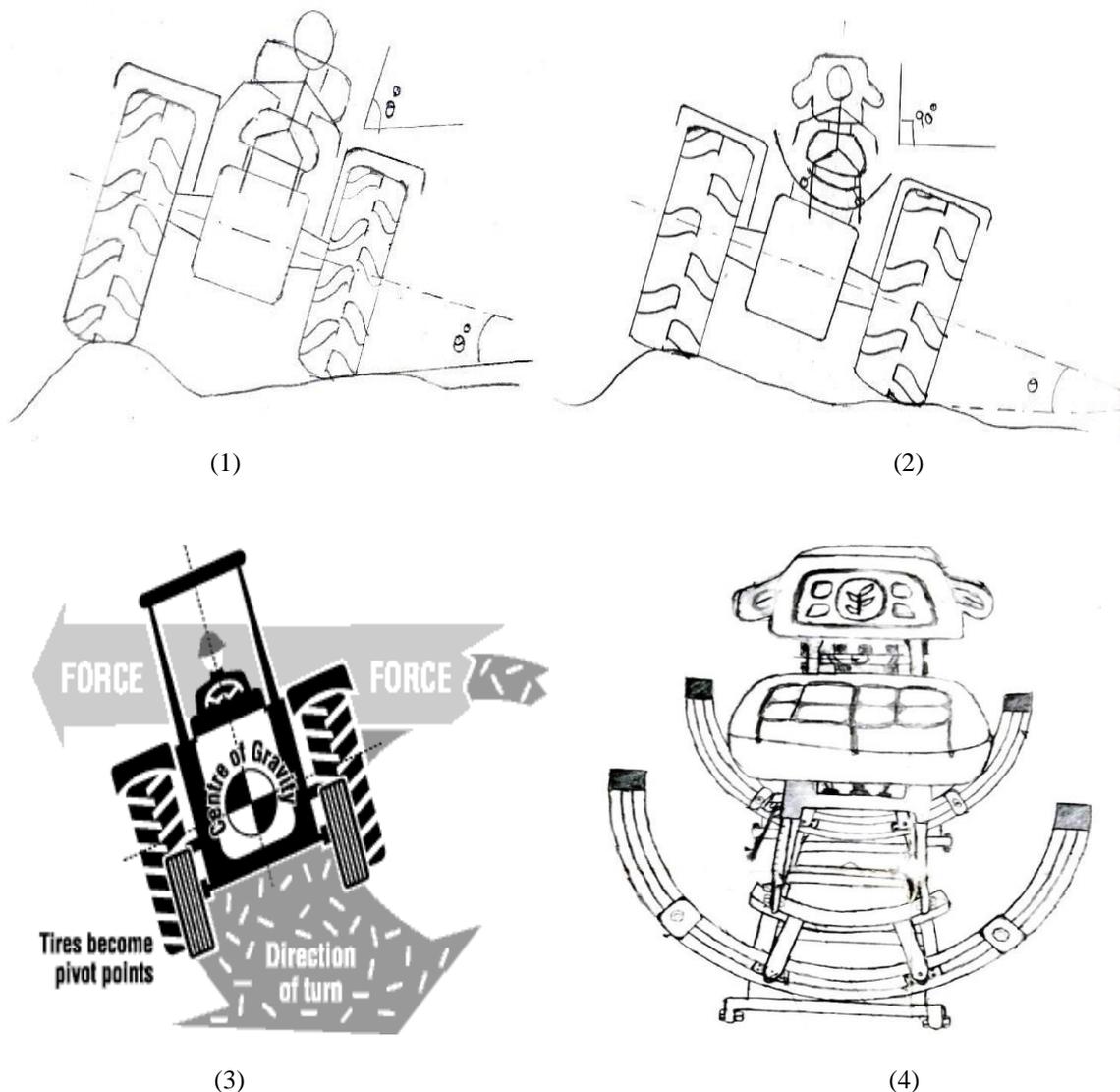
**3. METHODOLOGY**

The gravitational forces always act downward on the basis of gravity, the gravity tractor seat frame was designed. The gravity tractor seat frame is used to give the stability and comfort to the operator while driving a tractor on un- even roads. The stability of the operator works on the sliding mechanism by using needle roller bearings in the gravity frame, in the suspension system having the lumbar closed coil expansion springs. The springs absorb the vertical shocks and vibrations., inside the gravity frame having the needle roller bearings. It is used for sliding mechanism and it absorbs the horizontal shocks and vibrations ( with respect to the horizontal axis parallel to the rear wheel axle axis).

The gravity tractor seat automatically generates the stability to the tractor operator and giving comfort to the operator while driving a tractor on un-even roads.

**4. EXPERIMENTAL WORK**

Figures shows the comparison and working of gravity tractor seat system .fig1: shows the present tractor seating system.fig2.shows the gravity tractor seat frame seating system of the operator. fig3. shows the driving condition of the operator and forces acted on the tractor and present tractor seating system while the tractor moving in uneven roads.fig4.shows the line diagram of gravity tractor seat frame system.fig.5.shows the testing of the gravity tractor seat frame in by the inspection officer, figure 6 shows the operator having stability and comfort by using gravity tractor seat frame.





(5)

(6)

## 5. EXPERIMENTAL RESULTS

### Tensile Test data and results

Material Testing is done to understand the characteristics and behavior of materials. Tensile test is helpful to determine the performance of isotropic materials during loading conditions. Results obtained are used to specify the suitability of the material for various structural applications. Such tests are carried out on a Universal Testing Machine (UTM). From this, the Ultimate Tensile Strength of the material is obtained, with Yield Strength and Fatigue Strength being closely interrelated. Here, tensile test was done on a mild steel specimen. The details of the specimen are shown below:

**Table 1: Data of Test Specimen**

Dimensions	values
Length	140mm
Diameter	10&12mm
Material	MS Rod
<b>Part</b>	<b>Material</b>
FRAME	PLAIN CARBON STEEL
SHAFT	MILD STEEL ROD



**Fig. 1: Photo of Test Specimens**

The specimen was loaded on a Universal Testing Machine (UTM) and subjected to gradually applying loads, with the corresponding elongations being recorded. This continued till failure of the material. The UTM used was of ANSLER make, and is shown in Figure 2 below. The specifications of the UTM are shown in Table 2 below. The obtained stress strain diagram is shown in Figure 3 below, with Test results in Table 3 below.

**Table 2: Specifications of Universal Testing Machine (UTM)**

Parameters	Values
Capacity	10 Tons
Dist. Between the gripping heads	0 to 530 mm
Maximum test speed per minute	140 mm per
Electric motor	0.5 HP
Net weight	680 kg approx.



Fig. 2: Universal Testing Machine (UTM)

Table 3: Test results obtained of MS Specimen from UTM

Parameters	Values 10mm diameter	Values 12mm diameter
Young's Modulus	$1.9 \times 10^6 \text{ N/mm}^2$	$1.9 \times 10^6 \text{ N/mm}^2$
Yield Stress	$63.66 \text{ N/mm}^2$	$44.20 \text{ N/mm}^2$
Ultimate Stress	$586.96 \text{ N/mm}^2$	$584.045 \text{ N/mm}^2$
Fracture Stress	$763.94 \text{ N/mm}^2$	$795.77 \text{ N/mm}^2$

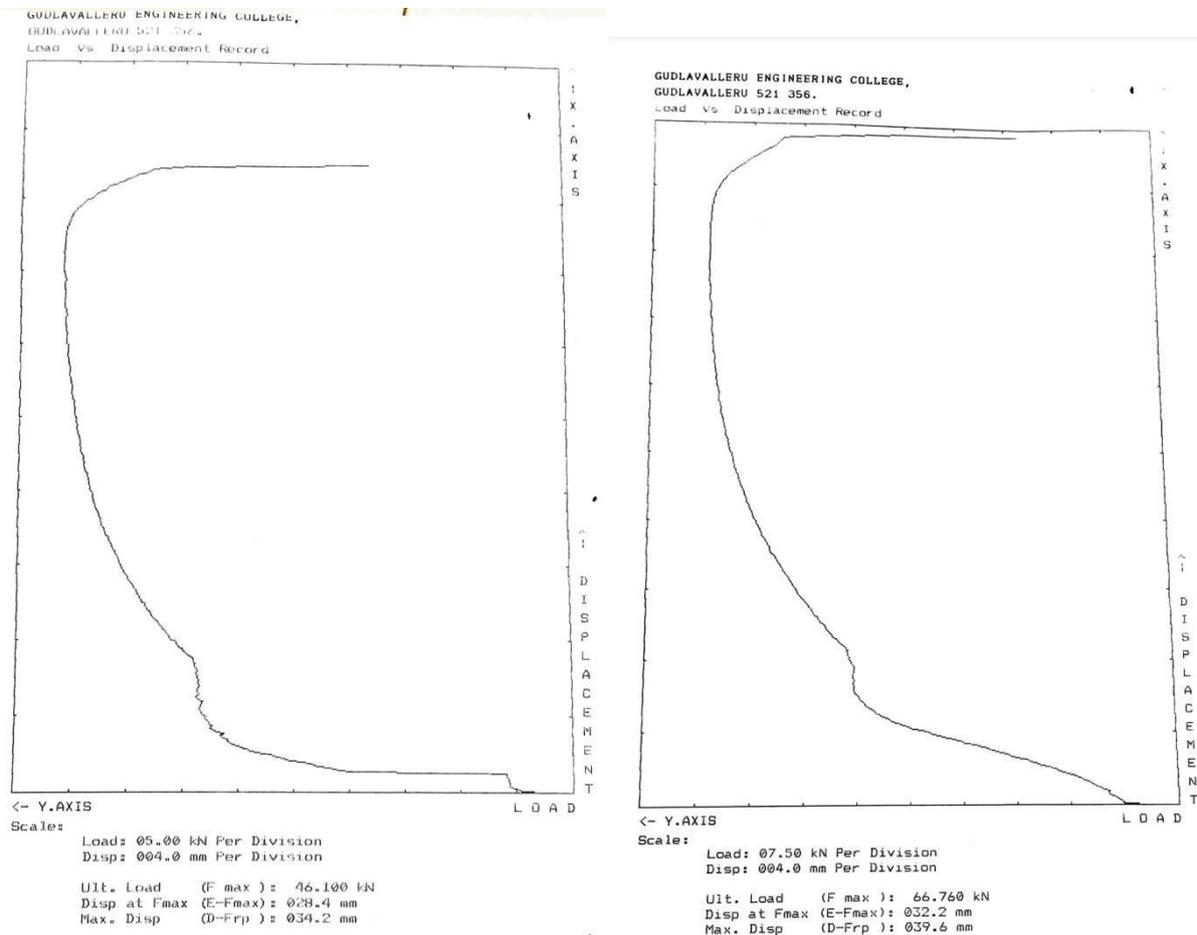


Fig. 3: Stress-Strain diagram of Mild steel (diameter 10&12mm)

The material test is based on the load act on the various parts of the gravity seat frame. Based on that different diameters of mild steel are tested and used to reduce the shocks and vibrations of the seat. The lowest diameter of mild steel shaft is more suitable to minimize the effects to the operator, so that it is useful to reduce the material cost of the product.

## 6. CONCLUSION

Based on this preliminary study, the vibration transmitted is high at off-road surface, both during moving and no moving activity, as compared to the seat transmissibility on on-road surface condition. A pronounced resonance frequency was observed around 2 – 3 Hz for all road conditions. The calculated SEAT values suggested that the suspension has minimal effect on attenuating the vibration transmitted to the person.

We have implemented gravity tractor seat frame for giving comfort and stability to the tractor operator. Our gravity tractor seat frame successfully gives the stability and comfort to the tractor operator, while driving a tractor on uneven roads .we have applied our gravity system for various tractor seats for giving comfort and stability to the tractor operator

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