A REVIEW PAPER ON DESIGN OF TEST RIG FOR MOTORCYCLE SEAT FOR HUMAN COMFORT

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Abstract: Today, a rebellious race is taking place among the automobile industry so as to produce highly developed models and the automobile industry has seen a market shift towards sport-utility vehicles. In order to maintain the level of comfort that customers expect from vehicles and still maintain the high safety standards of automobiles, attempts are made to develop an ideal vehicle (motorcycle) which is aesthetically pleasing, ergonomically running and most important is safety. This work solves the problems of human discomfort procured from riding the motorcycle. Seat of motorcycle is one of most important component of vehicle and which are in direct contact with the drivers. From last few decades the majority of Indian population depends upon two wheeler motorcycle and mopeds. Due to improper design and bad road condition riders subjected to extreme vibration. In this project new modified seat developed and compare with existing seat of two wheeler with different weight condition.

Keywords: Lumber support, lower back pain, seat design and analysis, FEA

I.INTRODUCTION

In the overall Asia zone and especially in India two wheelers (motorcycles and mopeds) are an important transportations tool of people for daily activities. Motorcycle are preferred as they are compact, less fuel consumption, pass easily through congested areas as in cities as well as villages, it is quite cheaper to buy and require less maintenance as compared to cars. Instead of these advantages motorcycle riding is a relatively complex and risky process as compare to cars. Motorcycle riders exposed to a variety of hazards in their surroundings especially on bad condition roads.

Apart from that, the motorcycle seat has complicated challenges for design adjustments to engineers about seat comfort and safety aspects. The majority of the motorcycles seat design is not equipped with a backrest support. Therefore, the motorcyclists tend to adopt a variety of postures during their riding process in order to balance the equilibrium of stresses in their body (Karmegamkaruppiah, et al, 2008) [1]. The mechanical vibrations of motor cycle are most hazardous to the health for musculoskeletal symptom in the lower backbone pain (LBBP), degeneration of the spine and whole body vibration (WBV)(Adam M A, et al, 2006)[2]. There only few studies that have specifically examined the effect of exposure by developing models.

Under this paper, the Critical Survey carried out in Nagpur city (Maharashtra State, India) for problem identification of lower backbone pain in two wheeler operators (motorcyclist) due to drawback in recent seat designs. In this survey, more than 500 motorcyclists or two wheeler riders (subjects) interrogated for lower backbone pain study by questionnaire. Based on survey, it has found

that in an average 45% - 62% motorcyclist facing the musculoskeletal problem i.e. lower backbone pain (LBBP) in whole body vibrations (WBV) especially between ages of 30-65 years. Which demanding the better design of seat for seating comfort or it is a need of thousand and lacks of two wheeler riders that is motorcyclists to redesign recent seat with lumbar support. Hence, this paper has objectives of redesign of seat with the help of different type of study.

II. LITERATURE REVIEW

In today's scenario, the seat design of motorcycles is a complex process as it involves a very constrained space between the motorcyclist and the motorcycle. In design of the motorcycle seat, different needs of motorcyclist must be considered. Generally, the main aspect of a new design motorcycle seat is to provide for the safety vertebra spine and comfort of the motorcyclist by reducing or eliminating fatigue during mechanical vibration transfer toward the lower back bone (lumbar) during riding process. This identification of problem of lumbar support demands more in this country because in India there are huge numbers of two wheelers using by citizen. Moreover, structure of the human (motorcyclists) and its vertebra is one of the complicated and critical parts as shown in figure 2.1. The literature review for this dissertation has focused on different research works on automobile vehicle seat and specifically for two wheeler motorcycle seat and comfort of lower back i.e. Lumbar Spine of human (motorcyclist's).

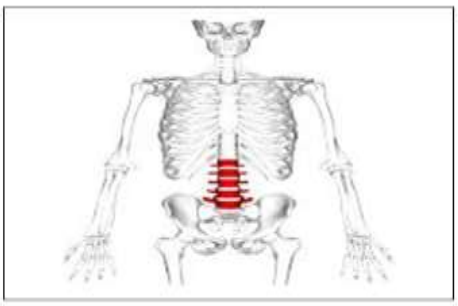

Figure 2.1 Lumbar Spine in Human (motorcyclist) Vertebra

1. Population of vehicles in India. [1]

Its rising population, mountain urbanization, motorization, and low per capita income characterize India like other developing countries. Its total urban population burgeoned over the past three decades rising from 109 million in 1971 to 160 million in 1981(+47%), 217 million in 1991 (+36%), and 285 million in 2001 (+31%). The rapid growth of India's cities has generated a corresponding growth in travel demand and increased levels of motor vehicle ownership and use. As Indian cities have grown in population, they have also spread outward. A lack of effective planning and land use controls has resulted in rapid, extending beyond old city boundaries. Most public policies in India encourage sprawl and new commercial development often takes place in distant suburbs, hence for that demands large number of vehicles and roads. From category wise percentage of vehicle (2007-2008)(Figure 2.2) and regular sales (demand) trends of various vehicles (Figure 2.3) can be said that increment in two wheeler vehicles in India.

The sprawling, low-density development around Indian cities makes cars and motorcycles increasingly necessary, especially given the unsatisfactory alternative of slow, overcrowded, undependable, dangerous public transport services. At the same time, rising incomes among India's middle and upper classes make car and motorcycle ownership increasingly affordable.[5]

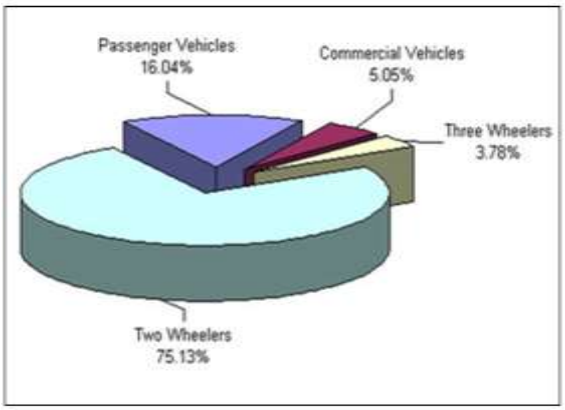

Figure 2.2 Category-wise percentage of Vehicle [5]

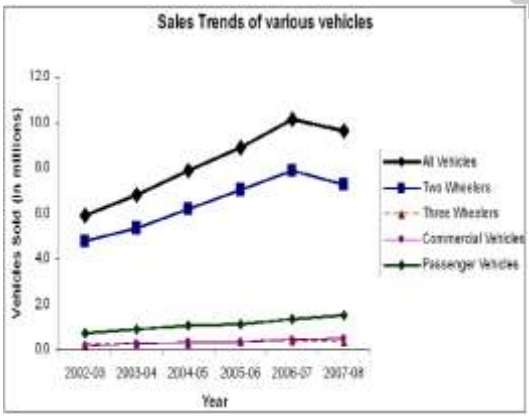

Figure 2.3 Sales trends of different Vehicle [5]

2.The influence of backrest inclination and lumbar support. [2]

The influence of backrest inclination and lumbar support on the shape of the lumbar spine in sitting posture had studied radio-graphically. Spinal X-rays were taken from four different groups of subjects at four different sitting conditions on an experimental chair as,

1. Standing and unsupported sitting posture,
2. 80° to 110° of seatback angle, without lumbar support,
3. 90° seatback angle, -2 to + 4 cm of lumbar support, relative to the plane of the seat back,
4. 110° of seatback angle, +4 cm of lumbar pad and L1, L3, and L5 as support locations.

Nine different angles including total lumbar angle were evaluated from X-rays (Figures 2.5 and 2.6). The measurements showed an average of 38° reduction of total lumbar angle (i.e. decrease of lumbar lordosis). This reduction is mainly due to the rotation of pelvis (28°) and changes in the vertebral body angles of the two lower lumbar segments (10°).

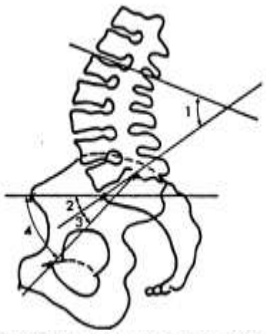

FIGURE 2 :5Angles measured from the radiographs of subjects in the study: 1=total lumbar angle; 2=sacral-horizontal angle; 3=sacral-pelvic angle: 4=pelvic-horizontal angle.

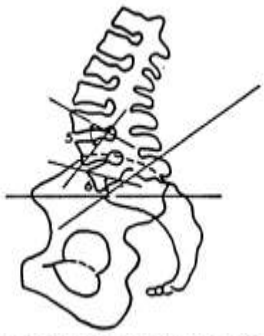

FIGURE : 6 Angles measured from the radiographs of subjects in the study: 5=vertebral body angles L1-2, L2-3, L3-4, L4-5, and 6=the L5-S1 angle.

With +4 cm lumbar pad, the lumbar curvature closely resembles the lumbar curve of the standing posture. The location of the lumbar support with respect to the level of L1 to L5did not significantly influence any measured angles. A simple geometric calculation shows that the lumbar support moves about 4.5 cm upward with respect to the lumbar spine when the backrest angle increases from 90° to 105°. Therefore, it is necessary to increase the inclination of the seat and backrest simultaneously [7].

3. The influence of age, sex and musculoskeletal health upon the subjective evaluation of vehicle seating. [3]

In the study conducted by Porter, J.M.; and Sharp, J.C., they examined the influence of subject variables such as sex, age and musculoskeletal health upon the subjective evaluation of vehicle seating. Seventy-two subjects carefully selected from a stature range common to both British males and females. This sample was composed of three age ranges (18-24, 30-40,50+ years), each range containing three stature groups (156-164, 165-171, 172-178 cms)consisting of equal numbers of males and females, half of whom experienced persistent back problems. Each subject sat on the same seat for a continuous period of 24 hours in the laboratory. Subjects allowed to adopt postures normally assumed when traveling as a passenger in a car. A video monitor was used to ensure that the subject looked forward for the majority of the time and also to reduce boredom. All subjects completed discomfort ratings over 14

body areas using a five-point scale after 15, 45, 75, 105, and 135 minutes of sitting. The data analyzed in terms of the number of subjects reporting discomfort at each of the above times, and the number of minutes of discomfort over the whole period of sitting. The number of minutes of discomfort calculated by summing 30 minutes of discomfort for each report of discomfort at the intervals above. The final interval allocated was 15 minutes. The maximum number of minutes of discomfort was 135 minutes. Analysis of variance performed on the comfort data, averaged over the fourteen body areas. The summarized data are shown in following table 2.1 are representing the intensity of discomfort due to low back area during riding.

Factor	Mean Duration of Reported Discomfort (minutes) (Maximum=135 minutes)				
	All Body	Low Back	Neck	Buttock	Thighs
Age					
18–24 yrs.	30	66	39	32	31
30–40	31	60	46	50	32
50+	21	74	74	35	30
Stature					
156–164 cm	29	46	43	37	21
165–171	29	70	42	35	39
172–178	23	50	36	45	34
Sex					
Male	25	55	42	36	30
Female	29	56	63	42	32
Back Trouble					
Sufferer	29	67	59	43	40
Non-Sufferer	25	43	47	35	22

Table 2.1 Duration of report for overall body area (14 Area) & for four most frequently area of discomfort [8]

Significant differences found among age groups although the 50+ age group reported a mean of 21 minutes discomfort per subject over all body areas, whereas both the younger groups reported similar discomfort at a 50% longer duration. There were no effects of stature in the mean discomfort rating over fourteen body areas except for Low back and neck area (the shortest group did report a significantly longer duration) [8]

4. Anatomical geometry and seating. [4]

In this paper, three different body size groups (small female, average male, and large male) and two different driving postures (erect and reclined) were defined, and the kinematic properties of the body and its important segments are reported in a usable form for seat design. Body structures which are particularly important considerations for automotive seat design are the femur, pelvis, spinal column (lumbar, thoracic, and cervical), and head. Figure 2.7 shows the idealized postures of each body-size group.

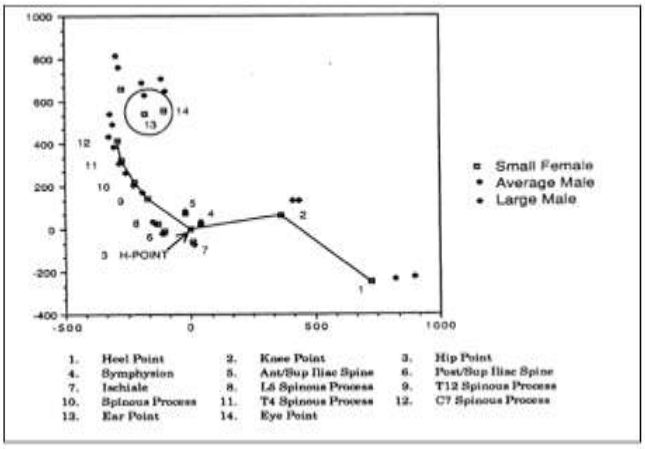

Figure 2.7 Location of anthropometric landmarks in an automobile seat with a 26.5° seatback angle [9]

The authors note striking differences between the SAE 5826 practice and body configuration based upon this study.

1. The erect body posture requires seat contours to provide support of the lower thorax and lumbar curvature-designs based upon SAE-2D templates will force the upper thorax forward and produce slumped postures. When the body is slumped, the pelvis rotates rearward, the lumbar spine flexes which straightens the low back curvature; the thorax rotates forward throwing the shoulder forward; to keep the head level, the head rotates rearward with cervical extension producing a lordotic neck curvature.

2. In erect body posture, the eye positions are changed rearward and upward.

3. When reclining in any of the currently marketed automobile seats, the seatback tends to move upward relative to the seated persons' back and pull on their clothing. Seatback motion does not follow torso motion (Figure 2.8) [9].

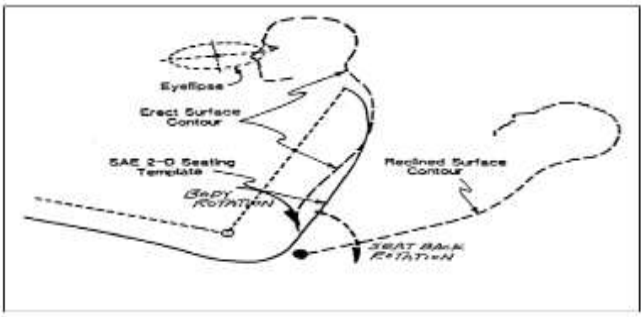

Figure 2.8 Erect and reclined body surface contours for an average adult and SAE 2-D seating template contour and eyelids [9]

III. CAUSES & EFFECTS OF LOWER BACK PAIN

There are three types of work posture (standing, sitting and sit standing) and motorcycle riders are associated with sitting posture during riding bike. Various studies shows that for sitting without lower back support will generate pain in lower back and while sitting without back support will generate pain in central back of body.

The back posture for human in lumbar area as shown in figure 3.1 is one of the most common health complaint since ancient time.

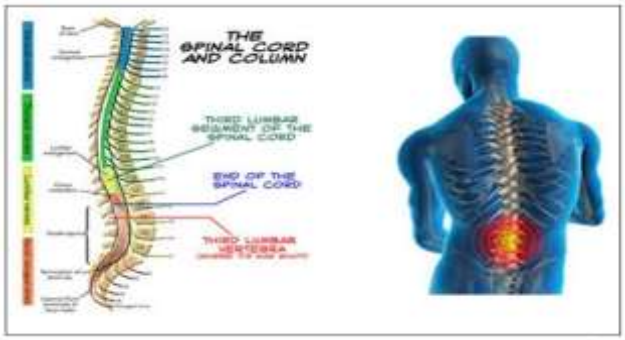

Figure 3.1 Schematic diagrams of human spinal cord & vertebral column & Lumbar Pain

Low back pain occurring in adults (50-90%) with high recurrence rate (up to 90%) is most common musculoskeletal disorders (MSD). Intradiscal pressure in lumbar region of spine can actually be greater while seated posture than standing. Back_pain is the second most common type of pain in adults (the most common being headaches). By far the most common cause of back pain is muscle strain. The back muscles can usually heal themselves within a couple of weeks, but the pain can be intense and debilitating. Other common sources of back pain include disc problems, such as degenerative_disc disease or a lumbar disc, many types of fractures, such as spondylolisthesis or an osteoporotic fracture or osteoarthritis.

The discs begin to lose fluid and flexibility, which decreases their ability to cushion the vertebrae. Pain can occurs particularly when there are transfer of mechanical vibrations to the lower body (lumbar)through seats and as most of the Indian roads conditions are very poor so it damage lumbar more and more also someone lifts something too heavy or overstretches causing a sprain, strain or spasm in one of the muscles or ligaments in the back. So that the spine becomes over strained or compressed, a disc may rupture or bulge outward as shown in fig 5. This rupture may put pressure on one of the more than 50 nerves rooted to the spinal cord that control body movements and transmit signals from the body to the brain. When these nerve roots become compressed or irritated, strong and long life back pain results.

Fig 3.2 Lumbar ruptures or bulges outward

Fig 3.3 Strained or compressed lumbar

Seat without lumbar support causes low back pain may reflect nerve or muscle irritation or bone lesions. Also pain accompanied by fever or loss of bowel or bladder control, pain when coughing and progressive weakness in the legs may indicate a pinched nerve or other serious condition. People with diabetes may have severe back pain or pain radiating down the leg related to neuropathy. Nearly everyone has low back pain sometime. Men and women are equally affected. It occurs most often between ages 30 and 50; due in part to the aging process but also because of sedentary life styles with too little exercise, heavy work and mental stresses. The risk of experiencing low back pain from disc disease or spinal degeneration increases with age.

Any damage to the spinal cord can result in a loss of sensory and motor function below the level of injury. For example, an injury to the thoracic or lumbar area may cause motor and sensory loss of the legs and trunk (called paraplegia). An injury to the cervical (neck) area may cause sensory and motor loss of the arms and legs.

To overcome this lower back pain by mechanical vibration of two wheeler motorcycle, this paper presents development of new seat design including recent design of seat, analysis of both seats along the pressure/load distributions on buttocks in sitting, stress-strain analysis of seat without (old seat) and with (new seat) lumbar support.

IV. MATERIALS AND METHOD

The design and development of a new lumbar support for motorcyclists is based on total design process of model. There are six important components in this model, viz. Identification of problem, research survey of lower back (lumbar) pain in two wheeler riders (subjects), study and evaluation of survey and related research papers, design and redesign of seats (recent without lumbar support seat and conceptual seat with lumbar support) and analysis of both seats in Ansys V11 software shown in figure 4.1. An important guide in designing

the lumbar support is the information of orthopedic surgeons and specialist association data table 4.1 and it is the scenario of Nagpur city, Maharashtra (India) which is found out in physical survey of the motorcyclists, which are needed to ensure that the designed model can be adapted to suit the majority of users.

TOTAL DESIGN PROCESS OF MODEL

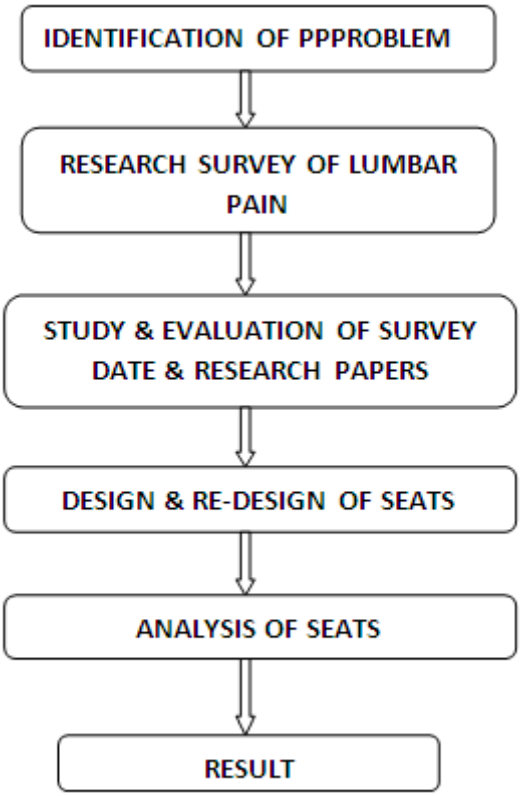

Figure 4.1 Total design process of Model

In this survey questionnaire was prepared for riders interactions and some was collected from orthopedic surgeons, ayurvedic specialists from Nagpur (India) city about number of patients in a day, a week and per month about lower back bone pain (LBBP). After this survey and discussion with doctors lower back bone pain is the common and serious problem of maximum motorcycle riders (subjects).

There are some questions which are included in survey questionnaire: -

1- Sr. no. of rider (subject)
2- Name f Rider (Motorcyclist's)
3- Age
4- Model of two wheeler
5- Company
6- Manufacturing Year of Vehicle
7- Daily Usage of Vehicle
8- Problem of Back Pain
9- Since Year (Years of pain)
10- Suggestions & Remark

V. CONCLUSION

From the above study it is observed that ,In India here ar numbers of two wheeler riders which are facing lower back pain problem due to uncomfortable seat design of common two wheelers and bad road condition So it is necessary to redesign two wheeler seat for human comfort and provide the support to riders while riding two wheeler. The designing of new seat will do as per the design process of model flow chart.

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