

# TOTAL QUALITY PRODUCT SYSTEM FOR NEW PRODUCT DEVELOPMENT ( LOW HP TRACTOR SEAT )

Thesis submitted in partial fulfillment of the requirements for the award of the degree of  
MASTER OF ENGINEERING IN MECHANICAL ENGINEERING  
( INDUSTRIAL ENGINEERING )  
of BHARATHIAR UNIVERSITY

By

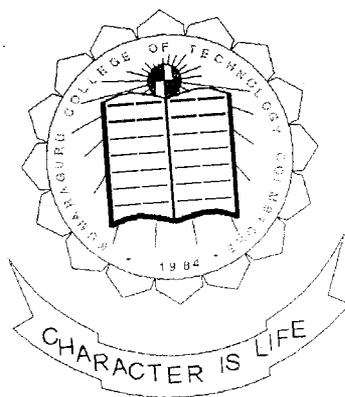
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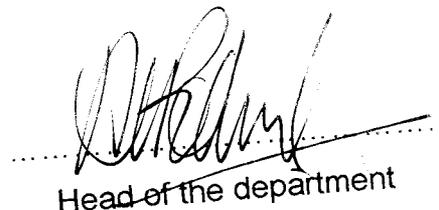


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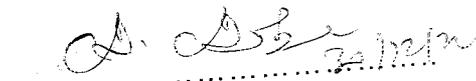
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# CERTIFICATE

This is to certify that this thesis work entitled "**TOTAL QUALITY PRODUCT SYSTEM FOR NEW PRODUCT DEVELOPMENT: LOW HP TRACTOR SEAT**" being submitted by **SHOBA PRIYADHARSHINI.L.** (Reg. No. 9937H0012) for the award of degree of **MASTER OF ENGINEERING IN MECHANICAL ENGINEERING (INDUSTRIAL ENGINEERING)**, is a bonafide work carried under my guidance. The results embodied in this thesis have not been submitted to any other University or Institute for award of any Degree or Diploma.

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**Certificate**

This is to certify that Miss. **L. Shoba Priyadharshini** of Kumaraguru College of Technology, Coimbatore, has successfully completed the project work on "**TOTAL QUALITY PRODUCT SYSTEMS FOR NEW PRODUCT DEVELOPMENT**" during the period of six months from 7<sup>th</sup> June 2000 to 7<sup>th</sup> December 2000.

We appreciate the efforts taken by her during the tenure in identifying the key areas for cost savings in the design and development of Low HP Tractor Seat. This proposed design is in line with the customer requirements and feasible for manufacture. The prototype samples are being sent to various prospective customers for their approval.

We wish her very best in all her future endeavours.



**YOGESH.N.KALE,**  
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Hosur.

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## SYNOPSIS

As competitive pressures grow and the search for new products and processes accelerates, the need for a total quality systematic approach becomes evident. Companies face the prospect of introducing new products at a frightening pace. The need for teamwork, efficient and effective management systems and appropriate technologies has become critical. Given that the success of an Organization is dependent on its ability to develop and produce new products that customers want, the R&D organization and culture is turning towards Total Quality Product System to reduce the cycle time and cost incurred for the design and development of new products and also meet the customer requirements through continuous improvements. This has led to the new product development of low hp tractor seats. This project work aims at Total Quality Product System during this new product development by following the QS9000 procedures. Since the actual production of the new product will take more time due to the fixtures, tools and mould developments, this project covers the first two phases of the New Product Development. The objective of this project is to develop a prototype sample of the proposed design and validate the same.

# **CHAPTER 1**

## **INTRODUCTION**

## **1.1. COMPANY PROFILE**

Harita Grammer Ltd., is an automobile ancillary unit of TVS group of companies, set up in collaboration with GRAMMER-AG, Germany, a world leader in manufacturing of automotive seating systems. The main plant is located at Bellagondapalli, Hosur. Harita Grammer has established itself as a manufacturer of hi-tech and quality seating systems to suit the requirements of the customers. Pioneering work in R&D has augmented HGL's attempt to attain international standards in quality and manufacturing process. It has recently been awarded the prestigious QS-9000 award for excellence in quality standards and systems.

The product design process incorporates computer aided design techniques and 3D -modeling. The company has adopted state-of-the-art foam-in-place technology to produce durable, contoured cushions for enhanced user comfort. Harita Grammer has been one of the Indian Companies to meet international SAE, ECC & ISO standards. This has increased the reliability on seating systems for all export models. The main plant at Hosur comprises of two manufacturing units- HGL-I and HGL-II. HGL-I comprises paint shop, thermoforming shop, stitching shop and assembly cells. HGL-II comprises foaming shop, mould shop, welding shop and stores. The company has setup another unit at Ranjangaon near Pune for catering to the needs of western customers such as TELCO, M&M, L&T JOHN DEERE etc.

When started in 1988 HGL (formerly called Roloform Polymers Ltd.) had a turnover of Rs. 14 million. The turnover has grown to Rs.602 million in 1999-2000.

### **1.1.1. CUSTOMER LOCATIONS OF HGL**

#### **LOCATION :CUSTOMERS**

Calcutta	: Hindustan Motors
Chennai	:TAFE, Ashok Leyland
Delhi	:Escorts, NewHolland
Hosur	:TVS Suzuki, Ashok Leyland
Indore	:Eicher.
Mumbai	:Mahindra & Mahindra, Gogrej, Voltas.
Pune	:Telco, L & T John Deere

### **1.1.2. SEGMENTS/ PRODUCTS**

- ◆ Cars & Multi Utility Vehicle (MUV) seats.
- ◆ Tractor seats.
- ◆ Luxury Bus Passenger Seats (BPS).
- ◆ Commercial Vehicle seats.
- ◆ Construction Machinery seats.
- ◆ Driver seats.
- ◆ Two-Wheeler seats.
- ◆ Industrial Equipment seats.

### **1.1.3. QUALITY POLICY**

HARITA GRAMMER LTD. is committed to achieve Total Customer Satisfaction by supplying Quality Products at right time, in right quantity and at agreed price.

### **1.1.4. PURPOSE OF HGL**

- ∞ To be an innovator and market leader by supplying quality transport seating systems.
- ∞ By being proactive to the needs of customers, employees, business associates, shareholders and the society.
- ∞ Through a team of competent and motivated people committed to Continuous Improvements and achieve continuous growth in sales and profits through best business practices and fair means.

### **1.2. INTRODUCTION TO PROJECT**

Total Quality Product System for New Product Development [Low HorsePower Tractor Seats] involves the design and development of a new product. i.e. tractor seats for low horse power(below 35 HP) tractors using QS9000 procedure for New Product Development.

Total Quality is total in three senses: it covers all parameters of process, job, and person. Total Quality also goes beyond the traditional idea of quality, which has been expressed as the degree of conformance to a standard or the product of workmanship. Enlightened organizations accept and apply the concept of quality as the degree of user satisfaction or the fitness of the product for use.

### **1.3. NEED FOR THE PROJECT**

The existing models of tractor seats are used on the entire range of tractors, which is produced in India. The existing tractor seat is high when compared to other seat manufacturers with respect to low cost. The Original Equipment Manufacturer's (OEM) i.e. the tractor manufacturers are demanding for a low cost seat for their low hp tractors. A market survey has also indicated good potential for low hp tractor seats in India in near future. From all the above-mentioned reasons a need is felt to create a low cost seat for the low hp tractors. Also, the need to ensure quality at low cost to satisfy the requirements of the customers has necessitated following total quality procedures as per QS9000.

### **1.4. OBJECTIVES OF THE PROJECT**

- To design and develop a modular tractor seat following the NPD procedure as per QS9000.
- Material cost target for the seat is Rs.800.
- Design and develop concepts.
- Conduct design reviews for Design For Assembly and Design For Manufacturability.
- Manufacture Proto samples and validate them.

## 1.5. INTRODUCTION TO TRACTOR SEATS

Driving a tractor often means extreme stress for the driver due to heavy vibrations. Since the typical course of work with cultivation, planting, harvesting, etc. produces a static body posture, often with twisted upper body, head and neck areas. This occurs when the driver twists himself to the rear while coupling and uncoupling attachments or to check on the progress of the work while driving. On the other hand, a high amount of dynamic stress can also occur. As a result of the generally rough driving surface of the field or construction site, vibration of high intensity, transmitted practically without damping through a chassis having virtually no suspension, impact the seat. The development of tractors in the direction of larger and heavier vehicles unavoidably yields sinking natural frequencies for these vehicles. Correspondingly, the natural frequencies of the seat must also be reduced. For this reason, the suspension of the tractor seat is of the utmost importance.

Harita Grammer is producing wide varieties of tractor seats according to its customer's requirements. The major classifications in the tractor models are:

1. Standard model.
2. Deluxe model.
3. Super Deluxe model.

The various additional features given along with the suspension and weight adjustment mechanism are:

1. Height Adjustment.
2. Lumbar Support.
3. Fore & Aft mechanism.

The existing TAFE STANDARD model tractor seat assembly consists of the following major sub-assemblies:

**1. ASSEMBLY SEAT BASE:**

Assembly seat base provides support for the driver to sit. Usually in tractor seats, thigh support is not given in standard Indian models.

**2. ASSEMBLY BACK REST:**

Assembly backrest provides support to the driver's back. Here, normally support is not provided to the shoulders in Indian seats.

**3. ASSEMBLY SUSPENSION MECHANISM:**

Suspension mechanism with the built in weight adjustment dampens the unwanted vibrations. The seat can be adjusted for the damping according to the weight of the driver using the weight adjustment. Weight can be adjusted between 50 kg to 120 kg. This is provided using two vertical tension springs and a shock absorber. Weight adjustment is achieved by changing the tension in the springs.

**4. ASSEMBLY CARRIER PLATE:**

Assembly carrier plate is the support for the seat base and backrest pans. It transfers the load from these assemblies to the springcase and the assembly swingarm. The carrier plate along with the seat base assembly and back rest assembly is the moving unit that slides along the springcase using two rollers.

**5. ASSEMBLY SPRINGCASE:**

Assembly springcase consisting of the base plate lower .i.e. the mounting plate is the rigid part of the seat assembly. This serves the main purpose of transferring the load from the carrier plate to the seat mounting. It also encloses the two tension springs and the shock absorber.

**6. ASSEMBLY SWINGARM:**

Assembly swingarm enables the seat to swing due to the spring action. It converts the longitudinal motion of the springs to angular motion of the carrier

plate with one end as the fixed one and the other as the swinging end.

## **7. OTHER COMPONENTS:**

This consists of all the loose components such as the fasteners, springs, shock absorber etc.

## **THE VARIOUS PARTS IN EACH SUB-ASSEMBLIES ARE GIVEN BELOW:**

### **1. ASSEMBLY SEATBASE**

The seat base assembly consists of the following major parts:

- 1.1. Seatbase Pan.
- 1.2. Foam.
- 1.3. Rexine
- 1.4. Endliner & clips.

### **2. ASSEMBLY BACKREST**

The backrest assembly consists of the following major parts:

- 2.1. Backrest Pan
- 2.2. Foam
- 2.3. Rexine
- 2.4. Endliner & clips.

### **3. ASSEMBLY SUSPENSION MECHANISM**

The suspension mechanism consists of the following major components:

- 3.1. Tension springs
- 3.2. Shock Absorber.

### **4. ASSEMBLY CARRIER PLATE**

The carrier plate is a sheet metal component used to connect the backrest

and Seatbase pan and to transfer the load from these to the Assy. Springcase. One end of the shock absorber and the tension springs are mounted in the carrier plate using brackets.

## **5. ASSEMBLY SPRINGCASE**

The springcase is a sheet metal pressed part that houses the rollers. The two tension springs and the shock absorber are also housed within the springcase. At its base, this is connected to the mounting plate called the base plate lower using two support plates.

## **6. ASSEMBLY SWINGARM**

The swingarm assembly consists of one rod at the fixed end and two rods at the swinging end. Two connecting tubes with a buffer are used to connect both the ends. This assembly connects the carrier plate end and the base of the springcase to facilitate a swinging movement for the seat.

## **7. OTHER COMPONENTS**

The other loose components used for the assembly such as bolts, nuts, grooved shafts, bushes, rivets etc. come under the Other Components.

A model of the existing TAFE STD. Tractor seat can be seen in Fig. 1.1.

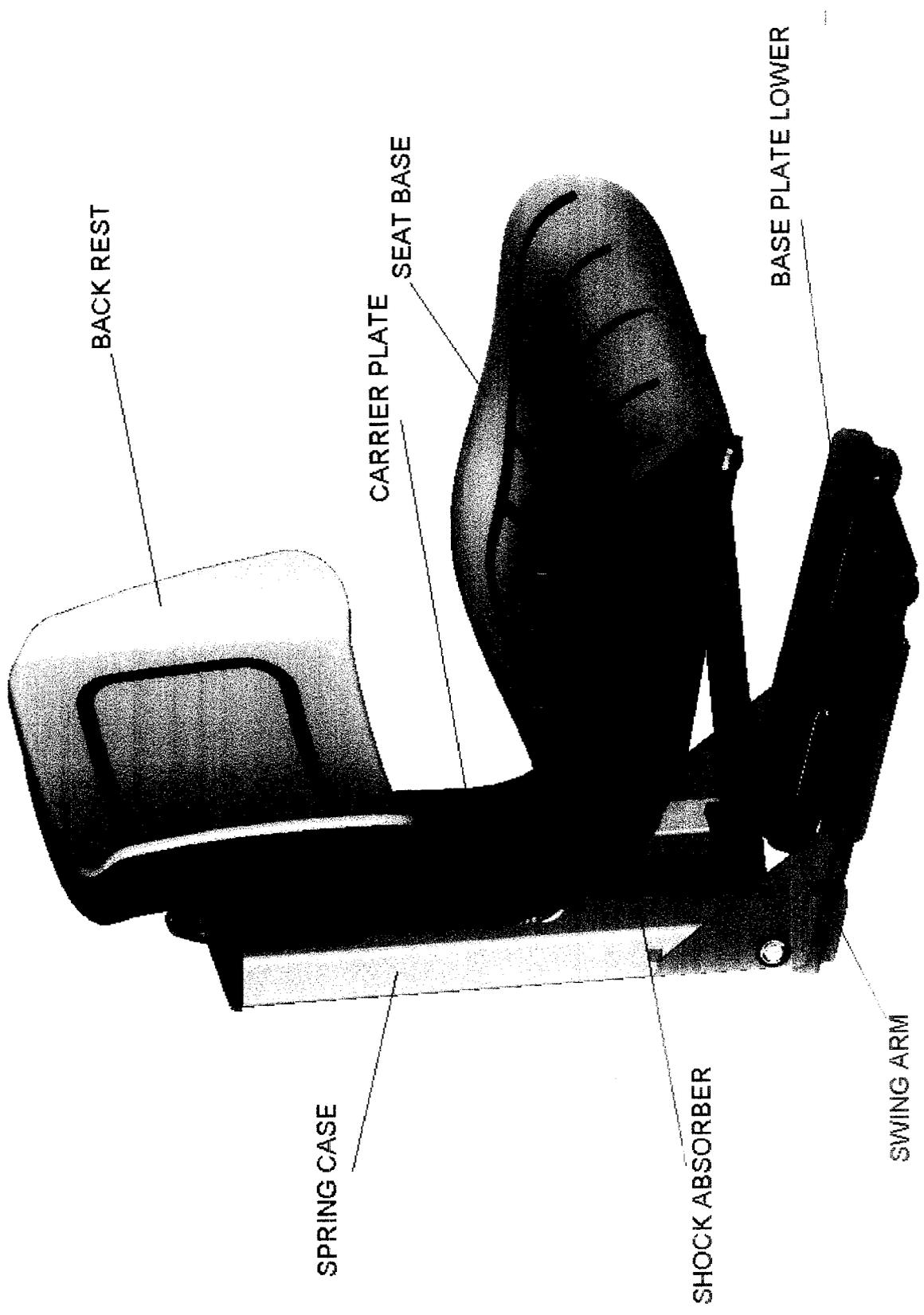


FIG.1.1. EXISTING TAFE STD. TRACTOR SEAT.

**CHAPTER 2**  
**NEW PRODUCT DEVELOPMENT**  
**PROCEDURE**

## **2.1. INTRODUCTION:**

New Product Development (NPD) procedure covers all product and process related activities from product development through dispatch to customer. This procedure is also applicable to all products undergoing modifications/ improvements.

The new products are normally categorized into customer driven and OEM driven product. OEM driven products are that whose design, development and launch are with discretion of the company. These products are normally offered to various customers/ markets.

## **2.2. PHASES OF NPD:**

NPD procedures are classified under five different phases as below, as per QS9000 requirements:

PHASE 1: Planning.

PHASE 2: Product Design and Development .

PHASE 3: Process Design and Development.

PHASE 4: Product and Process Validation.

PHASE 5: Feedback, Assessment and Corrective Action.

This project covers only the first two phases of the QS9000 system, which covers upto proto sample production and validation. The other phases will follow this, but as the fixture, tools and mould development for production takes more time this could not be completed within the project duration. The various activities under the first two phases of New Product Development are detailed in the following chapters.

# **CHAPTER 3**

## **PLANNING PHASE**

### **3.1. INTRODUCTION:**

Planning phase needs inputs for new product development. This includes Customer requirements, Data collection, Analysis of the data and preparation of timing plan for project execution.

### **3.2. DATA COLLECTION:**

The following are the inputs for New Product Development:

- ♣ Historical warrant and quality information of similar existing products are collected and reviewed to ensure the deficiencies observed are taken care for the new product under development. (Table 3.1.)
- ♣ Market information from customer/ market for any want of new product and about the customers and the competitors are collected. (Table 3.2 & 3.3.)
- ♣ Market potential giving the sales trend of Low HP Tractor seats in India was gathered to study the feasibility of the new product. (Fig.3.1. & Table 3.4.)
- ♣ Previous NPD experience such as Things Gone wrong/Right (TGW/TGR) report are also considered. (Appendix A: A1)
- ♣ Customer's voices are collected through market survey by distributing questionnaires and collecting their feedback. (Appendix A: A2)

### **3.3. BENCHMARKING:**

#### **a) INTRODUCTION:**

Benchmarking involves comparing the “value attributes” of “our product’ with those of the market leaders to identify our shortcomings or the “value gap”. It helps in competitive assessment of our product with those of the market leaders to findout the drawbacks in our product and also identifies the opportunities for further improvements in our product.

**TABLE 3.1. HISTORICAL WARRANT AND QUALITY INFORMATIONS**

CUSTOMER COMPLAINTS	CUSTOMER'S NAME			
	TAFE	M&M	NHL	L&T
1. U- pad missing	☆			
2. Paint scratches	☆	☆		
3. Lateral Play	☆			
4. Wrong supply	☆			
5. Tens. Adj. Spring dislocated	☆			
6. Baseplate lower bend	☆			
7. Locking lever not working	☆			
8. S/A pin broken	☆		☆	
9. Stop bkt. Weld broken	☆			
10. B/R Cushion damage	☆			
11. 1.6 Carrier plate bend	☆			
12. Sliding play	☆	☆		
13. Groove shaft removed	☆			
14. S/B Cushion damage	☆			
15. Circlip missing	☆			
16. Washer & Circlip missing		☆		
17. Wt. Adj. Knob broken		☆	☆	
18. Fore & Aft. Lever knob missing		☆		
19. Sliding struck		☆		
20. Sliding fouling with housing		☆		
21. Dowel pin rubbing withspringcase		☆		
22. Carrierplate pin broken		☆	☆	
23. Mounting bkt. Broken		☆		
24. S/B & B/R cushion waviness at corner		☆		
25. Rexin crack/ damages		☆		☆
26. Wt. Adj. Setting not done			☆	
27. Carrier plate deformation			☆	
28. Dust accumulation in seat base				☆

TABLE 3.2. MARKET INFORMATION

HGL'S CUSTOMERS	OTHER SUPPLIERS	EXTRA FEATURES & PRICE OFFERED BY THEM	FEEDBACK FOR HGL'S SEATS
1. TAFE	Krishna Fabricators	Dampers Present Rs.1300.	Need Dampers
2. International Tractors	Small Scale Industry at Punchkula	Rs.950.	Dampers is a must.
3. ESCORTS	HILTA(ESCORTS Group)	Similar to NAYAK Model Rs.1700.	-

**TABLE 3.3. COMPETITOR'S CUSTOMERS**

<b>COMPETITORS</b>	<b>CUSTOMERS OF HGL'S COMPETITORS</b>
1. Krishna fabricators	TAFE ESCORTS HMT
2. Small Scale Industry at Punchkula	International Tractors only.
3. HILTA (ESCORTS Group)	ESCORTS only.

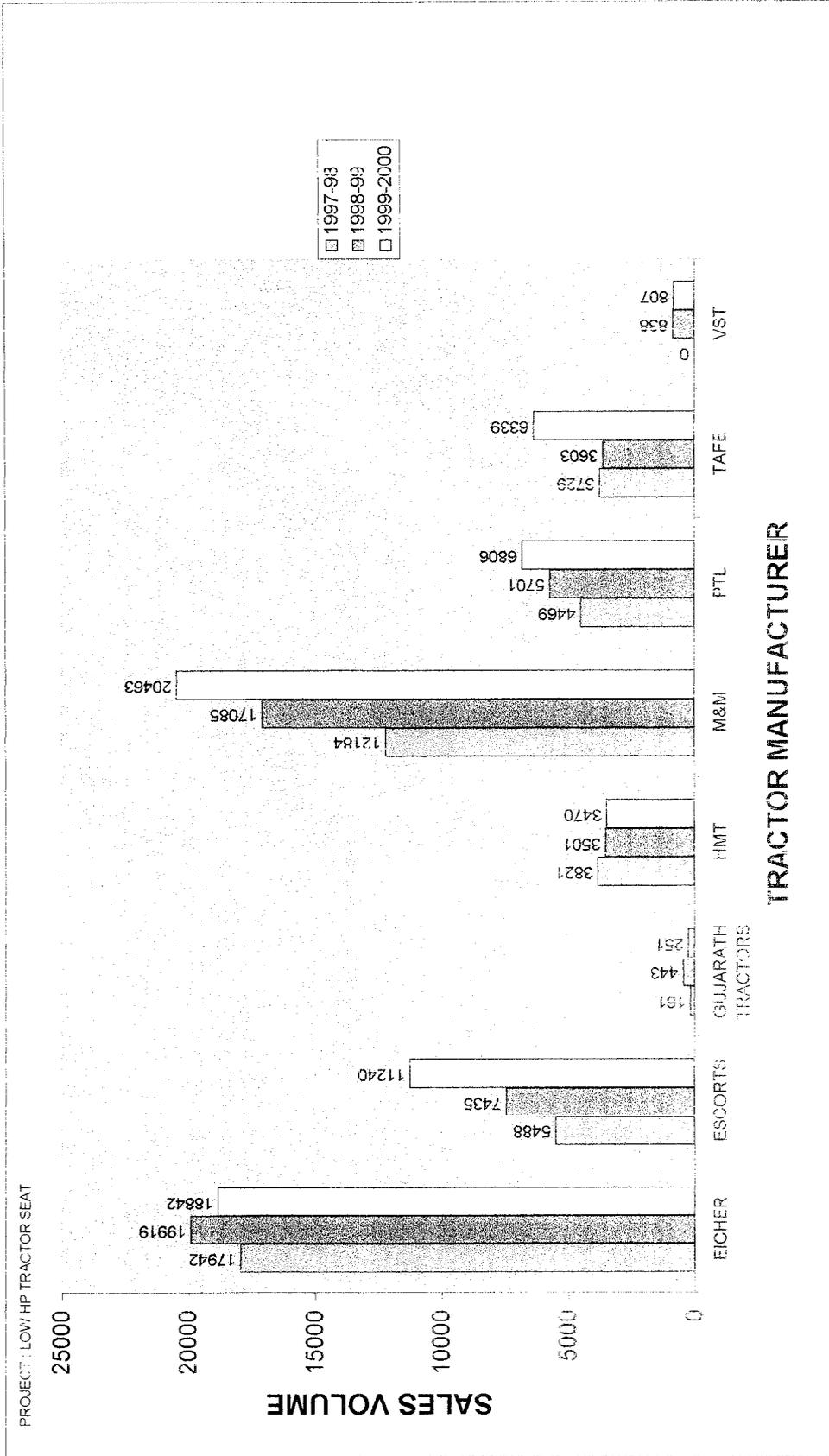


FIG 3.1 SALES TREND OF LOW HP TRACTORS

**TABLE 3.4. MARKET POTENTIAL FOR LOW HP TRACTORS**

OEM'S	SALES VOLUME			SEAT MANUFACTURER
	1997-98	1998-99	1999-2000	
1. EICHER	17942	19919	18842	POLAR
2. ESCORTS	5488	7435	11240	NIKY TASHA
3. GUJARATH TRACTORS	161	443	251	-
4. HMT	3821	3501	3470	PUNJAB SCOOTERS
5. M&M	12184	17085	20463	POLAR & ALF
6. PTL	4469	5701	6806	INHOUSE
7. TAFE	3729	3603	6339	KRISHNA FABRICATORS
8. VST	-	838	807	-

**TABLE 3.5. LOW HP(BELOW 30 HP) TRACTOR MODELS**

OEM'S	LOW HP TRACTOR MODELS
MAHINDRA & MAHINDRA	18 HP AND 25 HP.
TAFE	25 HP AND 30 HP.

## **b) METHODOLOGY:**

- ❖ First benchmarking for the major layout dimensions of tractor seats was done using HGL and Grammer AG catalogues.
- ❖ Frequently repeated dimensions were noted. (Table 3.6.)
- ❖ Next the following tractor seats were benchmarked for part count and variety count according to sub-assemblies:
  - a) TAFE Std. Seat. (Fig.3.2, 3.3. & Table 3.7.)
  - b) Krishna Fabricator's Seat. (Fig.3.4, 3.5. & Table 3.8.)
  - c) Grammer AG's Seat. (Fig.3.6, 3.7. & Table 3.9.)
  - d) John Deere's Seat. (Fig.3.8, 3.9. & Table 3.10.)
- ❖ Process benchmarking of the various foam assembly tucking methods was also done.(Appendix A: A3)

## **c) OUTPUTS OF BENCHMARKING:**

1. The dimensional benchmarking was used to decide on a dimensional layout for the product.
2. The process benchmarking was used to decide on an alternate tucking method in S/B and B/R assemblies, to eliminate the end-liners and to improve product quality.

## **3.4. ANALYSIS OF DATA**

### **3.4.1. INTRODUCTION:**

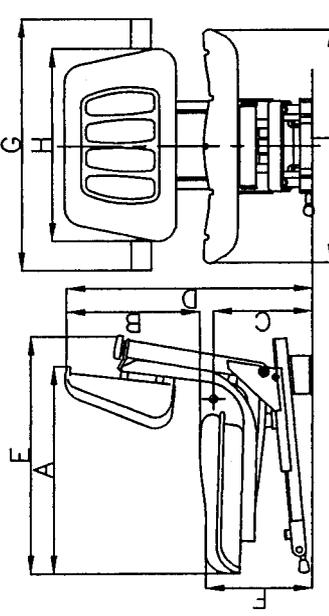
The available inputs are analysed systematically using various technical tools such as:

1. Quality Function Deployment.
2. Value Engineering.
3. Process Mapping.

TABLE.3.6.BENCHMARKING OF DIMENSIONS

PROJECT: LOW HORSE POWER TRACTOR SEAT

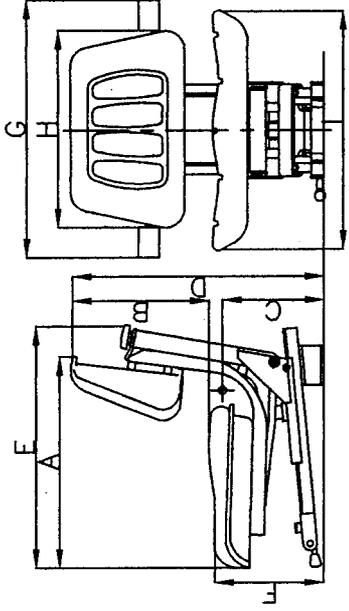
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SNo	MODEL DESCRIPTION	A mm	B mm	C mm	D mm	E mm	F mm	G mm	H mm	I mm	REMARKS
1.	DS 20/1	-	-	125	495	555	180	-	-	490	Suspension stroke 50mm.
2.	DS 20/4	-	-	155	470	540	225	-	530	530	Suspension stroke 90mm.
3.	DS 20 D 3 H	-	-	245	600	570	340	-	460	520	Seat plate folding upwards.
4.	DS 20 H 90	-	-	165	550	575	225	470	430	480	Automatic seatbelt retractor
5.	DS 44 L	-	270	125	440	470	185	-	-	420	Suspension stroke 50mm.
6.	DS 44/1 H	-	-	170	535	545	225	-	480	480	Suspension stroke 90mm.
7.	DS 44/2 H	-	-	175	515	545	225	540	-	490	Suspension stroke 100mm.
8.	DS 44/2 H 4	-	-	185	520	570	230	555	-	485	SS 100MM.
9.	DS 44/H 90	-	-	185	550	575	235	-	470	500	Lumbar support adj.
10	DS 44/H 90 A	-	-	200	580	680	260	590	-	485	B/R Suspension, SS 100mm, Armrest available.
11	DS 85 H/3	500	-	190	525	-	233	-	475	465	SS 80mm, Air suspension.
12	DS 83 H/8	465	-	190	490	-	-	-	400	400	Air suspension.
13	DS 85 H1/90 AR	550	-	225	770 (615)	-	270	585	-	500	Attached B/R extn., SS100mm tiltup armrest, Lumbar support
14	DS 85 H/ LA	615	-	200	920	-	275	660	-	500	Attachable B/R extn., Flipup armrest, Lumbar support.

PROJECT: LOW HORSE POWER TRACTOR SEAT

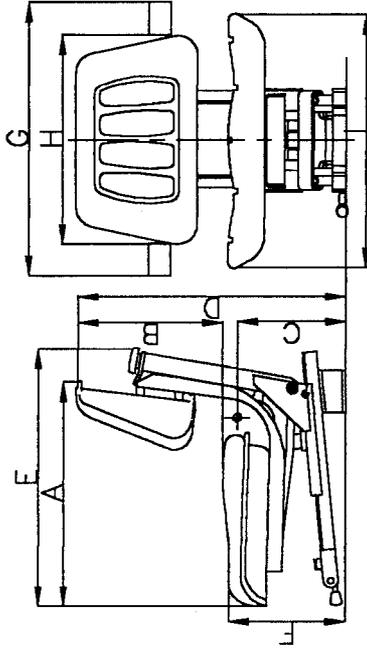
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SNd	MODEL DESCRIPTION	A mm	B mm	C mm	D mm	E mm	F mm	G mm	H mm	I mm	REMARKS
15	LS 95 H 1/ 90 AR	560	-	225	815	-	300	585	-	-	Air suspension, B/R extn., Lumbar support, Tilt armrest, SS 120 mm.
16	DS 44/ 1 HB	-	-	170	520	595	180	-	425	470	SS 100mm.
17	UNIVERSO XM	-	-	185	582	554	248	-	450	450	
18	MAXIMO M	589	-	-	674	-	283	648	482	520	Armrest foldable, SS 100mm, Lumbar support, B/R adj.
19	MAXIMO XXL	601	-	-	755	-	313	640	482	530	Air suspension, Adj. armrest, Lumbar support, B/R adj.
20	DS 83 H/ 3 S	500	-	230	615	-	240	-	420	-	'X' Style suspension, SS80mm.
21	DS 83 H/ 3 B	510	-	220	600	-	270	-	-	465	Mech. suspension protected by rubber boot.
22	DS 44/ 8	-	-	105	420	520	160	-	400	400	SS 80 mm.
23	LS 44/ 1 HB	-	-	190	530	600	200	600	435	475	
24	DS 44 H/ 90 R	-	-	185	755 (560)	575	-	590	470	490	SS 80mm, Ht. adj., tilt arm rests of integral foam, B/R extn. attachable, Removable seatpan & B/R cushion.
25	DS 85/90	545	-	165	560	-	210	-	430	485	SS 80mm, suspension mech. seated in bellow, Removable seatpan & B/R cushion.
26	DS 85 H/90 A	-	-	185	-	-	-	585	430	490	Foldable, ht. adj. armrest, bellows, Removable seatpan & B/R cushion.

PROJECT: LOW HORSE POWER TRACTOR SEAT

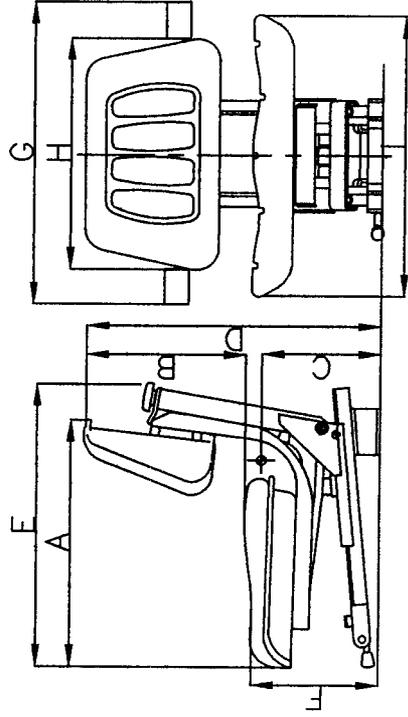
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SNd	MODEL DESCRIPTION	A mm	B mm	C mm	D mm	E mm	F mm	G mm	H mm	I mm	REMARKS
27	DS 85 H/ 90	535	-	185	585	-	240	585	430	490	SS 100mm, Angle adj. of B/R Lumbar support adj.
28	DS 85 H1/90 A	550	-	225	615	-	270	585	-	500	Fore & Aft Isolator lockable, Lockable, turnable swivel range +/-10°
29	DS 20/4 R	-	-	125	630	-	175	-	520	520	Attachable B/R extn., SS 90 mm, maintenance free.
30	DS 44/1	-	-	155	544	520	264	-	430	425	
31	M&M EXPORT	-	-	-	538	-	225	-	430	525	
32	ESCORTS FORD	-	-	172	530	-	259	-	430	525	SS 90mm
33	ESCORTS FORD	-	-	172	530	-	250	-	430	425	SS 90mm
34	TAFE	-	-	155	544	520	264	-	430	425	SS 90mm, Wt. adj., B/R ht. fixed.
35	M&M	-	-	105	480	534	189	-	430	525	

PROJECT: LOW HORSE POWER TRACTOR SEAT

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SNo	PARTICULARS	A mm	B mm	C mm	D mm	E mm	F mm	G mm	H mm	I mm	SUSPENSION STROKE mm
1.	MINIMUM VALUE	465	270	105	420	470	160	470	400	400	50
2.	MAXIMUM VALUE	615	270	230	920	680	340	660	530	530	120
3.	AVERAGE VALUE	540	270	167	670	575	250	565	465	465	85
4.	REPEATED VALUE	500	-	185	530	520	225	585	430	500	100
5.	MODE OF REPEATED VALUE	2	-	5	3	3	5	5	9	4	7

TABLE 3.7. BENCHMARKING DETAILS OF TAFE VE SEAT

PARTICULARS	TUBULAR		SM		FASTENERS		TURNED		RODS		SPRINGS		PLASTICS		OTHERS		TOTAL	
	COUNT	VARIETY	COUNT	VARIETY	COUNT	VARIETY	COUNT	VARIETY	COUNT	VARIETY	COUNT	VARIETY	COUNT	VARIETY	COUNT	VARIETY	COUNT	VARIETY
Backrest	0	0	19	4	4	1	0	0	0	0	0	0	1	1	2	2	26	8
Seatbase	0	0	29	4	4	1	0	0	0	0	0	0	1	1	2	2	36	8
Suspension	5	3	13	9	2	2	5	4	1	1	2	1	7	2	6	3	41	25
Fore & Aft mechanism	0	0	6	3	2	2	1	1	3	2	0	0	5	2	0	0	17	10
Loose Parts	0	0	12	3	18	3	4	1	0	0	0	0	2	1	2	2	38	10
TOTAL	5	3	79	23	30	9	10	6	4	3	2	1	16	7	12	9	158	61

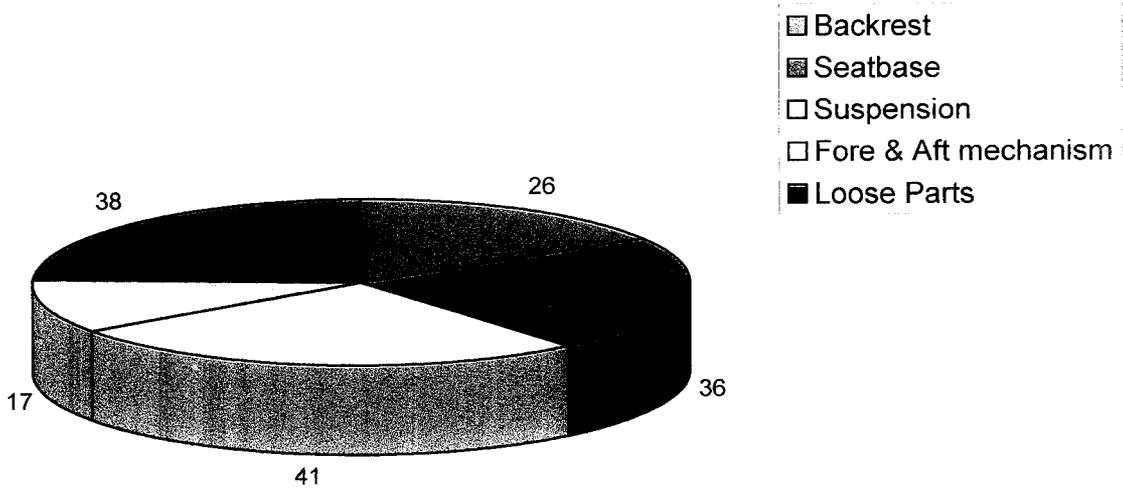


FIG. 3.2(a). PART COUNT TAFE VE-SUB ASSY WISE

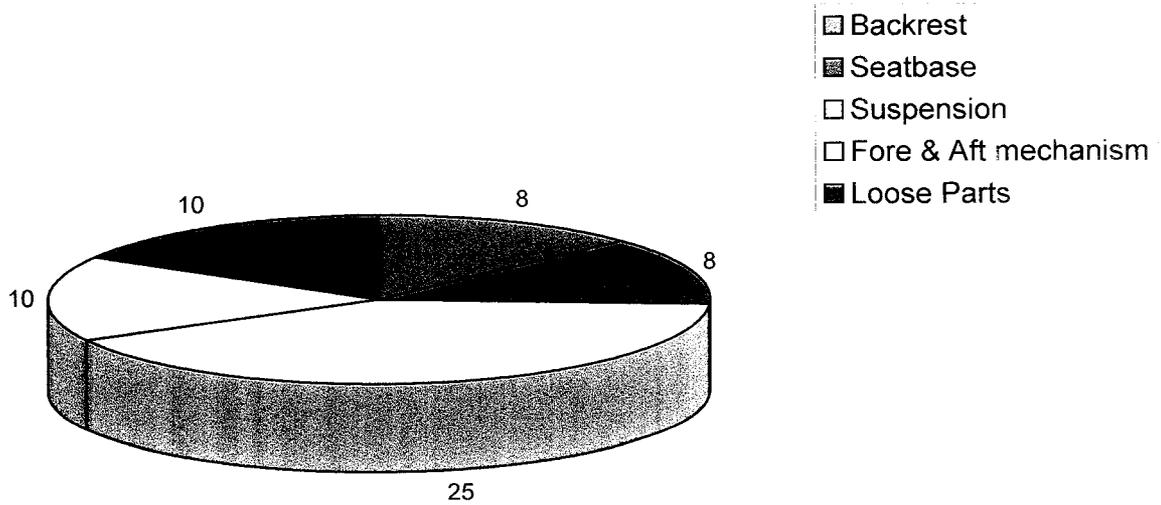


FIG.3.2(b). PART VARIETY TAFE VE-SUB ASSY WISE

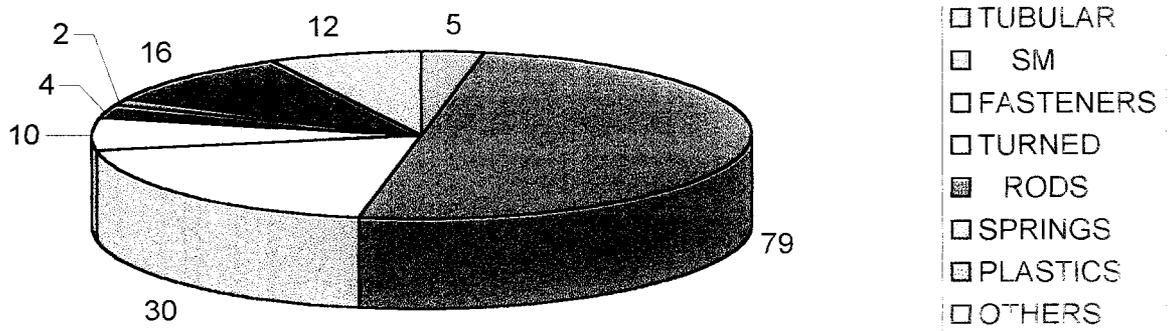


FIG.3.3.(a). PART COUNT TAFE VE-PART TYPE

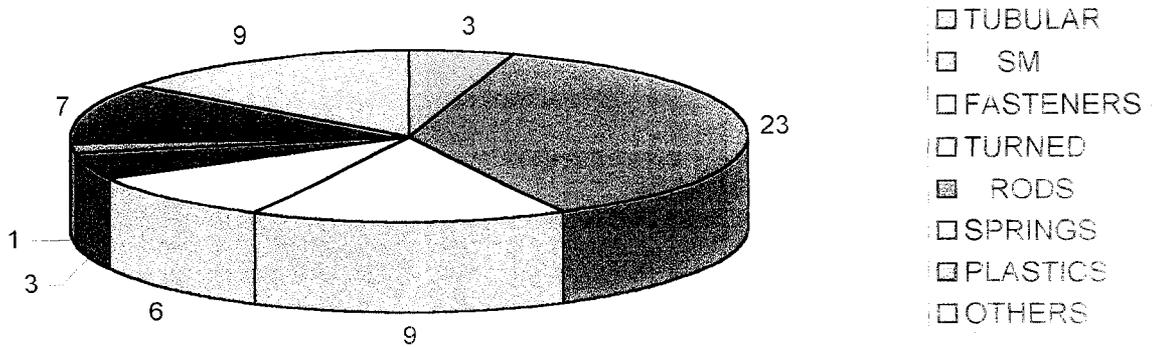


FIG.3.3(b). PART VARIETY TAFE VE-PART TYPE

TABLE 3.8. BENCHMARKING DETAILS OF KRISHNA FAB. SEAT

PARTICULARS	PART TYPE AND QUANTITY																	
	TUBULAR		SM		FASTENERS		TURNED		SPRINGS		PLASTICS		OTHERS		TOTAL			
	QTY	VTY	QTY	VTY	QTY	VTY	QTY	VTY	QTY	VTY	QTY	VTY	QTY	VTY	QTY	VTY		
Backrest	-	-	20	5	4	1	2	1	-	-	-	-	3	3	29	10		
Seatbase	-	-	30	4	4	1	2	1	-	-	-	-	3	3	39	9		
Suspension	3	2	21	13	2	2	-	-	2	1	1	1	12	7	41	26		
Fore & Aft mechanism	3	3	-	-	2	2	-	-	-	-	5	2	1	1	11	8		
Loose Parts	1	1	1	1	18	3	-	-	-	-	8	2	1	1	29	8		
<b>TOTAL</b>	<b>7</b>	<b>6</b>	<b>72</b>	<b>23</b>	<b>30</b>	<b>9</b>	<b>4</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>14</b>	<b>5</b>	<b>20</b>	<b>15</b>	<b>149</b>	<b>61</b>		

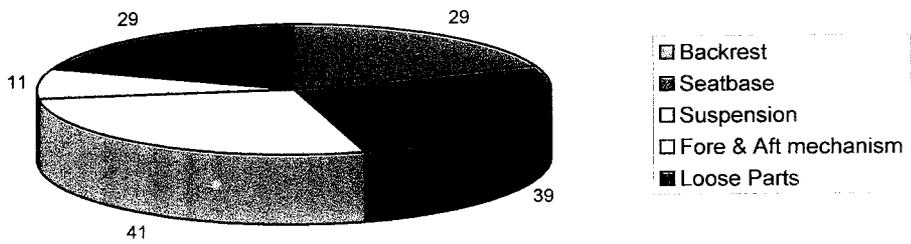


FIG.3.4(a). PART COUNT KF-SUB ASSY WISE

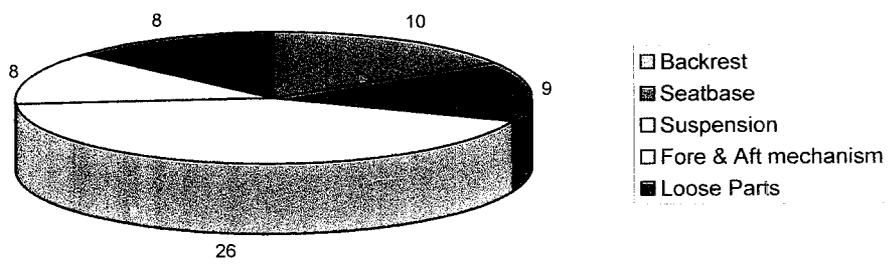


FIG.3.4(b). PART VARIETY KF-SUB ASSY WISE

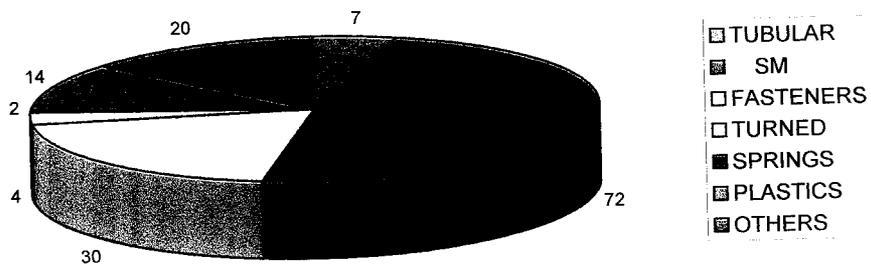


FIG.3.5(a). PART COUNT KF -PART TYPE WISE

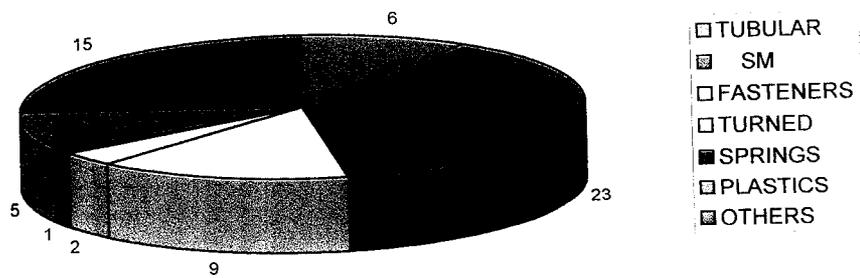


FIG.3.5(b). PART VARIETY KF-PART TYPE WISE

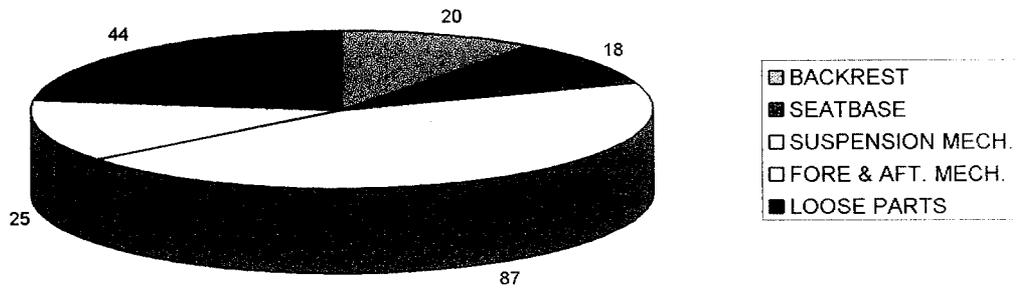


FIG.3.6(a). PART COUNT GAG-SUB ASSY WISE

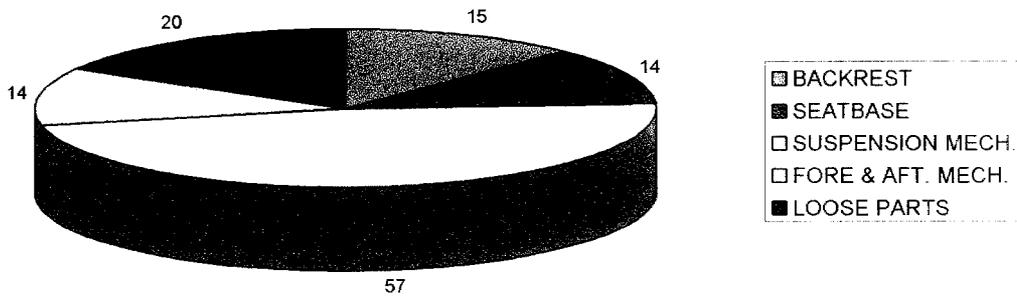


FIG.3.6(b). PART VARIETY GAG-SUB ASSY WISE

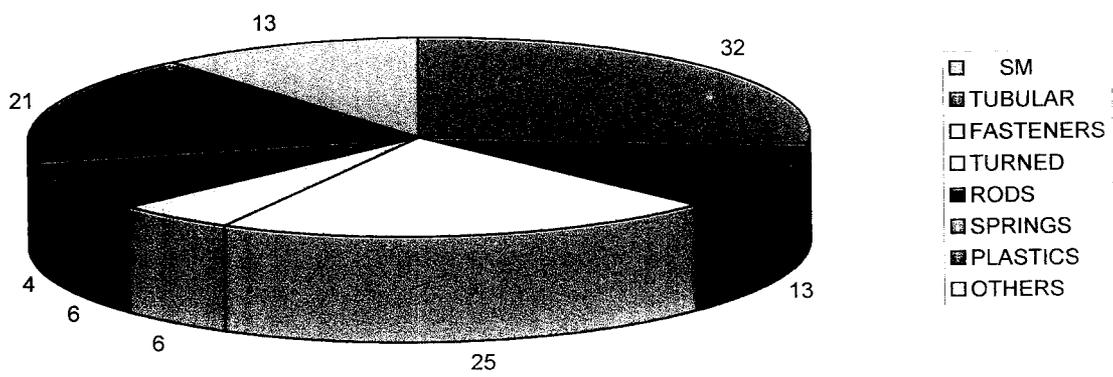


FIG.3.7(a). PART VARIETY GAG-PART TYPE WISE

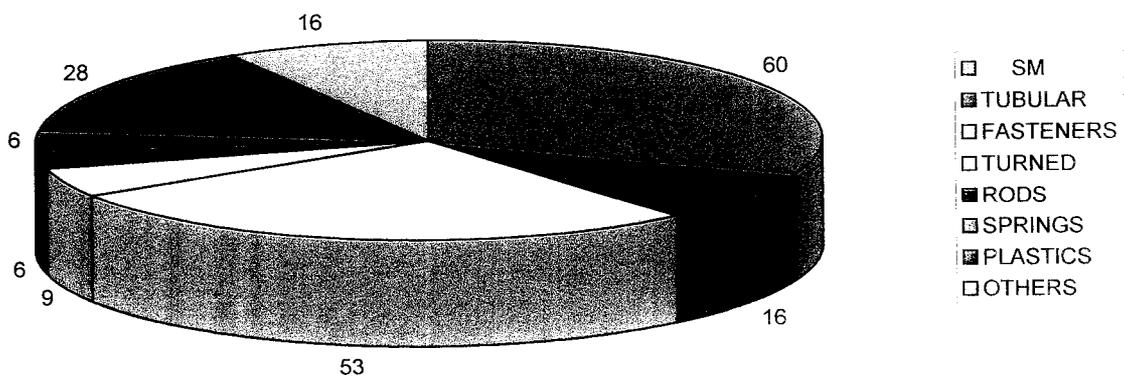


FIG.3.7(b). PART COUNT GAG-PART TYPE WISE

TABLE 3.10. BENCHMARKING DETAILS OF JOHN DEERE SEAT

PARTICULARS	PART TYPE AND QUANTITY																	TOTAL	
	SM		TUBULAR		FASTENERS		TURNED		RODS		SPRINGS		PLASTICS		OTHERS		QTY	VTY	
	QTY	VTY	QTY	VTY	QTY	VTY	QTY	VTY	QTY	VTY	QTY	VTY	QTY	VTY	QTY	VTY			
BACKREST	-	-	-	-	8	3	-	-	-	-	-	-	1	1	2	2	11	6	
SEATBASE	-	-	-	-	1	1	-	-	-	-	-	-	2	2	3	3	6	6	
SUSPENSION MECH.	10	10	4	3	8	2	3	2	2	2	-	-	3	2	4	3	34	24	
FORE & AFT. MECH.	6	4	-	-	8	2	-	-	1	1	1	1	-	-	1	1	17	9	
LOOSE PARTS	-	-	2	2	-	-	4	1	1	1	2	1	4	2	4	1	17	8	
	16	14	6	5	16	4	7	3	4	4	3	2	7	4	9	5	68	41	

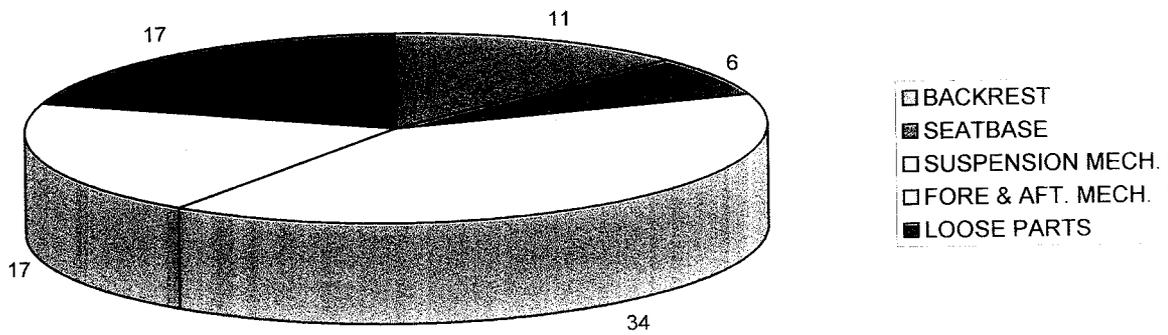


FIG.3.8(a). PART COUNT JD-SUB ASSY WISE

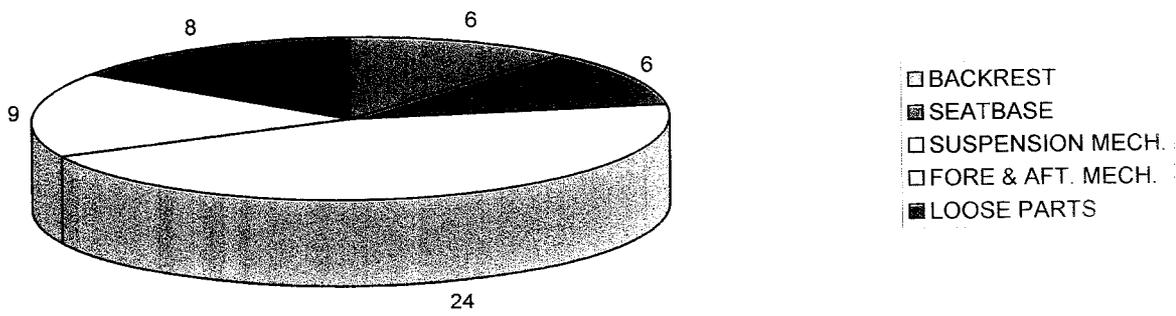


FIG.3.8(b). PART VARIETY JD-SUB ASSY WISE

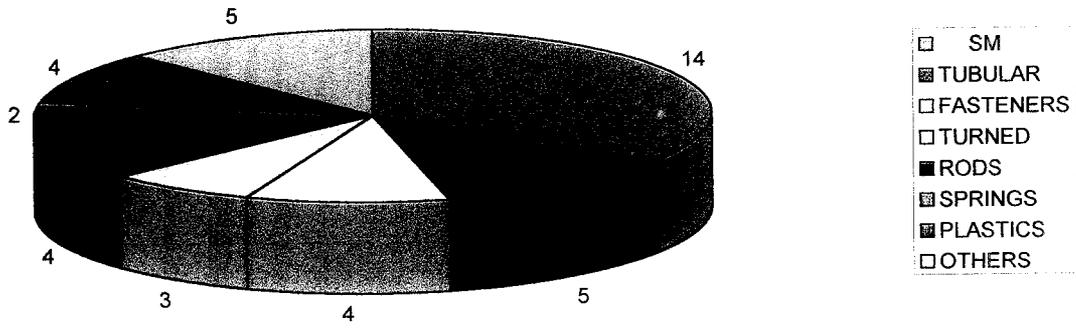


FIG.3.9(a). PART VARIETY JD-PART TYPE WISE

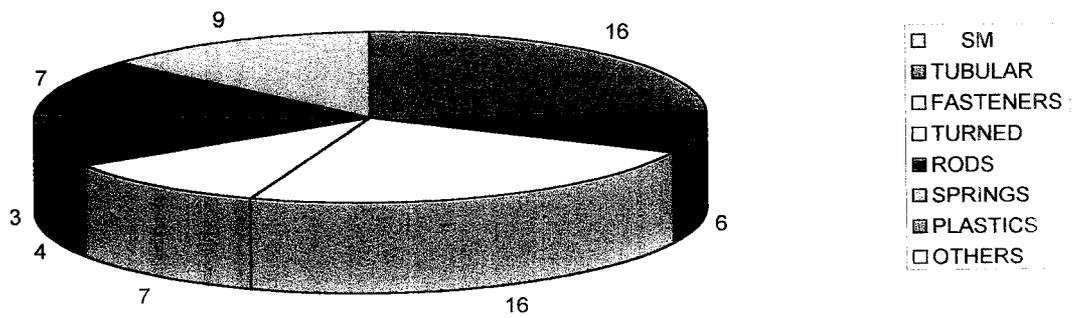


FIG.3.9(b). PART COUNT JD-PART TYPE WISE

4. Customer Matrix.
5. Supplier Matrix.

All the above mentioned techniques are detailed below:

### **3.4.2. QUALITY FUNCTION DEPLOYMENT**

#### **a) INTRODUCTION:**

QUALITY FUNCTION DEPLOYMENT (QFD) is defined as converting the consumer's requirements into "quality characteristics" and developing a design quality for the finished product by systematically deploying the relationships between the requirements and the characteristics, starting with the quality of each functional component and extending the deployment to the quality of each part and process.

QFD provides specific methods for ensuring quality throughout each stage of the product development process, starting with design. It also provides ways to assure the design quality while the product is still in the design stage.

#### **b) METHODOLOGY:**

- ❖ Separate questionnaires for the end-users and the OEM's for tractor seats were prepared.
- ❖ Market survey was conducted to collect the voices of the end-users for the questionnaire.
- ❖ Questionnaires for the OEM's were sent through e-mail and their replies collected.
- ❖ Consolidated Customer and End-user's voices were prepared. (Appendix A:A2).
- ❖ These voices were grouped as primary, secondary and tertiary customer requirements and importance given according to the replies got.
- ❖ The technical requirements for low hp tractor seats were listed and the direction of improvement specified.
- ❖ The QFD matrix showing the strong, moderate and weak relationships between the customer requirements and the technical requirements were identified.

- ❖ Test specification details for tractor seats were collected.
- ❖ The collected test specifications and standards were used to define the technical specifications.
- ❖ The Grammer and the John Deere seats were compared with HGL seat and ranked according to customer and technical requirements for competitive assessment.
- ❖ All these were used to prepare the QFD chart. (Appendix A: A4).

### **c) OUTPUTS OF QUALITY FUNCTION DEPLOYMENT**

The outputs of Quality Function Deployment (QFD) process have been mainly categorized into 2 categories, tangible and intangible ones.

#### **TANGIBLE OUTPUTS:**

1. Design parameters for the concepts were decided.
2. Priorities of customer and consumers were arranged sequentially.
3. The understanding of the customer and end user about the product has been brought out.
4. The competitive standing of the product has been brought out.
5. The wants' and musts' have been distinguished.
6. Design priorities have been arranged.
7. The "Catch-up" position, the position of the "Current strength", and an "Opportunity" are highlighted.
8. A systematic method of justifying concepts has been evolved and the matrix provides decision support at all stages of product development.
9. The need for various kinds of action has been brought out.
10. A crucial set of data is available to decide on product attributes where a "give" or "don't give" kind of decision is required.
11. Gives data to manage conflicting requirements.
12. Acts as input to FMEA, during concept finalisation and proto drawing release.

## **INTANGIBLE OUTPUTS:**

1. The product is oriented towards the end-user in the best possible way.
2. The difference in perception based on geographical location of the city was brought out.
3. Perception of comfort was better understood.
4. The psychological aspects of the perception and its importance were appreciated.
5. The small factors that make a big difference were identified.
6. The awareness levels about the product and their influence on comfort have been better understood.
7. All the constraints related to product development and improvement has been brought under one roof.

### **3.4.3. VALUE ENGINEERING**

#### **a) INTRODUCTION TO VE:**

Value Engineering, also called as “Value Analysis”, “Value Management” or any other numerous names was formally implemented in 1961 in the Department of Defense (DOD) in USA. VE is an intensive review of the product functions/ features and the development of alternatives by the use of appropriate value analysis utilising engineering techniques, behavioral science and creativity in a systematic way.

VE is the systematic application of recognised techniques, which identify the function(s) of a product or a service, establish a monetary value for that function and provide the necessary function reliably at lowest overall cost. VE utilises a systematic procedure for analysing the requirements and translating these into the most economical means of providing the essential functions without sacrificing the performance, reliability, quality and maintainability.

VE identifies and reduces the areas of excessive or unnecessary costs and attempts to improve the value of the project. It provides the same or better performance at a lower cost, without compromising on the quality of the product.

Two prominent technical tools used in VE are:

**i) FAST DIAGRAM:**

Function Analysis and System Technique (FAST) is a diagramming technique used to graphically show the logical relationships of the functions of an item, system or procedure.

A FAST diagram helps :

- \* To organise random listing of functions.
- \* To check for missing functions, that may be overlooked in the above random listing process.
- \* To identify the basic function.
- \* To test the function through a deterministic logic.
- \* To deepen the involvement, visualisation of the problem to be solved.
- \* To develop more creative alternatives.

Refer Fig.3.10. FAST is a tool that certifies that the diagrammer has the perfect knowledge of the technique and theory. All the functions are written in the Noun-Verb methodology. The TASK function that appears to the left of the scope line is the function of the highest order. The remaining basic and supportive functions that answer the question "HOW ?" appear to the right of the scope line. In this way, the subsequent functions which answer the question "HOW ?" were fit into the FAST diagram until it finally led to the component level. Similarly, all the functions answer to the question "WHY ?" when coming from right to left till we reach the higher order function.

**ii) FUNCTION COST ANALYSIS:**

Function cost analysis is the technique of assigning weightage to the various functions of a part in terms of their cost, calculating the worth cost and find the value gap between them. The following are the weightages given for various functional worth:

Main function : 45%

Aesthetics : 5%

PROJECT : LOW HP TRACTOR SEAT

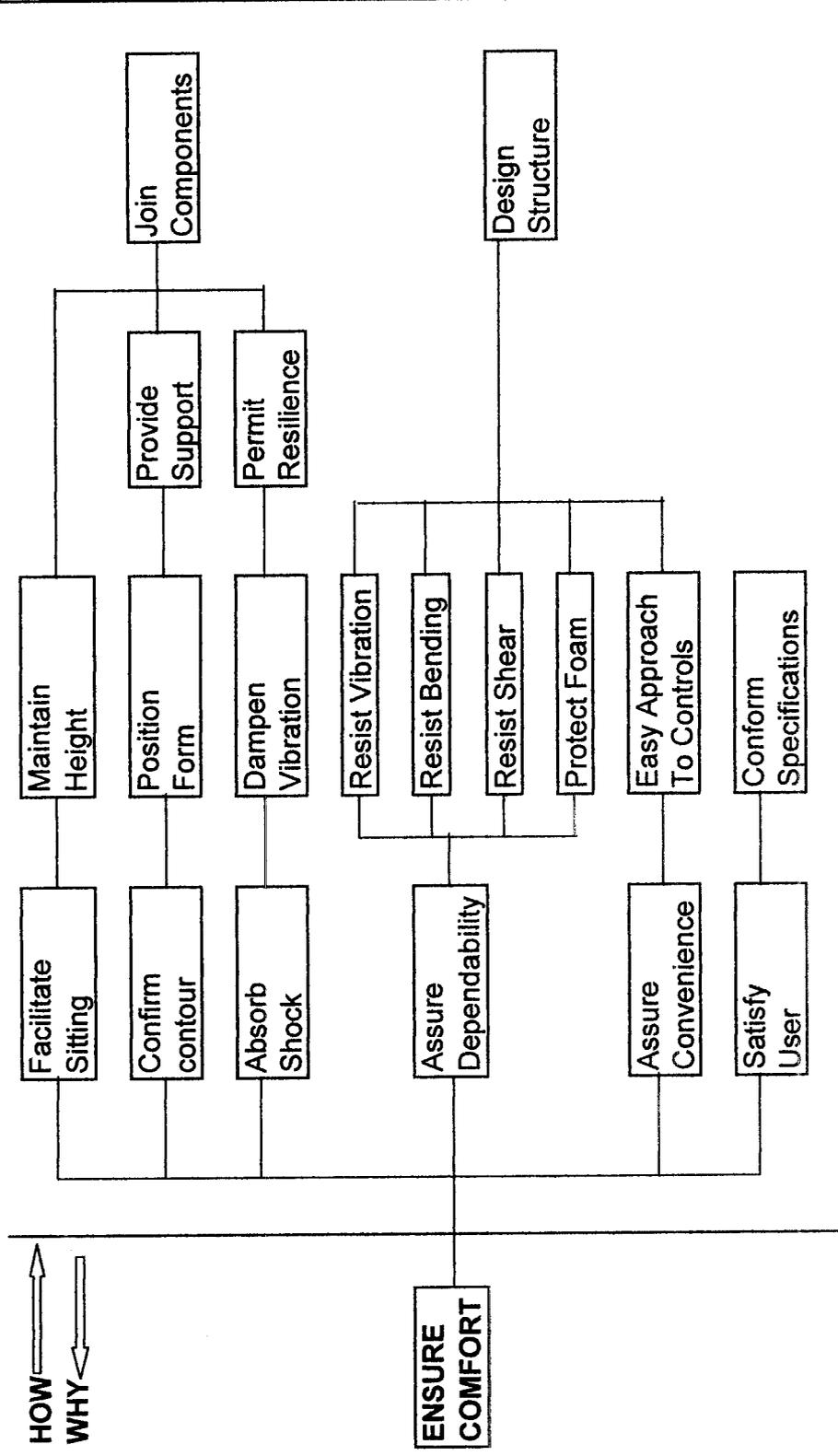


FIG.3.10. TASK ORIENTED FAST DIAGRAM

Ergonomics : 20%

Reliability : 30%

#### **b) METHODOLOGY:**

Function Cost Analysis was done as below.

- ❖ The present material cost details of the existing TAFE Std. Seat was collected.
- ❖ All the functions of each and every part/ component were listed sub-assembly wise.
- ❖ A matrix was constructed by allocating a percentage of the part material cost for all of its functions depending on the weightage of the function it performs.
- ❖ The total "Function Cost" for each sub-assembly was then calculated.
- ❖ The actual "Function Worth" for each function was then decided.
- ❖ The "Value Gap" for each sub-assembly was obtained by finding the difference between the "Function Cost" and "Function Worth".
- ❖ Finally, the total "Value Gap" for the complete TAFE STD. Seat was calculated. Refer Table 3.11.

#### **c) OUTPUTS OF VALUE ENGINEERING:**

The "Value Gap" for the sub-assemblies were identified using the Function Cost Analysis worksheet.

This value gap can be eliminated by removing the non-value added parts, redundant parts and also by alternate material usage. (Appendix A: A5).

### **3.4.4. PROCESS MAPPING**

#### **a) INTRODUCTION:**

Component Process Mapping is a technique, which involves the study of the entire processes for manufacturing a component to identify the low yielding processes and arriving at alternate process sequence to increase the material yield. It also aims at reducing the scrap generated during the conversion process from the raw materials to the finished components. It projects the difficulties faced during this

TABLE 3.11. FUNCTION COST WORKSHEET

S. NO.	FUNCTION	↑	[S/B ASSEMBLY]		Support cushion	Transfer Load	Join Components	Facilitate Fixing	Provide Comfort	Protect Cushion	Resist Buckling	Facilitate Assembly	Permit Resilience	Conform Contour	Provide Swinging	Prevent Fouling/Failure	Retain Spring	Stop Movement	Support Roller	Prevent Rotation	Facilitate Mounting	Facilitate Movement	Damp Vibration	Display Information	Provide Indication	Prevent Damage	Support B/R & S/B	Avoid Floating	Prevent Corrosion	
			COMPONENT	COST(Rs)																										
1	Seat Pan		53.42	4.41	30.9	-	-	-	-	-	52.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Weldnut M8		1.96	-	-	1.57	-	-	-	-	-	0.39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	Endliner		20.66	-	-	-	20.3	-	-	-	-	2.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Nut UNF "7/16		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Clip		0.77	-	-	0.77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Springclip		-	-	-	-	-	-	5.57	-	-	1.39	-	55.7	6.98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	S/B Cushion		69.68	-	-	-	-	-	-	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	Rexine		33.99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	FUNCTION COST(C)		217.09	4.41	30.9	2.34	20.3	5.57	34	52.9	4.04	56.7	6.98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	FUNCTION WORTH(W)		174.28	4.41	23.2	2.34	20.3	5.57	23.8	40.2	4.04	44.6	5.93	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	VALUE GAP(G)		42.81	-	7.71	-	-	-	10.2	12.7	-	11.2	1.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

FUNCTION COST WORKSHEET

S. NO.	[B/R ASSEMBLY] COMPONENT	COST(Rs)	FUNCTION		Support cushion	Transfer Load	Join Components	Facilitate Fixing	Provide Comfort	Protect Cushion	Resist Buckling	Facilitate Assembly	Permit Resilience	Conform Contour	Provide Swinging	Prevent Fouling/ Failure	Retain Spring	Stop Movement	Support Roller	Prevent Rotation	Facilitate Mounting	Facilitate Movement	Damp Vibration	Display Information	Provide Indication	Prevent Damage	Support B/R & S/B	Avoid Floating	Prevent Corrosion	
			↑																											
1	B/R Pen	53.42			2.67	18.7	-	-	-	-	32.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Weldnut M8	1.96			-	-	1.86	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	Endliner	20.66			-	-	-	18.6	-	-	-	2.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Clip	0.77			-	-	0.77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Springclip	-			-	-	-	-	3.57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	S/B Cushion	44.6			-	-	-	-	-	24.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Rexine	24.63			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	<b>FUNCTION COST(C)</b>	<b>146.03</b>			<b>2.67</b>	<b>18.7</b>	<b>2.63</b>	<b>18.6</b>	<b>3.57</b>	<b>24.6</b>	<b>32.1</b>	<b>3.06</b>	<b>35.7</b>	<b>4.46</b>																
	<b>FUNCTION WORTH(W)</b>	<b>121.21</b>			<b>2.67</b>	<b>14</b>	<b>2.63</b>	<b>18.6</b>	<b>3.57</b>	<b>18.7</b>	<b>25.6</b>	<b>3.06</b>	<b>28.5</b>	<b>3.79</b>																
	<b>VALUE GAP(G)</b>	<b>24.82</b>			<b>-</b>	<b>4.7</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>5.91</b>	<b>6.41</b>	<b>-</b>	<b>7.14</b>	<b>0.67</b>																

FUNCTION COST WORKSHEET

PAGE 3 OF 7

S. NO.	COMPONENT	COST(₹)	FUNCTION																									
			Support cushion	Transfer Load	Join Components	Facilitate Fixing	Provide Comfort	Protect Cushion	Resist Buckling	Facilitate Assembly	Permit Resilience	Conform Contour	Provide Swinging	Prevent Fouling/ Failure	Retain Spring	Stop Movement	Support Roller	Prevent Rotation	Facilitate Mounting	Facilitate Movement	Damp Vibration	Display Information	Provide Indication	Prevent Damage	Support B/R & S/B	Avoid Floating	Prevent Corrosion	
	[SWING ARM ASSY. COMPL.]																											
1	Assy. Swing Arm	43.01		8.6	2.15							30.11				2.15												
2	Buffer	1.29																										
3	Blind Rivet	0.72			0.72																							
4	Washer	0.12																										
	FUNCTION COST(C)	45.14		8.6	2.87							30.11				2.15												
	FUNCTION WORTH(W)	37.37		7.5	2.87							25.59				2.15												
	VALUE GAP(G)	5.62		1.1								4.52																
	[SPRING BKT ASSY]																											
1	Special Nut	8.01		1.6	0.41																							
2	Spring Bkt.																											
3	Grooved Lock Pin																											
	FUNCTION COST(C)	8.01		1.6	0.41																							
	FUNCTION WORTH(W)	6.51		1.6	0.41																							
	VALUE GAP(G)	1.5																										

FUNCTION COST WORKSHEET

S. NO.	FUNCTION	↑	[ASSY. CARRIER PLATE]		Support cushion	Transfer Load	Join Components	Facilitate Fixing	Provide Comfort	Protect Cushion	Resist Buckling	Facilitate Assembly	Permit Resilience	Conform Contour	Provide Swinging	Prevent Fouling/Failure	Retain Spring	Stop Movement	Support Roller	Prevent Rotation	Facilitate Mounting	Facilitate Movement	Damp Vibration	Display Information	Provide Indication	Prevent Damage	Support B/R & S/B	Avoid Floating	Prevent Corrosion
			COST(Rs)																										
1	Carrier Plate		81.88			16.37					49.13	12.28															4.1		
2	Stopper Plate		2.32															2.32											
3	Spring Retainer		5.28			5.28																							
4	S/A Retainer		1.52			1.52														3.4									
5	Roller Plate		4.24									0.84																	
6	Roller Pin		2.33									0.24							2.09										
7	Washer		0.9									0.9																	
8	Boss B/R Mtg.																												
	FUNCTION COST(C)		98.47			16.37	6.8				49.13	14.26						2.32	5.49							4.1			
	FUNCTION WORTH(W)		79.71			13	5.5				38.32	10.98						2.32	5.49										
	VALUE GAP(G)		18.75			3.37	1.3				10.8	3.28																	



FUNCTION COST WORKSHEET

S. NO.	COMPONENT	FUNCTION	↑	COST(Rs)	Support cushion	Transfer Load	Join Components	Facilitate Fixing	Provide Comfort	Protect Cushion	Resist Buckling	Facilitate Assembly	Permit Resilience	Conform Contour	Provide Swinging	Prevent Fouling/ Failure	Retain Spring	Stop Movement	Support Roller	Prevent Rotation	Facilitate Mounting	Facilitate Movement	Damp Vibration	Display Information	Provide Indication	Prevent Damage	Support B/R & S/B	Avoid Floating	Prevent Corrosion
	OTHER'S																												
1	Grooved Shaft			8.33		0.85	1.25					0.41										5.83							
	(Fixed End)																												
2	Grooved Shaft			6.53		0.65	0.98					0.33										4.57							
	(Moving End)																												
3	Slotted Plate LH																												
4	Slotted Plate RH																				1.93								
5	Spring Washer			1.63																									
6	Plain Washer			0.82								0.82																	
7	Hex. Hd. Screw			3.06		0.81						2.25																	
	(M 8x12)																												
8	Hex. Hd. Screw																												
	(M 8x16)																												
9	Hex. Hd. Screw			4.2		0.84						3.36																	
	(M 8x35)																												
10	Buffer			1.88																									
11	Pan Hd. Tap Screw			0.41			0.41																						
12	Spring Dowel Pin			2.58																									
13	Tubular Rivet			1.22			1					0.22																	

FUNCTION COST WORKSHEET

PAGE 7 OF 7

S. NO.	COMPONENT	COST (Rs)	Support cushion	Transfer Load	Join Components	Facilitate Fixing	Provide Comfort	Protect Cushion	Resist Buckling	Facilitate Assembly	Permit Resilience	Conform Contour	Provide Swinging	Prevent Fouling/ Failure	Retain Spring	Stop Movement	Support Roller	Prevent Rotation	Facilitate Mounting	Facilitate Movement	Damp Vibration	Display Information	Provide Indication	Prevent Damage	Support B/R & S/B	Avoid Floating	Prevent Corrosion
	[OTHER's contd.]																										
14	Circlep	3.84	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.84	-	-	-	-	-	-	-
15	Plain Washer	1.29	-	-	-	-	-	-	-	1.29	-	-	-	-	-	-	-	-	-	-	7.45	-	-	-	-	2.13	-
16	Rollers	10.65	-	1.07	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
17	Guide Bush	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	71.99	-	-	-	-	-	
18	Assy. Ten. Adj. Screw	8.22	-	6.58	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
19	Shock Absorber	89.99	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
20	Tension Spring	34.44	-	34.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.97	-	-	-	-	
21	Protective Cover	6.45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	0.8	-	-	-	
22	Stickers	1.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
23	Polethene Cover	5.5	-	-	-	-	-	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	(S/B & B/R)	198.03	-	63.22	5.28	-	-	5.5	-	17.26	-	-	-	1.88	-	-	-	1.63	-	21.69	71.99	1.18	0.8	5.48	-	2.13	
	FUNCTION COST(C)	157.39	-	47.42	5.28	-	-	5.5	-	17.26	-	-	-	1.88	-	-	-	1.63	-	18.44	50.39	1.18	0.8	5.48	-	2.13	
	FUNCTION WORTH(W)	40.64	-	15.8	-	-	-	5.5	-	17.26	-	-	-	1.88	-	-	-	1.63	-	3.25	21.6	-	-	-	-	-	
	VALUE GAP(G)																										

TOTAL FUNCTION COST (C) = Rs. 921.64  
 TOTAL FUNCTION WORTH (W) = Rs. 750.07  
 TOTAL VALUE GAP (G) = Rs. 171.57

conversion process. It also helps to develop an effective design by considering the processes required for the manufacture of the designed component and the cost incurred. This enhances the design quality in the planning stage itself.

**b) METHODOLOGY:**

- ❖ The major sheet metal parts were identified.
- ❖ The list of suppliers for these parts was obtained.
- ❖ Visited the suppliers and conducted process study for these parts.
- ❖ The data such as the sequence of operations performed, the dimensions and weight of the raw material and finished part, the productivity/hour for each operation etc. were collected.
- ❖ The cost details such as the material cost and conversion cost for each operation were obtained from the purchase department and listed.
- ❖ The yield for the processing of each part was calculated from the input and output weights.
- ❖ The scrap value and raw material cost were also obtained.
- ❖ All the above data were tabulated to identify the low yielding parts.(Appendix A: A6)

**c) OUTPUTS OF PROCESS MAPPING:**

1. Changes in the sheet metal size and blank size were proposed wherever possible to increase the yield. (Appendix A: A7).

**3.4.5. CUSTOMER MATRIX**

**a). INTRODUCTION TO CUSTOMER MATRIX:**

The customer matrix is a matrix formed with the list of active parts for the entire tractor seat models produced at HGL and the customer for each item. This highlights the large number of parts, which are customer specific, and helps to identify the possibility to standardize some components thereby enabling easy identification of

these components and reducing the documentation.

**b). METHODOLOGY:**

- ❖ A sorted list of all the active parts of the entire range of tractor seats produced at HGL were obtained.
  - ❖ A list of all the customers for tractor seats produced at HGL was prepared.
  - ❖ All the standard/common parts among the total no. of parts were listed separately.
  - ❖ All the customer specific parts were marked in a matrix form. (Appendix A: A8).
  - ❖ The total no. of customer specific parts for each customer was then noted.
- Fig.3.12.

**c). OUTPUTS OF CUSTOMER MATRIX:**

1. TAFE parts, which are specific to some models alone, can be standardised.
2. Some customer specific components that vary for the same customer can also be standardised for that specific customer alone.

**3.4.6. SUPPLIER MATRIX**

**a). INTRODUCTION:**

Supplier matrix is a matrix format of the list of active parts of all tractor seat models produced at HGL, and their suppliers both supplierwise and similar componentwise.i.e. according to its part variety.

This identifies areas where there are larger numbers of suppliers for the same variety of components.

**b). METHODOLOGY:**

- ❖ A Sorted list of all the parts of tractor seats at HGL was prepared from the individual BOM's.

- ❖ A list of all the suppliers for tractor seat parts was prepared.
- ❖ The supplier for each part was identified from the Materials Requirement Planning data available at the purchase department and the matrix was prepared for all the parts of tractor seats.
- ❖ All the above parts were then classified as sheetmetal, tubular, rods, springs, plastics, rubber, stickers, fasteners, and others to get the supplier matrix according to the variety of the parts.
- ❖ Then, the total number of suppliers for the same variety of parts was listed separately. (Appendix A: A9, A10 & Fig.3.11.)

**c). OUTPUTS OF SUPPLIER MATRIX:**

- 1 The numbers of suppliers for sheetmetal components were identified to be larger. Hence it was proposed to reduce the number of suppliers to overcome the supplier follow-up difficulties and the excess documentation.
- 2 Next larger numbers of suppliers identified were for fasteners, which can be reduced.
- 3 The number of suppliers for rods and plastic parts can also be reduced.

PROJECT : LOW HP TRACTOR SEAT

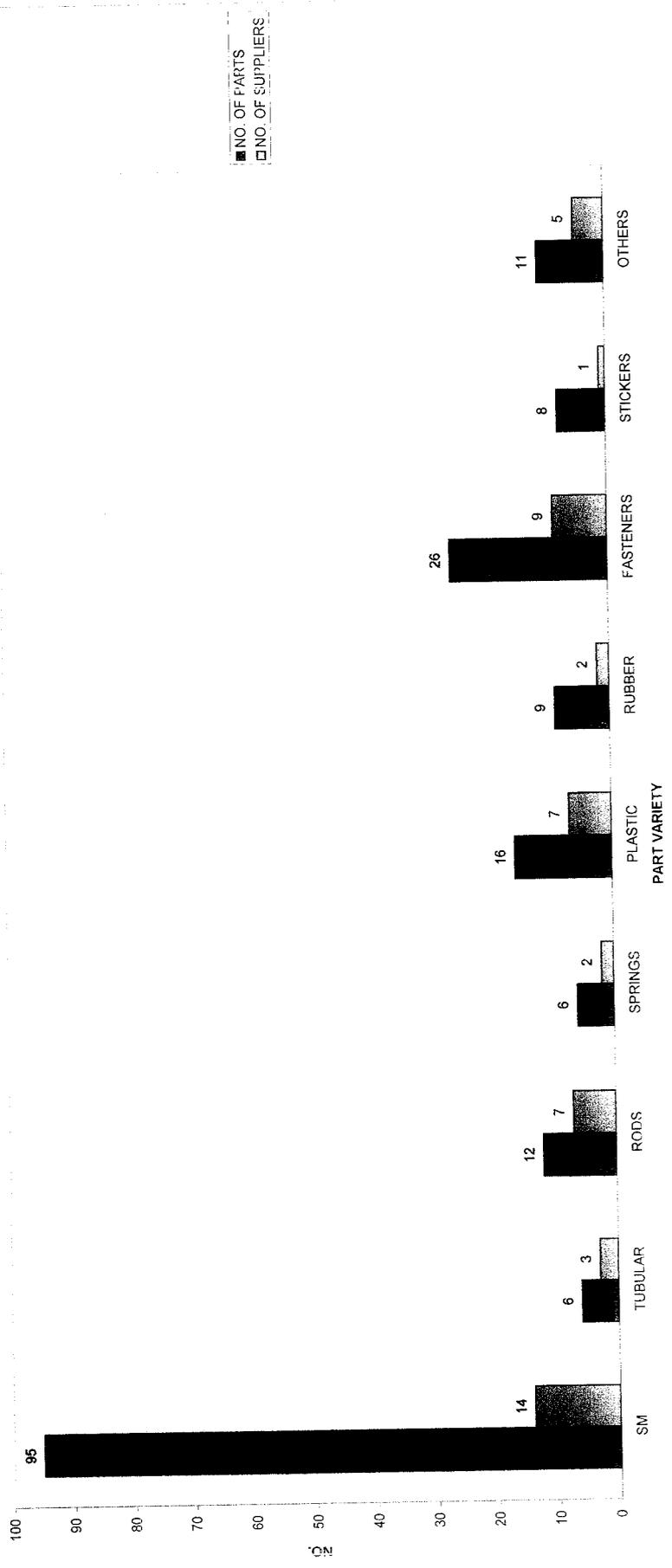


FIG.3.11. PART VARIETY - SUPPLIER CHART FOR TRACTOR SEATS

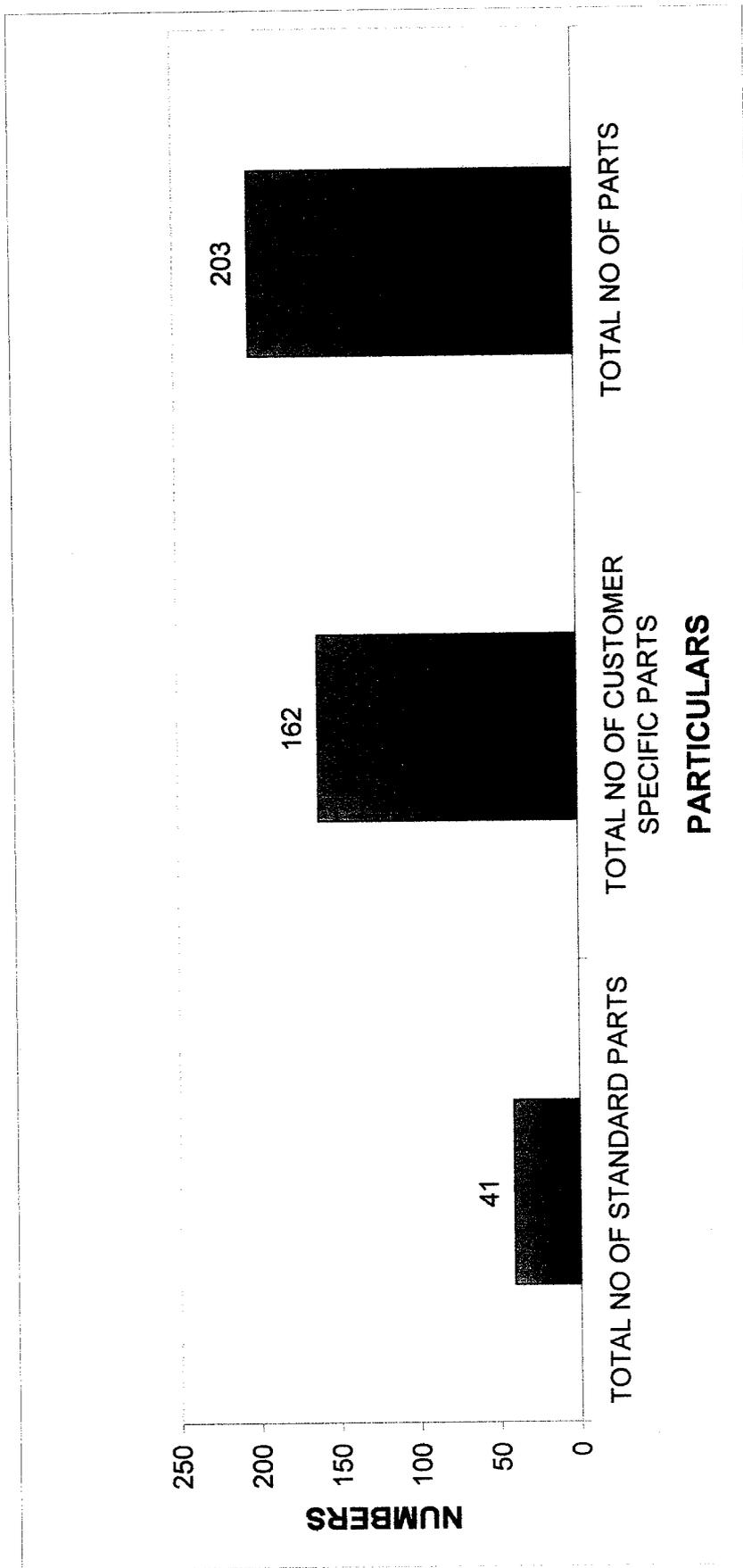


FIG.3.12. STANDARD AND CUSTOMER SPECIFIC PARTS FOR TRACTOR SEATS.

**CHAPTER: 4**  
**PRODUCT DESIGN**  
**AND**  
**DEVELOPMENT PHASE**

#### **4.1. INTRODUCTION:**

The product design and development phase consists of the following activities:

1. Concept Generation.
2. Concept Evaluation.
2. Proto Planning.
3. Protosample Manufacturing.
4. Protosample validation.

#### **4.2. CONCEPT GENERATION:**

##### **4.2.1. INTRODUCTION:**

A concept is an idea that can be represented in a sketch or with notes, in an abstraction, to meet customer requirements by various methods and means. The generation of concepts is an iterative process.

##### **4.2.2. METHODOLOGY:**

Two techniques for generating design concepts are:

❖ **Functional decomposition:**

This involves finding the overall function that needs to be accomplished and then decomposing the function into subfunctions.

❖ **Generating concepts from functions:**

This involves the development of concepts for each function and then combining the concepts.

##### **4.2.3. CONCEPTS:**

First, the freezing of the overall dimensions of the product was done. Refer Fig.4.1. The dimensional layout provides the basic idea for components design. The major sub-assemblies were identified and the concepts for each

PROJECT: LOW HP TRACTOR SEAT

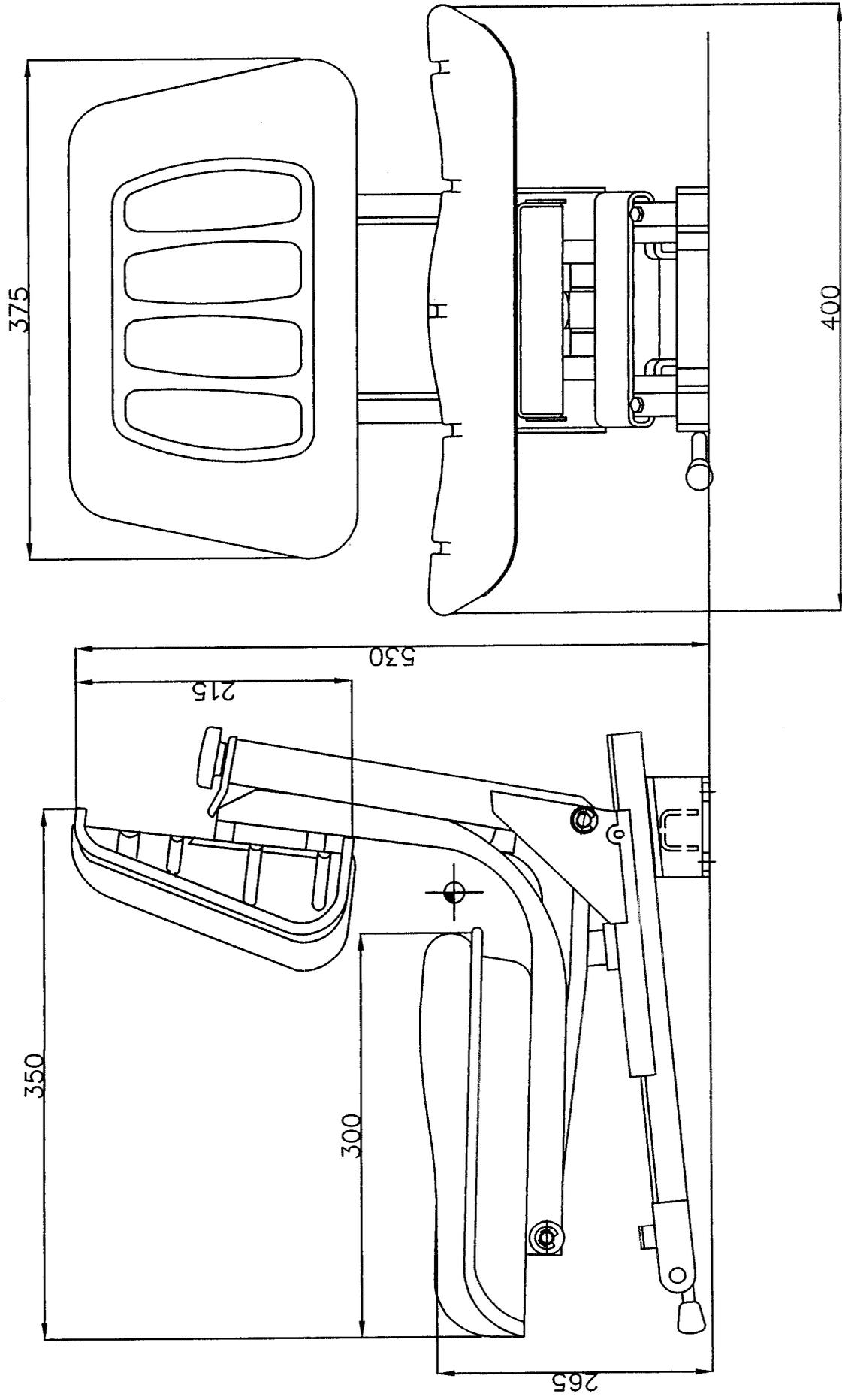


FIG.4.1. LAYOUT DRAWING

Sub-assemblies were worked on. They are:

**a. CONCEPTS FOR S/B AND B/R ASSY.:**

- The seat base and backrest pans were redesigned with optimum dimensions as per specifications.
- Both the seat base and backrest cushion contours were redesigned and an alternate tucking mechanism, insert with Foam-in-place Rexine that can be fastened to the pans, eliminating endliners, circlips and springclips was recommended.

**b. CONCEPTS FOR ASSY. CARRIER PLATE:**

Two alternate concepts for assy. carrier plate were suggested as below:

➤ **SQUARE TUBE VERSION:**

The square tube version suggested, consists of two 19mm x 2mm thick square tubes assembled together with three reinforcements of square tube or 'L' angle or a combination of both. Holes can be provided in the square tubes for mounting the seat base and backrest pans. The shock absorber mounting 'U' bracket can be welded to the top reinforcement square tube. The 'L' angle reinforcement provided at the bend can also serve as the spring retainer by providing two notches in it. Refer Fig. 4.2.

➤ **'L' ANGLE VERSION:**

The 'L' angle version consists of two 30mm x 30mm x 2.5 mm 'L' angle sheet metal bent part provided with three reinforcements as in the above concept. Two square tubes at the ends and an 'L' angle at the bend can be an optimized reinforcement. The shock absorber mounting 'U' bracket and the spring retainer can as mentioned in the previous concept. Refer Fig. 4.3.

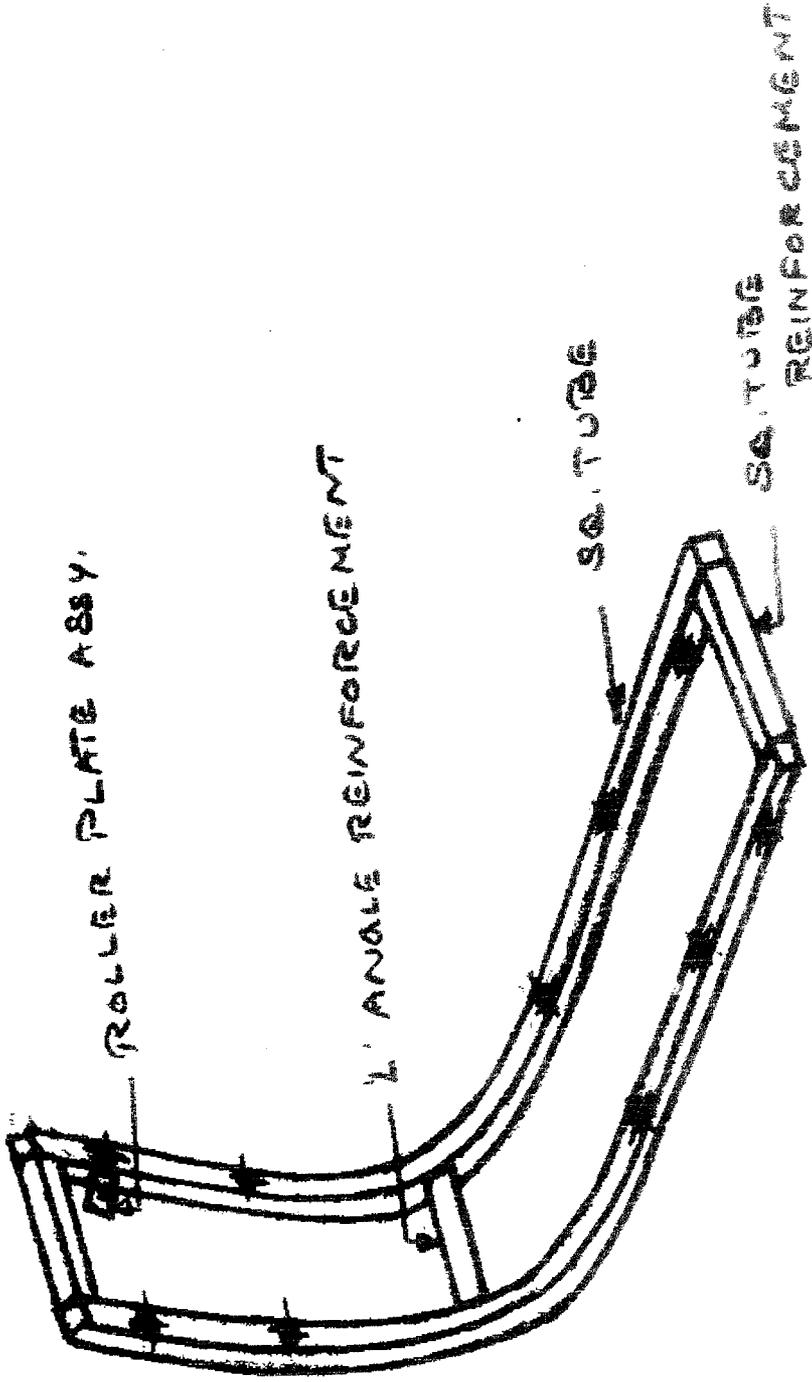


FIG. 4.2. ASSY. SQUARE TUBE CARRIER PLATE.

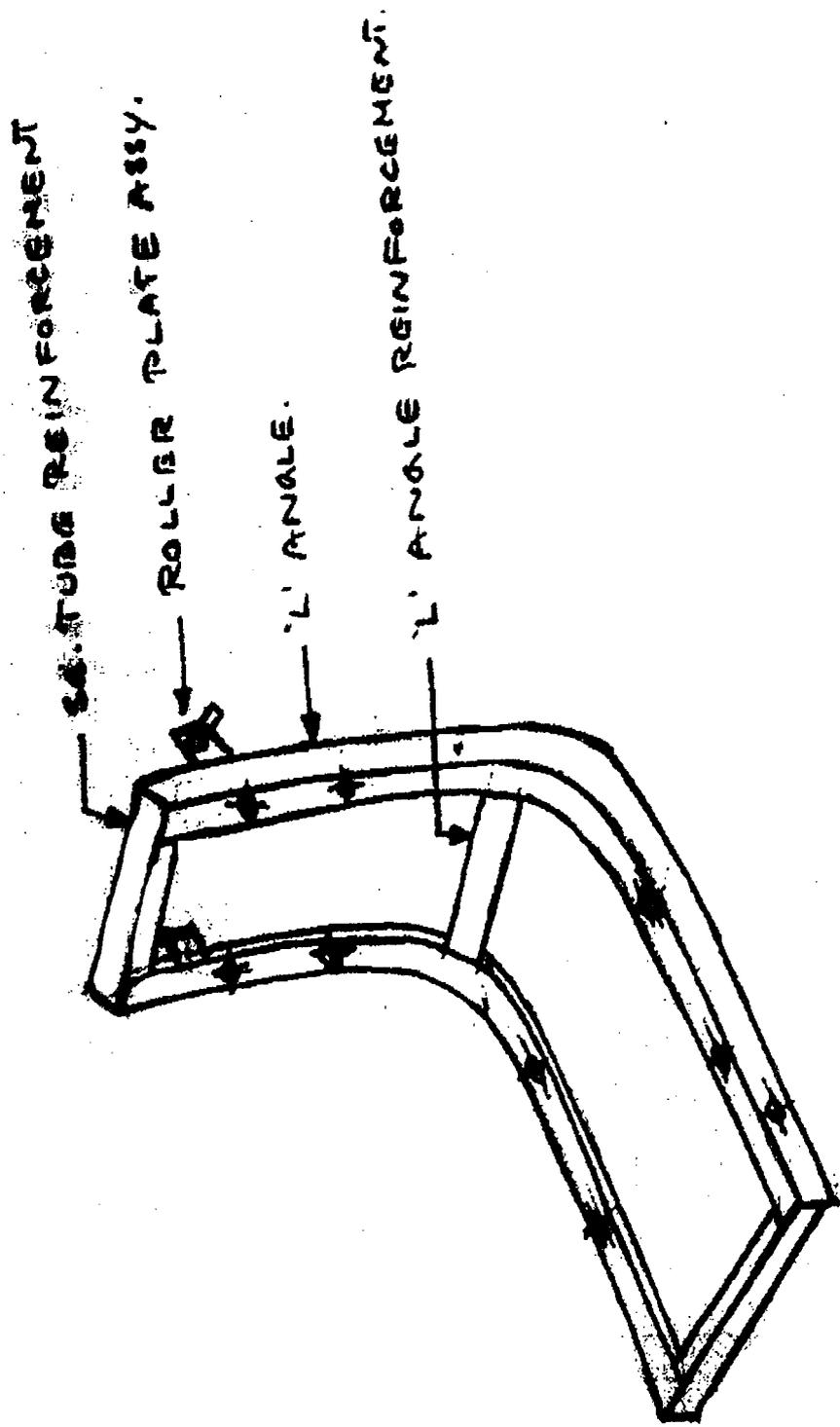


FIG. 4.3. ASSY. 'L' ANGLE CARRIER PLATE

### **c. CONCEPTS FOR ASSY. SPRINGCASE:**

Three alternate concepts for the assy. springcase were suggested as below:

#### **➤ SPRINGCASE WITH ROLLERS AND BACKCOVER VERSION:**

In this version, two 'U' bent sheetmetal channels for the rollers to slide within can be covered with a backcover of 0.8mm sheetmetal part tag welded from inside. A top plate with holes can also be welded from inside. Two support plates can be used to connect this assembly with the base plate lower. Refer Fig. 4.4.

#### **➤ 'L' ANGLE WITH SLOTS AND BACKCOVER VERSION:**

In this version, two 30mm x 30mm x 2.5mm 'L' angle sheetmetal bent part provided with slots for the roller pin to slide along and a 0.8mm thick sheetmetal backcover welded at its inner side was suggested. Two support plates can be used to connect this assembly to the base plate lower. Here, the rollers can be eliminated and the slots can be provided with plastic covers for the pin to slide within them. Refer Fig. 4.5.

#### **➤ 'U' CHANNEL VERSION:**

In this version, two 'U' channels that integrate both the springcase and the base plate lower can be used. A 0.8mm thick sheetmetal back cover can be used for the springcase and the base plate can be slid within the 'U' channel using 'U' pads or by bolting. Refer Fig. 4.6.

### **d. CONCEPTS FOR ASSY. SWINGARM:**

- The length of the end tubes in the existing design were reduced and made equal. The diameter of the tubes was reduced to 22mm from 25mm. The connecting tubes were redesigned and an alternate 1mm thick sheetmetal pressed part with hole for insert buffer was suggested. Refer Fig. 4.7.

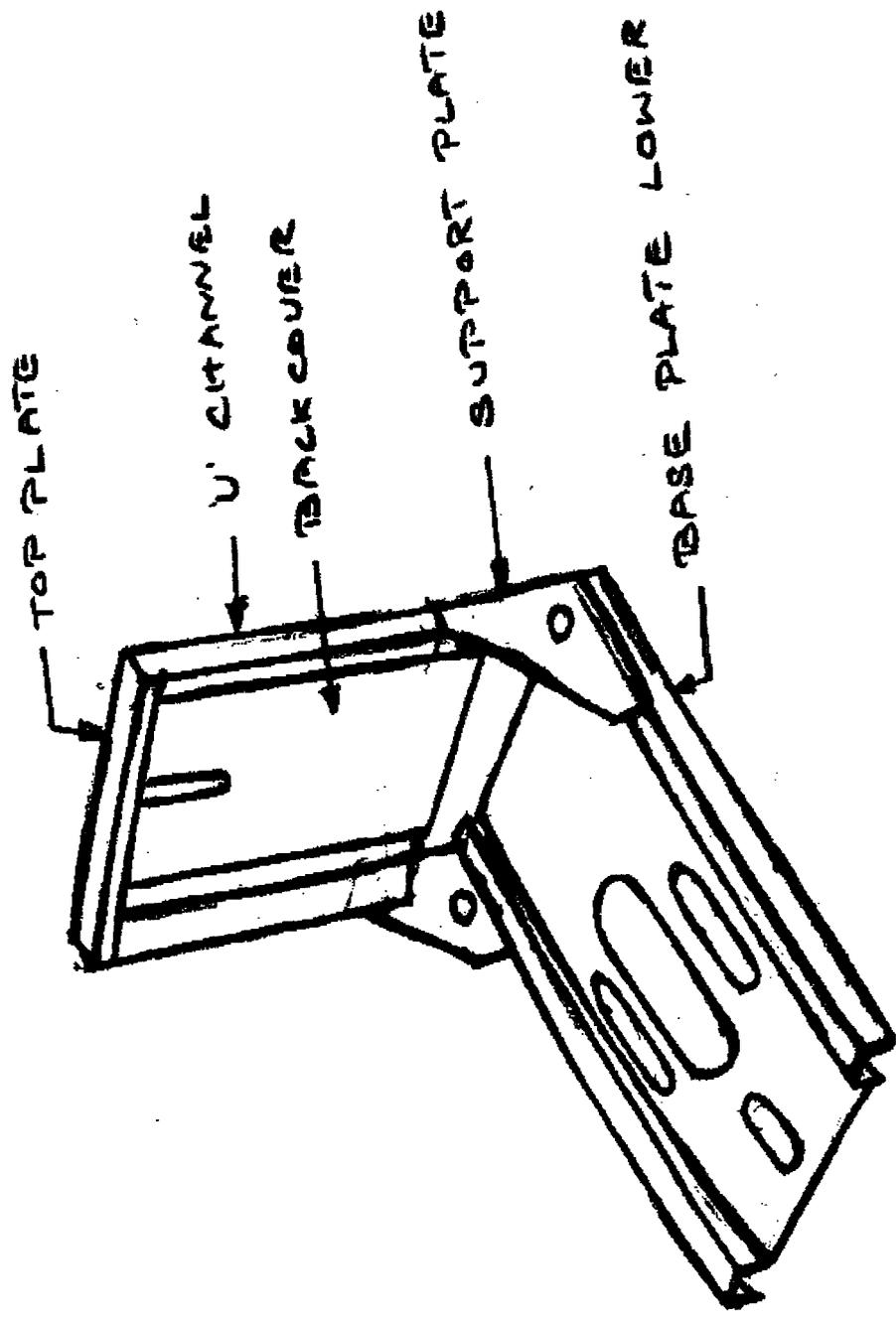


FIG. 4. 4. ASBY. SPRINKCASE WITH  
ROLLERS AND BACK COVER



**Fig.4.5.ASSY. SPRINGCASE**  
**(‘L’ ANGLE WITH SLOTS VERSION).**

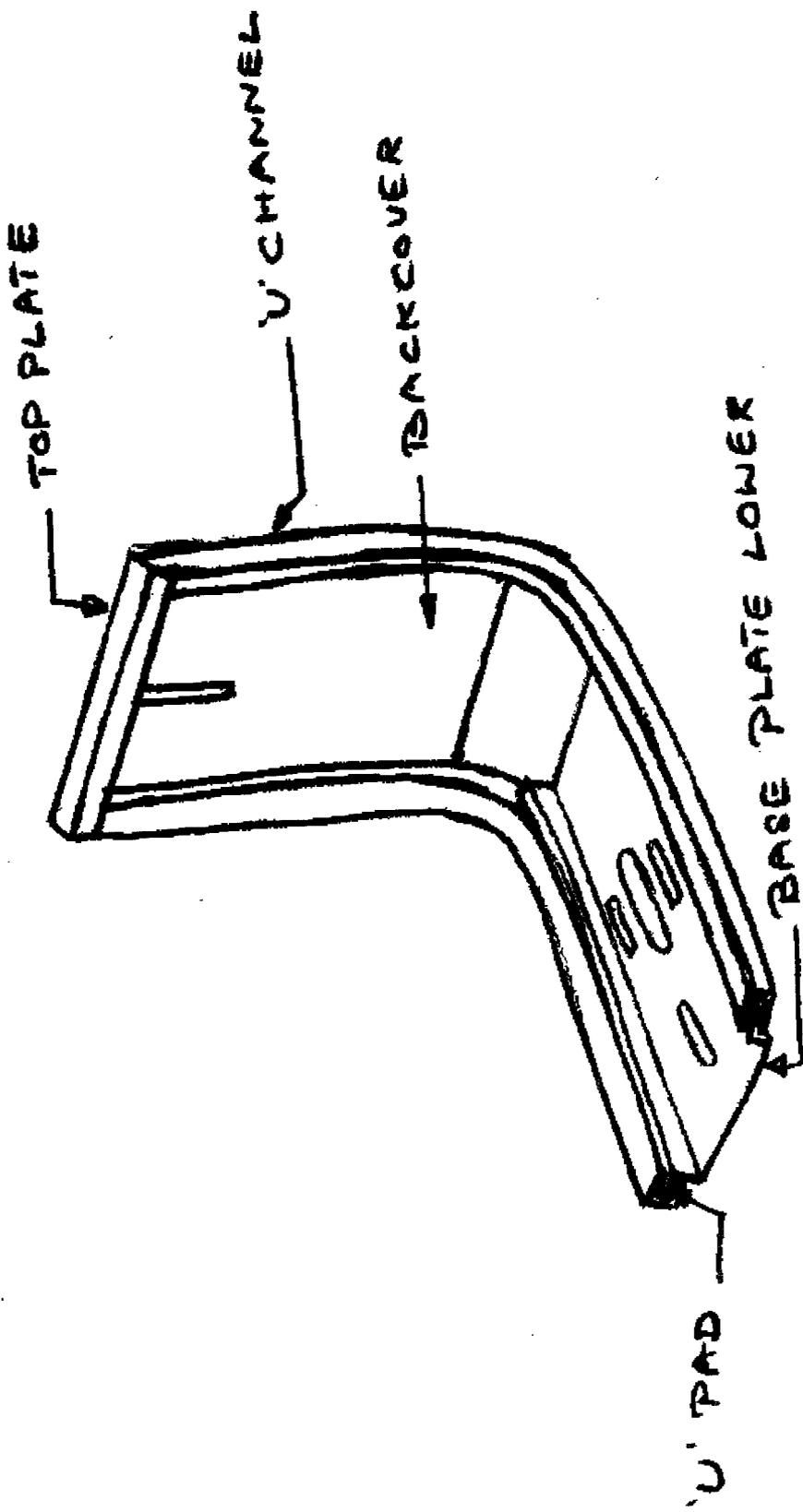
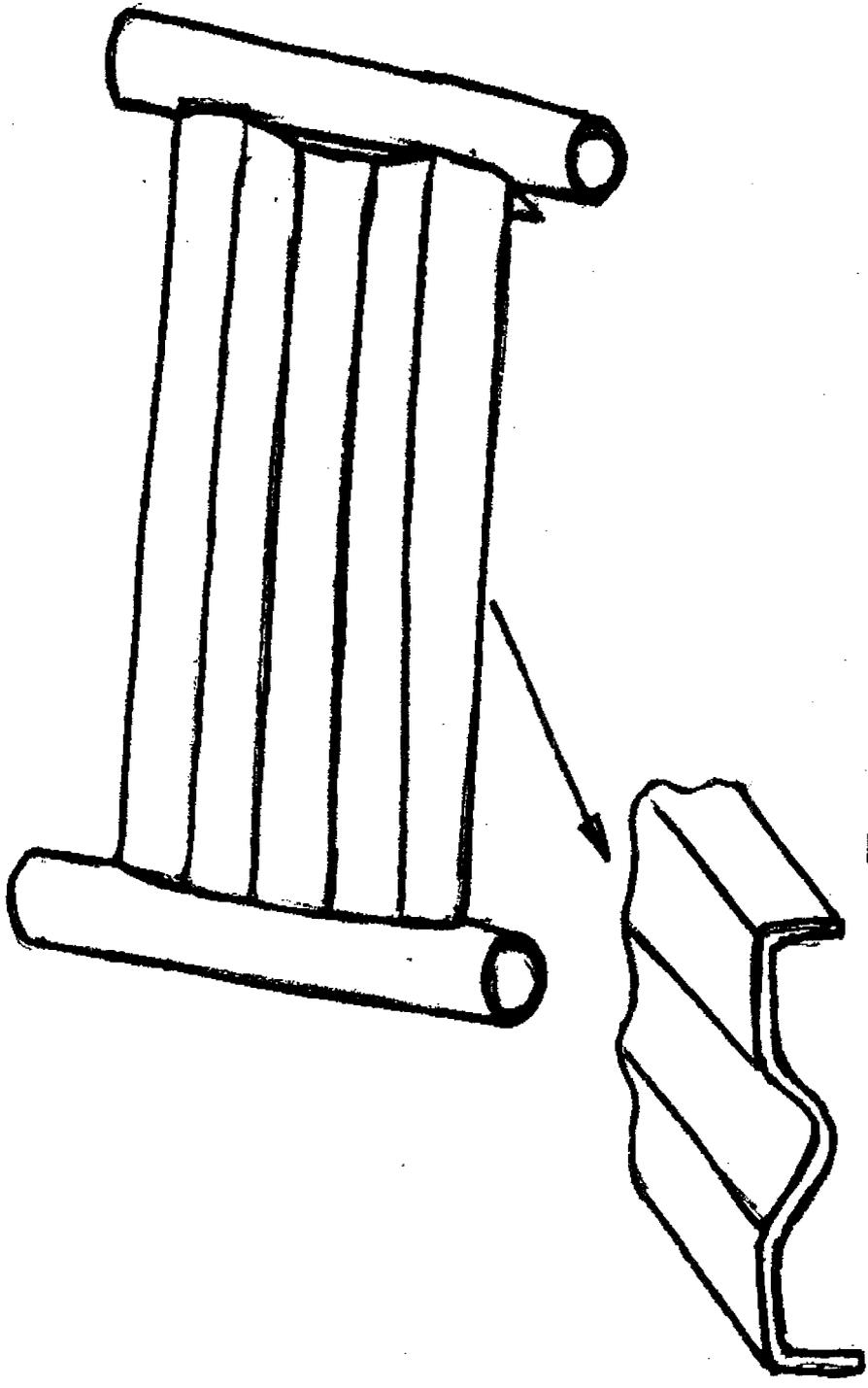


FIG. 4.6. 'U' CHANNEL SPRINGCASE  
ASSY.



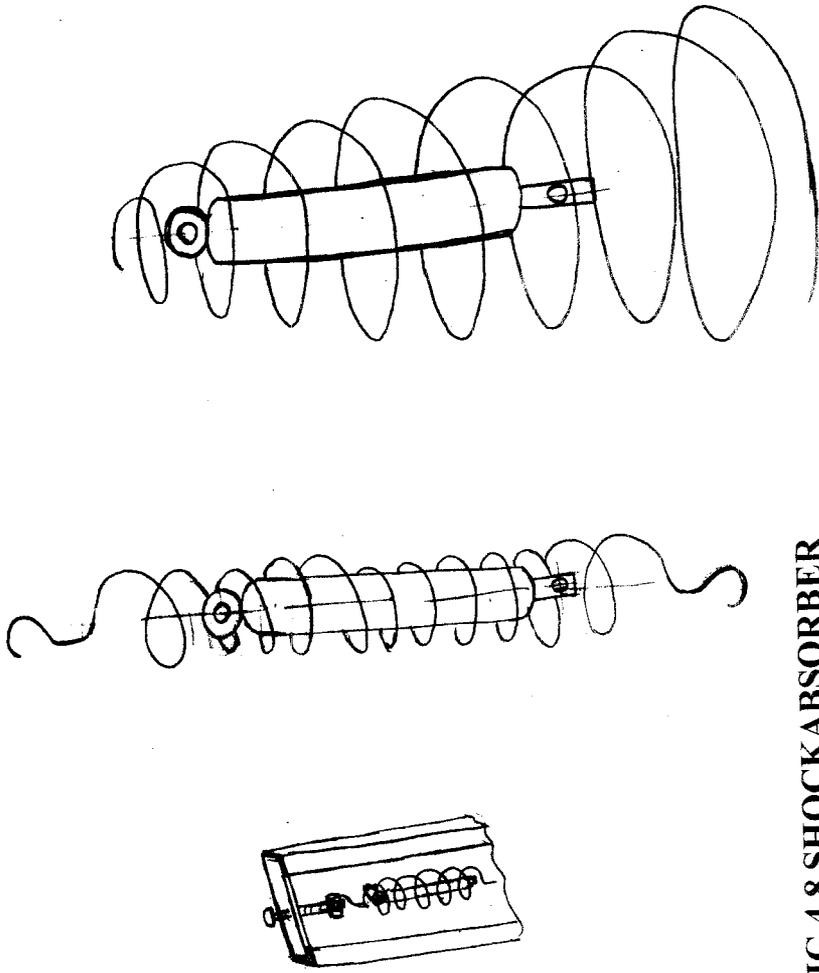
CONNECTING PRESSED PART  
FIG. 4.7. ASSY. SWINGARM  
[PRESSED VERSION]

#### **e. CONCEPT FOR SPRING RETAINER:**

- The existing spring retainer is a sheetmetal part with various operations. An alternate suggestion of plastic spring retainer with a redesign was given. This will reduce the weight as well as the cost of the part.

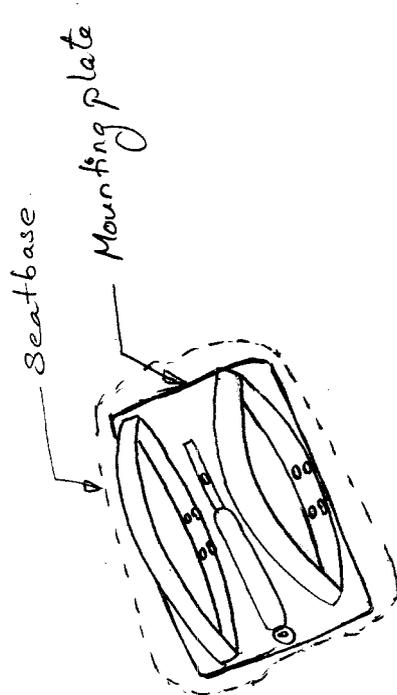
#### **f. CONCEPTS FOR SUSPENSION MECHANISM:**

- **SHOCK ABSORBER WITHIN A SINGLE TENSION SPRING:**  
A shock absorber can be mounted within a tension spring i.e. both the shock absorber and the tension spring should be co-axial without fouling. This assembly can be used as a suspension mechanism, mounted either behind the backrest or below the Seatbase. Refer Fig. 4.8.
- **SHOCK ABSORBER WITHIN A SINGLE COMPRESSION SPRING:**  
This concept is similar to the previous one, except for replacing the tension spring with a compression spring. The compression spring can be either a straight one or a conical compression spring. Refer Fig. 4.9.
- **TWO LEAF SPRINGS WITH SHOCK ABSORBER:**  
In this concept, two full leaf springs can be mounted below the Seatbase, connecting the Seatbase pan and the base plate lower. A shock absorber can be provided inclined within this space below the Seatbase. Refer Fig. 4.10.
- **TWO COMPRESSION SPRINGS WITHOUT SHOCK ABSORBER:**  
In this, a conical compression spring can be mounted vertically below the Seatbase. One compression spring can be mounted horizontally between two sets of links that can slide within using a slot and roller arrangement. These two springs can provide a cushioning effect. Refer Fig. 4.11.



**FIG.4.8.SHOCKABSORBER  
WITHIN TENSION SPRING.**

**FIG.4.9. SHOCK ABSORBER WITHIN  
COMPRESSION SPRING.**



**FIG.4.10.TWO LEAF SPRINGS & SHOCK  
ABSORBER**

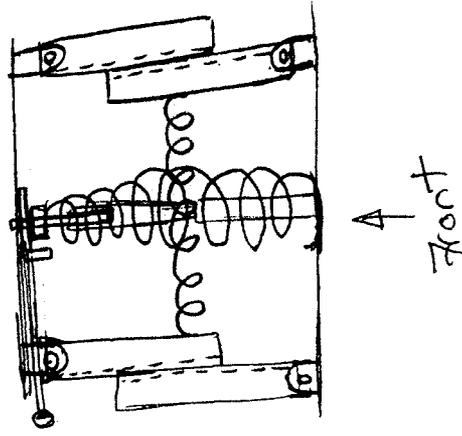
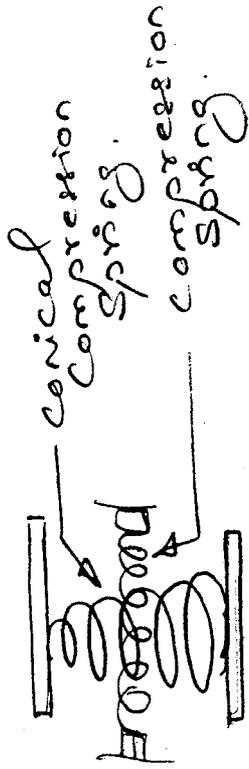


Fig.4.11.TWO COMPRESSION SPRINGS WITHOUT SHOCK ABSORBER.

All the above mentioned concepts for suspension mechanism require some detailing for the provision of weight adjustment in them. Due to time constraint the detailing part was not done and left for future consideration. Since the existing suspension mechanism is a proven concept and accepted globally, the same was taken in this assembly.

#### **g. CONCEPTS FOR THE COMPLETE SEAT ASSY.:**

- The individual concepts for the sub-assemblies were assembled in various combinations to arrive at a number of complete seat concepts. Refer Table 4.1.

### **4.3. CONCEPT EVALUATION**

#### **4.3.1.INTRODUCTION:**

Concept Evaluation uses many techniques for choosing the best of the concepts for development into products. 'Evaluation' implies both 'comparison' and 'decision making'. These are tightly interrelated actions; in order to have enough information to make a decision on the development potential of a concept, the concept must be compared with something else and in order to make the comparison, the concepts to be compared must be couched in the same language and they must exist at the same level of abstraction.

Two types of evaluations conducted are:

- Functional evaluation.
- Cost evaluation.

#### **4.3.2. FUNCTIONAL EVALUATION:**

The techniques used for functional evaluation are:

- a. Feasibility Judgment.
- b. Technology readiness assessment.
- c. Go/ No-Go screening.

TABLE 4.1. COMPLETE SEAT ASSY. CONCEPTS

ASSY	CONCEPTS	1	3	4	5	6	7	8
ASSY S / B	EXISTING							
	NEW PAN	■			■			
	NHIL OPTIMISED COIR BOARD			■				■
ASSY B / R	EXISTING							
	NEW PAN	■			■			
	NHIL OPTIMISED			■				■
ASSY SWING ARM	EXISTING							
	TUBULAR PART	■			■			
	TUBES WITH S/M			■				■
ASSY SP. BKT	EXISTING	■						
	PLASTIC ASSY			■	■			■
ASSY CARRIER PLATE	EXISTING							
	SQUARE TUBE - SQ. REINF.	■						
	SQUARE TUBE - L ANGLE REINF.			■	■			■
	L ANGLE - L ANGLE REINF			■				
	L ANGLE - SQ. REINF L ANGLE - SQ. & ANGLE REINF							
ASSY SPRING CASE	EXISTING							
	WITH ROLLERS	■						
	WITH ROLLERS - BACK COVER			■				■
	WITH SLOTS							
	WITH SLOTS - BACK COVER				■			
	L ANGLE WITH SLOTS - BACK COVER							
U CHANNEL SQ. TUBE & U PAD								
OTHERS	GROOVED SHAFTS	■			■			■
	SCREWS							
	BUFFER							
	SPRING DOWEL PIN							
	CIRCLIP							
	SWING ARM MOV. END BKT							
	SWING ARM FIX. END BKT							
	BKT S / A MTG							
	PLAIN WASHER							
	TUBULAR RIVET	■						
	ROLLERS							
	ASSY TEN ADJ SCREW							
	SHOCK ABSORBER							
	TENSION SPRING							
	STICKERS							
	POLYTHENE COVERS							

#### **a. FEASIBILITY JUDGEMENT:**

Judgements about a concept's feasibility, i.e. it is not feasible: it will never work, it might work if something else happens, it looks worth considering, are based on "gut feel," a comparison made to prior experience stored as design knowledge.

#### **b. TECHNOLOGY READINESS ASSESSMENT:**

Technology readiness assessment refines the evaluation by forcing an absolute comparison with state-of-the-art capabilities. If a technology is to be used as a part of product design, it must be mature enough that its use is a design issue, not a research issue. The vast majority of technologies used in products are mature and the measures are readily met. However, in a competitive environment, there are high incentives to include new technologies in products.

#### **c. GO/ NO-GO SCREENING:**

Once it has been established that the technologies used in a concept are mature, the basis of comparison moves to the customer requirements. Each concept must be compared with the requirements in an absolute fashion. In other words, each customer requirement must be transformed into a question to be addressed to each concept. The questions should be answerable as either yes or maybe (go) or (no-go). If a concept has only a few no-go responses, then it may be worth modifying rather than being eliminated. This evaluation rapidly points out the weak areas in a concept so that it can be "patched" – changed or modified to fix the problem. During patching, the functional decomposition and morphology should be referenced and possibly updated as more is learned through the evaluation.

#### **4.3.3. COST EVALUATION:**

It is important to generate a cost estimate as early in the design as possible. The total cost of the product to the customer is to be calculated. First, the material cost, which is a major part of the direct cost has to be calculated. This includes the

expenses for all the materials that are purchased for a product, including the expense of the waste caused by scrap and spoilage. For most materials the scrap can be reclaimed, and the return from the reclamation can be deducted from the material costs.

In this project, since the cost target is for a material cost between Rs.750 to Rs.800, the material cost for all the complete seat assembly concepts were calculated.

#### **4.3.4. OUTPUTS OF CONCEPT EVALUATION:**

##### **a. FUNCTIONAL EVALUATION:**

- ☞ Feasibility judgement was done by conducting design review. Two complete seat concepts were selected for further development.
- ☞ Technology readiness assessment was also done in the review. The alternate tucking method with insert FIP technology was finalized.
- ☞ Go/ No-Go screening was done to check that the customer requirements were met by these two concepts and was found to do so.

##### **b. COST EVALUATION:**

- ☞ The material costs for the complete seat assemblies in Table 4.1 were calculated. (As these data are confidential, this is not attached in this report.)
- ☞ Two complete seat assembly proposals that had the minimum material costs (highlighted in the Table 4.1.) were selected for further development of the protosamples.

#### **4.4. PROTO SAMPLE PLANNING**

##### **4.4.1. INTRODUCTION:**

Protosample planning involves various activities that form the basics for the development of prototype samples. This includes the preparation of Preliminary Bill of Materials, Preliminary Costing and Proto Drawings.

#### **4.4.2. PRELIMINARY BILL OF MATERIALS:**

Two preliminary bill of materials consisting of the list of parts required for the proposed concepts were prepared and copies of each were forwarded to the prototype section of R&D for the procurement of the parts for the sample manufacture. Refer Table 4.2.

#### **4.4.3. PRELIMINARY COSTING:**

Calculating the individual cost for each component of the sub-assemblies and then arriving at the total material cost of each complete seat assemblies, the preliminary costing was prepared.

#### **4.4.4. PROTO DRAWINGS:**

Design reviews for the concept design are done during the preparation of proto drawings to reduce further major changes during proto build. Proto drawings are similar to engineering drawings of the parts and the sub-assemblies, drawn using AutoCAD R14 and forwarded to the prototype section to enable procurement of parts and parts manufacturing for the sample seat production. Existing parts were given the part numbers for procurement. PRO-E models were also developed. Refer Appendix B: B1.

#### **4.5. PROTO SAMPLE MANUFACTURING**

Protosample manufacturing involves the sample seat production using the proto drawings released. This is done using parts that are mostly manufactured in the prototype, as tooling parts for the proposed concepts are not possible at this juncture.

A sample low hp tractor seat for the proposed concept was done. Digital photos of this sample were taken. Refer Appendix B:B2.

TABLE.4.2. PRE - BOM

PART No :

ISSUE No.: 01

DESCRIPTION : Low Hp Tractor Seat - 'U' CHANNEL WITH ROLLERS VERSION

DATE : 06.11.2000

SL NO	PART No.	DESCRIPTION	QTY IN LEVELS					REMARKS
			1	2	3	4	5	
1		Assy Seat base Comp.	1					
2		Seat base pan		1				
3	111 25 101	Weld nut M8		4				
4	111 02 104	S/B cushion comp.		1				
5	116 09 016	Assy. Insert			1			
6	116 09 017	Brkt. Insert					4	
7	147 25 115	Weld Nut M5					4	
8		FIP Rexine - Seat Base			1			
9	135 06 065	Pan Head CRS Screws M5x12		5				
10		Assy Backrest comp.	1					
11		Backrest pan		1				
12	111 25 101	Weld nut M8		4				
13	116 03 107	B/R cushion comp.		1				
14	116 09 022	Assy. insert					6	
15	116 09 117	Brkt. Insert					6	
16	147 25 115	Weld Nut M5			1			
17		Rexine FIP - Back Rest		4				
18	135 06 065	Pan Head CRS Screws M5x12	1					
19		Assy swing arm		1				
20		Con. Pressed part swingarm		2				
21	116 09 011	Swingarm tube		1				
22	111 06 107	Buffer	4					
23	111 08 101	Guide bush	1					
24		Assy Spring brkt		1				
25	111 07 106	Grooved lock pin	1					
26		Assy Carrier plate		2				
27		Carrier Plate 'L' Angle		1				
28		Conn. 'L' Angle		2				
29		Conn square tube		1				
30	111 04 109	S/A retainer	1					
31		Assy. Roller Plate		2				
32		Roller plate		2				
33	111 04 112	Roller pin	1					
34		Assy Spring case		2				
35		U' Channel		1				
36		Top Plate - 'u' channel with rollers		1				
37		Springcase Back cover		1				
38		Base Plate Lower( ITL)		1				
39	174 05 170	Brkt. Shock Absorber Mtg.		2				
40		Support Plate		2				
41		Swingarm Bkt.(Fixed end)		2				
42		Swingarm Bkt.(Moving end)		2				
43	116 09 007	Grooved shaft		4				
44	111 25 103	Hex hd screw M8 x 12		4				
45	116 25 104	Hex hd screw M8 x 35		2				
46	111 05 106	Buffer		1				
47	111 07 108	Spring dowel pin		4				
48	111 25 109	Circlip C 9		2				
49	111 25 110	Plain washer		2				
50	111 07 112	Rollers		1				
51	111 07 101	Assy Ten adj screw		1				
52	111 07 120	Shock Absorber		2				
53	111 07 109	Tension Spring						
54		Stickers						
55		Polythene cover S/B & B/R						

PREPARED BY

CHECKED BY  
72

APPROVED BY

## 4.6. PROTO SAMPLE VALIDATION

Validation of the sample produced is done for the following:

- ☞ Functional or Performance validation.
- ☞ Validation for Ergonomics.
- ☞ Validation for Aesthetics.
- ☞ Cost Validation.

### 4.6.1. FUNCTIONAL VALIDATION:

The complete seat assembly undergoes various testing as below:

- ✱ Drop Test.
- ✱ Endurance test vertical.
- ✱ Backrest strength.
- ✱ DFMEA

#### a. DROP TEST:

Drop test is conducted for testing the seat's mechanical structure and to detect weak points. The seat was mounted on a platform at the far end of a horizontal single bearing lever beam periodically lifted by an eccentric disc and dropped on a truck tire. This test setup performs a specific deceleration in order to obtain a peak load. The test data are:

Stroke	: 125mm.
Deceleration	: 5 g.
Frequency	: 0.5 sec <sup>-1</sup>
Load	: 41 kg.
Strength class I	: 1, 20, 000 cycles.
Strength class II	: 1,80,000 cycles.

Requirements for result are:

- No cracks may occur.

- After the test, the seat has to be fully functional.

## **b. ENDURANCE TEST VERTICAL:**

The scope of endurance test vertical is testing of springs, dampers and the suspension kinematics and their fixing elements. The seat was mounted on a platform for sinusoidal excitation. After weight setting, the seat top was fixed with belts in such a way, that the suspension travels in mid stroke position. Then the endurance test was conducted for the load cycles as below:

Stroke	: 60mm.
Frequency	: 2 sec <sup>-1</sup> .
Duration	: 1,00,000 cycles.

Requirements for results are:

- No cracks may occur.
- Springs and dampers may be changed once.
- After the test, the seat has to be fully functional.
- The seat characteristic line may deviate in position and inclination by  $\leq 10\%$ .
- The friction value of the suspension (seat characteristic line) may increase by  $\leq 30\%$ .
- Loss in damper performance may be  $\leq 30\%$ .

## **c. BACKREST STRENGTH TEST:**

The backrest strength test can be tested in an endurance test followed by an overload test. The test data are:

**For Endurance Test:**

Moment	: 230Nm.
--------	----------

Point of force  
Application : 50mm below backrest top.  
Duration : 3, 00, 000 cycles.

**For Overload Test:**

Moment : 620Nm.  
Point of force  
Application : 50mm below backrest top.

Requirements for results are:

**For Endurance Test:**

- No cracks may occur.
- No fixation elements may come loose.
- Permanent deformation at the point of force application  $\leq 10\text{mm}$ .

**For Overload Test:**

- No cracks may occur.
- Permanent deformation at the point of force application  $\leq 20\text{mm}$ .

The test reports for the sample seat are given in Appendix B: B3 & B4.

**d. DESIGN FOR FAILURE MODE AND EFFECTS ANALYSIS:**

Design For Failure Mode and Effects Analysis (DFMEA) is an analytical technique used to assure that, to the extent possible, potential failure modes and their associated causes/mechanisms have been considered and addressed. This systematic approach parallels, formalizes and documents the mental disciplines that an engineer normally goes through in any design process. The design potential FMEA supports the design process in reducing the risk of failures by:

- \* Aiding in the objective evaluation of design requirements and design alternatives.
- \* Aiding in the initial design for manufacturing and assembly requirements.
- \* Increasing the probability that potential failure modes and their effects on system

- and vehicle operation have been considered in the design/development process.
- \* Providing additional information to aid in the planning of thorough and effective design test and development programs.
  - \* Developing a list of potential failure modes ranked according to their effect on the “customer”, thus establishing a priority system for design improvements and development testing.
  - \* Providing an open issue format for recommending and tracking risk-reducing actions.
  - \* Providing future reference to aid in analyzing fields concerns, evaluating design changes and developing advanced designs.

A DFMEA for the sample seat produced was made as shown in Appendix B:B5.

#### **4.6.2. VALIDATION FOR ERGONOMICS:**

The ergonomical validation of the seat was done by finding the SRP and SIP points in the sample and comparing with the standards. The General Assembly drawing was also checked for standards and found to be as per specifications.

#### **4.6.3. VALIDATION FOR AESTHETICS:**

The aesthetical look of the complete seat after final assembly was also evaluated by a group of people and found to be appealing.

#### **4.6.4. COST VALIDATION:**

The costing details from the cost estimate i.e. material cost of the seat were compared with that of the existing TAFE standard tractor seat. The cost savings was also calculated and projected. This savings was found to meet the target cost of Rs.750. As the cost details are confidential, this is not enclosed with this report.

# **CHAPTER 5**

# **CONCLUSIONS**

Two designs for the fixed Low HP Tractor Seat were proposed. The modular design enables the addition of add-on features like the fore and aft mechanism to develop a deluxe seat also. Both the fixed seats meet the cost target requirement of Rs. 800. This has been achieved by the alternate design and redesign of the structural components of the existing TAFE Standard tractor seat. Different technical tools like Benchmarking, Quality Function Deployment and Value Engineering were used to ensure the quality of the proposed designs, meeting the customer requirements and the cost target of the management. Brain storming and design reviews were conducted at various stages of development to reduce the redesign time. A prototype sample seat for one of the concepts. i.e. with rollers and back cover type was made for "International Tractors Ltd." and tested. **A saving of Rs.230 (23.68% of the existing material cost) per seat has been achieved without affecting the functionality of the seat.** Also the seat meets the standards for tractor seats. A Design For Failure Mode and Effects Analysis (DFMEA) was also done for this sample. Two more samples, one fixed and the other with fore and aft mechanism are under progress in the prototype for the customer "Eicher Tractors". The results are consolidated as shown in Appendix C.

A scope for further development is also available as some alternate concepts for the various sub-assemblies and the suspension mechanism have been put forward. A redesign of the shock absorber with a smaller barrel diameter can give some savings. The supplier matrix and the customer matrix show the possibility of reducing the number of suppliers to reduce the documentation and follow up activities. Also slight redesign of customer specific components can help in standardizing more components there by simplifying their procurement. As everyone speaks of "Continuous Improvements", there is always a scope of further improving any product, not only this proposed product design.

# **CHAPTER 6**

# **BIBLIOGRAPHY**

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# **APPENDIX**

# **APPENDIX - A**

# A1: TGW/TGR REPORT

PROJECT : LOW HP TRACTOR SEAT

## THINGS GONE WRONG

1. Customers are not satisfied by the suspension provided.
2. Suspension stroke is less.
3. Springs are too hard.
4. Scissor link suspension is costly, leads to finger trap and seat floating(play).
5. No weight adjustment.
6. Suspension is not effective due to front hinge.

## THINGS GONE RIGHT

1. Target price is met.
2. Assembly was easy.
3. Less no. of components.
4. Field evaluation was found okay.
5. Seat height can be varied as per customer requirement with minimum changes.

Prepared by	Date

Approved by	Date

## A2 (a): QUESTIONNAIRE FOR LOW HP TRACTOR SEATS

Dear Sir

I am doing my final year ME in Kumaraguru College of Technology, Coimbatore. As a part of my academic programme I have taken up a project in Harita Grammer Limited, Hosur. The project title is Design and Development of seats for Low Horse power tractors. As a part of capturing customer voice in the product Information phase, I require your inputs which will be valuable for preparing QFD.

NAME :

DESIGNATION :

EMAIL ADDRESS:

ORGANISATION:

1. From the total cost of the tractor what percentage you allot to the seat?  
\_\_\_\_\_%
2. How you rate the existing seat in your tractor?(in 1 to 10 scale)-1 for worst & 10 for best.
  - a. Feature wise: \_\_\_\_\_
  - b. Cost wise : \_\_\_\_\_
  - c. Function wise: \_\_\_\_\_
3. What kind of features you recommend for Low Horse power tractors which will be perceived by the end user?
  - 1)
  - 2)
  - 3)
4. Please rank the seating characteristics you find important for the performance of the low HP tractor in the field.(1to5)  
1- Vital, 2 - Essential,3- Desirable, 4-Acceptable,5- Redundant
  - Suspension :
  - Seat Base,Back rest contour & size:
  - Fore & Aft mechanism :
  - Ergonomics :
  - Height adjustment mechanism :
  - Aesthetics :
5. How you find the market growth for Low HP tractors in the last 3 years & in the future? Comment

6. Major customer End user irritants in the seat: need to be looked into / solved.

7. Your recommendations / suggestions specific to **Low HP tractor seats**(if any)

8. What additional features/accessories you would like to have in a **Low HP tractor seat**, which will be useful in end user point of view.

9. At what price/Life you would like to have a tractor seat for **Low HP tractors**. (Landed cost at your works)

Autograph

Kindly send your reply to → [yn.kale@hgl.co.in](mailto:yn.kale@hgl.co.in)

Dear Sir

I am doing my final year ME in Kumaraguru College of Technology, Coimbalore. As a part of my academic programme I have taken up a project in Harita Grammer Limited, Hosur. The project title is Design and Development of seats for Low Horse power tractors. As a part of capturing customer voice in the product information phase, I require your inputs which will be valuable for preparing QFD.

QUESTIONNAIRE FOR LOW HP TRACTOR SEATS

DATE: 6.7.2000

REF. NO: LHP / 0009

NAME : L. M. SHARMA  
DESIGNATION : SENIOR MANAGER  
EMAIL ADDRESS: sharma.laxman@mahindra.co.in  
ORGANISATION: M/s Mahindra & Mahindra Ltd.

1. From the total cost of the tractor what percentage you allot to the seat?  
0.5 %

2. How you rate the existing seat in your tractor?(in 1 to 10 scale)-1 for worst & 10 for best

a. Feature wise: 7  
b. Cost wise: 5  
c. Function wise: 5

3. What kind of features you recommend for Low Horse power tractors which will be perceived by the end user?

1) Back Adjustment  
2) Front & Rear Adjustment  
3) Good Suspension

4. Please rank the seating characteristics you find important for the performance of the low HP tractor in the field. (1 to 5)  
1- Vital, 2- Essential, 3- Desirable, 4- Acceptable, 5- Redundant

Suspension : 1  
Seat Base, Back rest contour & size: 3  
Fore & Aft mechanism : 2  
Ergonomics : 2  
Height adjustment mechanism : 4  
Aesthetics : 2

5. How you find the market growth for Low HP tractors in the last 3 years & in the future?  
Comment : Growth is poor as farmer wants to use the tractors for multi purpose like tilling etc. Maximum demand is for 30 to 45 H.P. Tractors.

6. Major customer End user irritants in the seats which need to be looked into / solved.

- 1) Ropin & foam failure.
- 2) Damper inoperative.

7. Your recommendations / suggestions specific to Low HP tractor seats (if any)

1. Improvement in Damper & Spring design to have more comfort to the driver.
2. Improvement in Plastic & rubber components.

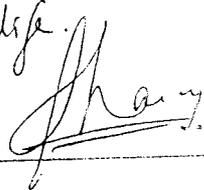
8. What additional features/accessories you would like to have in a Low HP tractor seat which will be useful in end user point of view.

Arm rest. 1) 2 people will not be able to sit which will reduce the failure rate  
2) Comfort to the driver in longage.

9. At what price/Life you would like to have a tractor seat for Low HP tractors (Landed cost at your works)

Rs. 1500 to 1700/- with atleast 2 year life.

Autograph



Kindly send your reply to → [yn.kale@hgl.co.in](mailto:yn.kale@hgl.co.in)

Dear Sir

I am doing my final year ME in Kumaraguru College of Technology, Coimbatore. As a part of my academic programme I have taken up a project in Harita Grammer Limited, Hosur. The project title is Design and Development of seats for Low Horse power tractors. As a part of capturing customer voice in the product information phase, I require your inputs which will be valuable for preparing QFD.

QUESTIONNAIRE FOR LOW HP TRACTOR SEATS

DATE: 07.07.2000  
REF. NO : LHP / 0009

NAME : G. SURESH  
DESIGNATION : Performance Group leader  
EMAIL ADDRESS: surresh.g @ mahindra. co. in  
ORGANISATION: Mahindra & Mahindra Ltd., AES, NAGPUR

1. From the total cost of the tractor what percentage you allot to the seat?  
\_\_\_\_\_ % Rs. 1000 to Rs. 1500/-
2. How you rate the existing seat in your tractor?(in 1 to 10 scale)-1 for worst & 10 for best

- a. Feature wise: 04  
b. Cost wise: 06  
c. Function wise: 04

3. What kind of features you recommend for Low Horse power tractors which will be perceived by the end user?

- 1) AUTOMATIC WEIGHT ADJUSTMENT
- 2) SLIDING ADJUSTMENTS (HORIZONTAL & VERTICAL)
- 3) BETTER AESTHETIC.

4. Please rank the seating characteristics you find important for the performance of the low HP tractor in the field.(1to5)

1- Vital, 2 - Essential, 3- Desirable, 4-Acceptable, 5- Redundant

- Suspension : (5)  
Seat Base, Back rest contour & size: (1)  
Fore & Aft mechanism : (2)  
Ergonomics : (1)  
Height adjustment mechanism : (5) (3)  
Aesthetics : (2)

5. How you find the market growth for Low HP tractors in the last 3 years & in the future?  
Comment

Major Sales is registered only in this segment.



**CUSTOMER VOICE**  
**[ HGL'S CUSTOMERS]**

1. Rexine and foam failure.
2. Damper inoperative.
3. Improvement in damper and spring design.
4. Improvement in plastic and rubber components.
5. Cracking of seats/ foams.
6. Jamming of suspension mechanism.
7. Reclining type seats preferred to reduce fatigue.
8. Features recommended:
  - a) Automatic wt. Adjustment.
  - b) Sliding adjustment ( horizontal and vertical).
  - c) Better aesthetics.
  - d) Good suspension.
  - e) Back adjustment.
  - f) Front and rear adjustment.

**A2 (b): QUESTIONNAIRE FOR LOW HP TRACTOR SEATS**  
[ FOR END-USERS]

<b>NAME :</b>	<b>HEIGHT:</b>
<b>OCCUPATION:</b>	<b>WEIGHT:</b>

1. How long are you using the tractor?  
-----(yrs).

2. Details about the tractor you use:

Company Name:

Seat Mfr's Name:

Model:

Features in the seat:

No. of hours used:

Horse Power:

3.a) Have you used any other older model tractor?  
Yes/No

b) If Yes, name it and compare both the old and the new seat comforts.

4. How often do you drive your tractor?

5. Do you know which company has manufactured the seat in your tractor?  
Yes/No

6. Where do you park your tractor?  
Shed/ Open space.

7. What kind of problems you face in the seat when using the tractor  
a) For field (ploughing) work:

b) For transportation:

8. What are the problems you came across in your seat?

9 a) Do you make use of the warranty & servicing facilities provided by the dealers?  
Yes/No

b) Have you serviced your seat?  
Yes/No

c) If No, why?

d) If Yes, are you satisfied with the

i) Spares available?	Yes/No
ii) Service by the dealer?	Yes/No
iii) Cost of repair?	Yes/No

10 a) Do you need an armrest in the seat?  
Yes/No

b) If Yes, should it be foldable?  
Yes/No

11 a) Do you prefer backrest extension?  
Yes/No

b) If Yes, do you want it to be adjustable?  
Yes/No

12. What other features do you recommend to improve the driving/ field operation to reduce fatigue?

13. List down your other requirements and suggestions for the tractor seat.

Autograph Please

# QUESTIONNAIRE FOR LOW HP TRACTOR SEATS

[ FOR END-USERS ]

NAME : Ananda	HEIGHT: 170 cm
OCCUPATION: agriculture	WEIGHT: 60 kg

1. How long are you using the tractor?  
 -----(yrs).

2. Details about the tractor you use:

Company Name: Tafe

Seat Mfr's Name: local

Model: ag Model

Features in the seat: fore & aft.

No. of hours used: 1600 hrs.

Horse Power: 50hp.

3.a) Have you used any other older model tractor?

Yes/No  No

b) If Yes, name it and compare both the old and the new seat comforts.

4. How often do you drive your tractor?

10 hrs/daily

5. Do you know which company has manufactured the seat in your tractor?

~~Yes/No~~ No

6. Where do you park your tractor?

~~Shed~~ Open space.

7. What kind of problems you face in the seat when using the tractor

a) For field (ploughing) work:

Body gets heat.

b) For transportation:

8. What are the problems you came across in your seat?

Wider B/R & S/B that can accommodate 2 persons.

9 a) Do you make use of the warranty & servicing facilities provided by the dealers?

~~Yes~~/No

b) Have you serviced your seat?

~~Yes~~/No

c) If No, why?

*only cushion*

d) If Yes, are you satisfied with the

i) Spares available? Yes/No

ii) Service by the dealer? Yes/No

iii) Cost of repair? Yes/No

10 a) Do you need an armrest in the seat?

Yes/~~No~~

b) If Yes, should it be foldable?

Yes/~~No~~

11 a) Do you prefer backrest extension?

Yes/~~No~~

b) If Yes, do you want it to be adjustable?

Yes/~~No~~

12. What other features do you recommend to improve the driving/ field operation to reduce fatigue?

*Increase S/B cushion let.*

13. List down your other requirements and suggestions for the tractor seat.

Autograph Please

QUESTIONNAIRE FOR LOW HP TRACTOR SEATS  
[ FOR END-USERS ]

NAME : MUNIREDDY. K	HEIGHT: 6 1/2 ft
OCCUPATION: AGRICULTURE	WEIGHT: 70 kg

1. How long are you using the tractor?  
25 (yrs).

2. Details about the tractor you use:

Company Name: ESCORTS

Seat Mfr's Name: NOT KNOWN

Model: 1972

Features in the seat: ONLY SUSPENSION

No. of hours used: 14 hrs/day

Horse Power:

3.a) Have you used any other older model tractor?  
Yes/No ✓

b) If Yes, name it and compare both the old and the new seat comforts.

4. How often do you drive your tractor? REGULAR

5. Do you know which company has manufactured the seat in your tractor?  
Yes/No ✓

6. Where do you park your tractor?  
Shed/ Open space. ✓

7. What kind of problems you face in the seat when using the tractor  
a) For field (ploughing) work:  
SPINAL CORD PAIN

b) For transportation:  
MORE VIBRATION

8. What are the problems you came across in your seat?  
NOT OBSERVED

9 a) Do you make use of the warranty & servicing facilities provided by the dealers?

Yes/No ✓

b) Have you serviced your seat?

Yes/No ✓

c) If No, why?

d) If Yes, are you satisfied with the

i) Spares available? Yes/No ✓

ii) Service by the dealer? Yes/No ✓

iii) Cost of repair? Yes/No

- AROUND RS 100/-

10 a) Do you need an armrest in the seat?

Yes/No ✓

b) If Yes, should it be foldable?

Yes/No ✓

11 a) Do you prefer backrest extension?

Yes/No ✓

BECAUSE WHILE PLOWING THEY WILL BE LOOKING BACKWARDS.

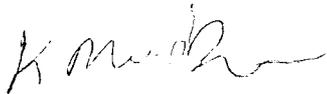
b) If Yes, do you want it to be adjustable?

Yes/No ✓

12. What other features do you recommend to improve the driving/ field operation to reduce fatigue?

- No

13. List down your other requirements and suggestions for the tractor seat.



Autograph Please

QUESTIONNAIRE FOR LOW HP TRACTOR SEATS  
[ FOR END-USERS ]

NAME : <i>Karuppudamy</i>	HEIGHT:
OCCUPATION: <i>Agriculture</i>	WEIGHT: <i>62 kgs.</i>

1. How long are you using the tractor?  
*--5--*(yrs).

2. Details about the tractor you use:

Company Name: <i>Ford</i>	Seat Mfr's Name:
Model: <i>1995</i>	Features in the seat: <i>Ht. adj.</i>
No. of hours used: <i>3200 hrs.</i>	<i>Wt. adj.</i>
Horse Power: <i>47 HP</i>	

3.a) Have you used any other older model tractor?  
*Yes/No*

b) If Yes, name it and compare both the old and the new seat comforts.

4. How often do you drive your tractor?  
*Daily 4 to 5 hrs.*

5. Do you know which company has manufactured the seat in your tractor?  
*Yes/No*

6. Where do you park your tractor?  
*Shed/ Open space.*

7. What kind of problems you face in the seat when using the tractor  
a) For field (ploughing) work:

b) For transportation:

8. What are the problems you came across in your seat?  
*Cushion gets damaged.*  
*Spring gets cut.*

9 a) Do you make use of the warranty & servicing facilities provided by the dealers?

Yes/~~No~~

b) Have you serviced your seat?

Yes/~~No~~

c) If No, why?

d) If Yes, are you satisfied with the

i) Spares available? Yes/~~No~~

ii) Service by the dealer? Yes/~~No~~

iii) Cost of repair? Yes/~~No~~

10 a) Do you need an armrest in the seat?

Yes/~~No~~

b) If Yes, should it be foldable?

Yes/~~No~~

11 a) Do you prefer backrest extension?

Yes/~~No~~

b) If Yes, do you want it to be adjustable?

Yes/~~No~~

12. What other features do you recommend to improve the driving/ field operation to reduce fatigue?

13. List down your other requirements and suggestions for the tractor seat.

Karuppisamy  
Autograph Please

QUESTIONNAIRE FOR LOW HP TRACTOR SEATS  
[ FOR END-USERS ]

NAME : <i>Chopal</i>	HEIGHT:
OCCUPATION: <i>Agriculture</i>	WEIGHT: <i>65 kg,</i>

1. How long are you using the tractor?  
*4* (yrs).

2. Details about the tractor you use:

Company Name: *M & M,*

Seat Mfr's Name: -

Model: *475.*

Features in the seat: *wt. adj., ht. adj.*

No. of hours used: *3600 hrs.*

*Fore & Aft with bolt ac*

Horse Power: *40 HP*

3.a) Have you used any other older model tractor?  
Yes/No

b) If Yes, name it and compare both the old and the new seat comforts.

4. How often do you drive your tractor?  
*6 hrs daily.*

5. Do you know which company has manufactured the seat in your tractor?  
Yes/No

6. Where do you park your tractor?  
*Shed/ Open space.*

7. What kind of problems you face in the seat when using the tractor  
a) For field (ploughing) work:

b) For transportation:

8. What are the problems you came across in your seat?

*wt. adj. bolt makes sound,  
Spring is weak & gets cut after,  
B/R ht. in less.*

9 a) Do you make use of the warranty & servicing facilities provided by the dealers?

✓ Yes/No

b) Have you serviced your seat?

Yes/No ✓

c) If No, why?

d) If Yes, are you satisfied with the

i) Spares available? Yes/No

ii) Service by the dealer? Yes/No

iii) Cost of repair? Yes/No

} okay

10 a) Do you need an armrest in the seat?

Yes/No ✓

b) If Yes, should it be foldable?

Yes/No ✓

11 a) Do you prefer backrest extension?

Yes/No ✓

b) If Yes, do you want it to be adjustable?

Yes/No ✓

12. What other features do you recommend to improve the driving/ field operation to reduce fatigue?

13. List down your other requirements and suggestions for the tractor seat.

Autograph Please

99

QUESTIONNAIRE FOR LOW HP TRACTOR SEATS  
[ FOR END-USERS ]

NAME : Annamalai.	HEIGHT:
OCCUPATION: Transportation & Agriculture.	WEIGHT: 49 kgs.

1. How long are you using the tractor?  
12 (yrs).

2. Details about the tractor you use:

Company Name: Mahindra  
Model: B-275, 1996.  
No. of hours used: 2352 hrs.  
Horse Power:

Seat Mfr's Name: -

Features in the seat:

Fore & aft bolting

3.a) Have you used any other older model tractor?

Yes/~~No~~

b) If Yes, name it and compare both the old and the new seat comforts.

New this is better.

4. How often do you drive your tractor?

3 days a week.

5. Do you know which company has manufactured the seat in your tractor?

Yes/~~No~~

6. Where do you park your tractor?

Shed/ ~~Open~~ space.

7. What kind of problems you face in the seat when using the tractor

a) For field (ploughing) work:

b) For transportation:

8. What are the problems you came across in your seat?

9 a) Do you make use of the warranty & servicing facilities provided by the dealers?

Yes/~~No~~

b) Have you serviced your seat?

~~Yes~~/No

c) If No, why?

d) If Yes, are you satisfied with the

i) Spares available? ~~Yes~~/No

ii) Service by the dealer? Yes/No

iii) Cost of repair? Yes/No

10 a) Do you need an armrest in the seat?

~~Yes~~/No

b) If Yes, should it be foldable?

~~Yes~~/No

11 a) Do you prefer backrest extension?

Yes/~~No~~

b) If Yes, do you want it to be adjustable?

Yes/~~No~~

12. What other features do you recommend to improve the driving/ field operation to reduce fatigue?

*Fore & Aft with levers needed.*

13. List down your other requirements and suggestions for the tractor seat.

*A. Annamalai*  
Autograph Please

QUESTIONNAIRE FOR LOW HP TRACTOR SEATS  
[ FOR END-USERS ]

NAME : <i>Murthy</i>	HEIGHT: <i>5'</i>
OCCUPATION: <i>Agri k transport</i>	WEIGHT: <i>50 kg.</i>

1. How long are you using the tractor?  
*5* (yrs).

2. Details about the tractor you use:

Company Name: *Mahindra*

Seat Mfr's Name:

Model: *475-D1*

Features in the seat:

No. of hours used: *4000*

Horse Power:

*NO pore & aft neck.*

*ht. adj is there at the base.*

3.a) Have you used any other older model tractor?

*Yes/No*

b) If Yes, name it and compare both the old and the new seat comforts.

4. How often do you drive your tractor?

*Daily*

5. Do you know which company has manufactured the seat in your tractor?

*Yes/No*

6. Where do you park your tractor?

*Shed/ Open space.*

7. What kind of problems you face in the seat when using the tractor

a) For field (ploughing) work:

b) For transportation:

*on road, when pebbles etc, vibration in no*

8. What are the problems you came across in your seat?

*ht. adj. has got cut.*

9 a) Do you make use of the warranty & servicing facilities provided by the dealers?

Yes/~~No~~

b) Have you serviced your seat?

~~Yes~~/No

c) If No, why?

d) If Yes, are you satisfied with the

i) Spares available? Yes/~~No~~

ii) Service by the dealer? Yes/No

iii) Cost of repair? Yes/No

10 a) Do you need an armrest in the seat?

Yes/~~No~~

b) If Yes, should it be foldable?

Yes/~~No~~

11 a) Do you prefer backrest extension?

Yes/~~No~~

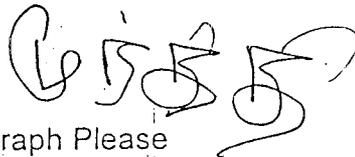
b) If Yes, do you want it to be adjustable?

Yes/~~No~~

12. What other features do you recommend to improve the driving/ field operation to reduce fatigue?

13. List down your other requirements and suggestions for the tractor seat.

Autograph Please



QUESTIONNAIRE FOR LOW HP TRACTOR SEATS  
[ FOR END-USERS]

NAME : Raja	HEIGHT: 170cms
OCCUPATION: agriculture	WEIGHT: 55kg

1. How long are you using the tractor?  
3 (yrs).

2. Details about the tractor you use:

Company Name: Mahindra <sup>475DI</sup>      Seat Mfr's Name: local mfr.  
Model: 95 model      Features in the seat: ✓  
No. of hours used: 5 yrs.  
Horse Power: 45 hp.

3.a) Have you used any other older model tractor?

~~Yes~~/No ✓

b) If Yes, name it and compare both the old and the new seat comforts.

4. How often do you drive your tractor?

12 hrs daily

5. Do you know which company has manufactured the seat in your tractor?

~~Yes~~/No ✓

6. Where do you park your tractor?

~~Shed~~ Open space. ✓

7. What kind of problems you face in the seat when using the tractor

a) For field (ploughing) work:

✓

b) For transportation:

✓

8. What are the problems you came across in your seat?

✓

\* Caught him on the road.

9 a) Do you make use of the warranty & servicing facilities provided by the dealers?

~~Yes/No~~

b) Have you serviced your seat?

~~Yes/No~~ No

c) If No, why?

d) If Yes, are you satisfied with the

i) Spares available? Yes/No

ii) Service by the dealer? Yes/No

iii) Cost of repair? Yes/No

} Okay

10 a) Do you need an armrest in the seat?

~~Yes/No~~

b) If Yes, should it be foldable?

Yes/No

11 a) Do you prefer backrest extension?

~~Yes/No~~

b) If Yes, do you want it to be adjustable?

Yes/No

12. What other features do you recommend to improve the driving/ field operation to reduce fatigue?

13. List down your other requirements and suggestions for the tractor seat.

Autograph Please

QUESTIONNAIRE FOR LOW HP TRACTOR SEATS  
[ FOR END-USERS]

NAME : Venkateshappa.	HEIGHT:
OCCUPATION: Agriculture	WEIGHT:

1. How long are you using the tractor?  
---3---(yrs).

2. Details about the tractor you use:

Company Name: Mahindra  
Model: 570 DI.  
No. of hours used: 2000 hrs  
Horse Power: ~~85~~

Seat Mfr's Name: Polar  
Features in the seat: —

3.a) Have you used any other older model tractor?  
Yes/No ✓

b) If Yes, name it and compare both the old and the new seat comforts.

4. How often do you drive your tractor?  
8 hrs / day.

5. Do you know which company has manufactured the seat in your tractor?  
Yes/No

6. Where do you park your tractor?  
Shed/ Open space. ✓

7. What kind of problems you face in the seat when using the tractor

a) For field (ploughing) work:

b) For transportation: —

8. What are the problems you came across in your seat?

One side Spring is ~~not~~ absent  
Blr foam is absent.  
Slr Resine is absent

9 a) Do you make use of the warranty & servicing facilities provided by the dealers?  
Yes/~~No~~

b) Have you serviced your seat?  
Yes/No

once in 300 hrs. (575)

c) If No, why?

d) If Yes, are you satisfied with the

- i) Spares available? Yes/No
- ii) Service by the dealer? Yes/No
- iii) Cost of repair? Yes/No

Salem Engg.

10 a) Do you need an armrest in the seat?  
Yes/No

b) If Yes, should it be foldable?  
Yes/No

11 a) Do you prefer backrest extension?  
Yes/No

b) If Yes, do you want it to be adjustable?  
Yes/No

12. What other features do you recommend to improve the driving/ field operation to reduce fatigue?

—

13. List down your other requirements and suggestions for the tractor seat.

—

Autograph Please

QUESTIONNAIRE FOR LOW HP TRACTOR SEATS  
[ FOR END-USERS ]

NAME : <i>Venkatesh.</i>	HEIGHT: <i>5'</i>
OCCUPATION: <i>Transportation.</i>	WEIGHT:

1. How long are you using the tractor?  
*10* (yrs).

2. Details about the tractor you use:

Company Name: *Massey Ferguson*  
Model: *1993 model.*  
No. of hours used: *5300 hrs.*  
Horse Power:

Seat Mfr's Name:  
Features in the seat: *wt. adj. only.*

3.a) Have you used any other older model tractor?  
~~Yes~~/No

b) If Yes, name it and compare both the old and the new seat comforts.

4. How often do you drive your tractor?  
*Daily,*

5. Do you know which company has manufactured the seat in your tractor?  
~~Yes~~/No

6. Where do you park your tractor?  
~~Shed~~/ Open space.

7. What kind of problems you face in the seat when using the tractor

a) For field (ploughing) work:

b) For transportation:

8. What are the problems you came across in your seat?

*Seat cushion worn out.  
Springs have to be changed.*

9 a) Do you make use of the warranty & servicing facilities provided by the dealers?

Yes/No

*once in, 250 hrs*

b) Have you serviced your seat?

Yes/No

c) If No, why?

d) If Yes, are you satisfied with the

i) Spares available? Yes/No

ii) Service by the dealer? Yes/No

iii) Cost of repair? Yes/No

}

10 a) Do you need an armrest in the seat?

Yes/No

b) If Yes, should it be foldable?

Yes/No

11 a) Do you prefer backrest extension?

Yes/No

b) If Yes, do you want it to be adjustable?

Yes/No

12. What other features do you recommend to improve the driving/ field operation to reduce fatigue?

—

13. List down your other requirements and suggestions for the tractor seat.

—

Autograph Please

—

—

**CUSTOMER VOICES**  
**[ END-USERS]**

END USER'S VOICE/ NEED	NO. OF CUSTOMERS.
1. Spring gets cut.	5
2. Roller wornout.	2
3. Bearings wornout.	1
4. Wt. Adjustment got cut.	1
5. Wt. Adjustment bolt is noisy.	1
6. Spring is weak.	1
7. B/R ht. Is less.	1
8. Cushion gets damaged.	5
9. Holes are formed in the pan.	1
10. Pan gets rusted.	2
11. Cushion ht. Is less.	1
12. Body gets heated.	2
13. Clearance in sliderails.	1
14. One side spring is absent.	2
15. Cushion is hard.	1
16. Noise is more.	2
17. Seat is shaky.	1
18. Need one more spring.	1
19. Pain in Spinal cord.	1
20. Need wider S/B & B/R to accommodate 2 persons.	1
21. Rexin damaged.	5
22. Floating of seat.	1
23. Fore & Aft. Mechanism with lever is preffered.	10

## A3: PROCESS BENCHMARKING

### BENCHMARKING OF BACKREST ASSEMBLY OF SEATS AVAILABLE AT HGL'S R&D.

#### 1. Grammer - Blue fabric :

- ✦ Plastic insert moulded with foam and fabric is heat sealed with it.
- ✦ Separate sheetmetal B/R pan is also available, which is fixed to the foam assembly using 4 screws.

#### 2. Grammer - Black Fabric :

- ✦ Plastic B/R pan with protrusions for assembly is available.
- ✦ Fabric is used to cover the cushion and stapled along with the pan.

#### 3. John Deere - Yellow Rexine :

- ✦ Foam -in - place technology is used to fix rexine and foam.
- ✦ Excess rexine is trimmed along the foam contour and glued to the plastic B/R pan.

#### 4. Grammer - Black plasticised PVC :

- ✦ Both B/R and S/B is a single unit with plastic pan and foam covered (completely sealed) with the PVC.
- ✦ Foam is insert moulded with transparent, recycled plastic provided with 4 holes for screws.

#### 6. Grammer - Yellow Rexine :

- ✦ Cushion placed within a recycled plastic mould and rexine is stapled to it.
- ✦ This is fixed to a plastic B/R pan using 8 PVC screws which can be pressed to fit into the holes in the inner plastic mould.

## A5: CONCLUSION FOR VALUE ENGINEERING

1. The task oriented FAST diagram for the Low HP Tractor Seat was drawn.
2. The value gap for the various sub- assemblies were as below :

S.NO.	SUB - ASSEMBLY	VALUE GAP(Rs.)
1	S/B ASSEMBLY	42.81
2	B/R ASSEMBLY	24.82
3	SWING ARM ASSY. COMPL.	5.62
4	SPRING BKT ASSY	1.5
5	ASSY. CARRIER PLATE	18.75
6	ASSY. SPRING CASE	35.25
7	OTHER's	40.64
	<b>TOTAL (Rs.)</b>	<b>171.57</b>

3. From the above table, the function worth was found to be Rs. 750.07.
4. Hence it is possible to reduce the material cost to Rs. 750.
5. This can be achieved by removing non - value added parts, redundant parts, alternate material identification and changes in the design itself.
6. Alternate foam tucking method can be used : A recycled plastic plate with holes provided for screws can be insert moulded with the foam. Then the rexin can be heat sealed or stapled to this sub - assembly and then the pan can be snap fitted to this assembly.

**A6: PROCESS MAPPING DETAILS FOR EXISTING TAFE SEAT  
[ SHEET METAL COMPONENTS ]**

PAGE 1 OF 12

S. NO. : 01

PART NAME : SEAT BASE PAN

PART NO. : 111 02 103

MATERIAL : IS: 513 GR DD

SUPPLIER NAME: ESTEE AUTO PRODUCTS LTD.

OPERATION NO.	PROCESS/ OPERATION	CONV. COST(RS)
10	Shearing	0.5
20	Drawing	2.7
30	Trimming	2.7
40	Piercing	0.7
50	Final Forming	1.45
60	Deburring	0.7
	<b>TOTAL</b>	<b>8.75</b>

		COST(Rs)
Sheet Size	1480 x 430 x 1.5	-
No. of components / Sheet	3	-
Input Weight(gm)	7380	200.8836
Weight of 1 component	1700	46.274
Output Weight(gm)	5100	138.82
Scrap	2400	10.80
Scrap Cost / Kg	-	4.5
<b>MATERIAL COST/ KG</b>	-	<b>27.22</b>

**MATERIAL COST/ COMPONENT= RS. 66.96**

**SCRAP VALUE / COMPONENT = RS. 3.6**

**YIELD = [Output Wt. / Input Wt.] x 100**

**YIELD = 69%**

PAGE 2 OF 12

S. NO. : 02

PART NAME : BACK REST PAN

PART NO . : 111 03 103

MATERIAL : IS: 513 GR DD

SUPPLIER NAME: ESTEE AUTO PRODUCTS LTD.

OPERATION NO.	PROCESS/ OPERATION	CONV. COST(RS)
10	Shearing	0.5
20	Blanking	1.5
30	Drawing	2.5
40	Forming	2.5
50	Piercing	1.25
60	Deburring	1
<b>TOTAL</b>		<b>9.25</b>

		COST(RS)
Input Weight(gm)	1365	39.9126
Weight of 1 component(gm)	1215	35.5266
Output Weight (gm)	1215	35.5266
Scrap(gm)	150	0.675
Scrap Cost / Kg	-	4.5
MATERIAL COST/ KG	-	29.24

MATERIAL COST/ COMPONENT= RS. 39.91

SCRAP VALUE / COMPONENT = RS. 0.675

YIELD = [Output Wt. / Input Wt.] x 100

YIELD =89%

PAGE 3 OF 12

S. NO. : 03

PART NAME : CARRIER PLATE

PART NO. : 111 04 103

MATERIAL : IS: 1079 GR-DD

SUPPLIER NAME: PRESSCOM PRODUCTS PVT. LTD.

OPERATION NO.	PROCESS/ OPERATION	PRODUCTIVITY / HR	CONV. COST(RS)
10	Sheet Shearing	-	0.5
20	Corner Notching	300	-
30	Embossing	300	0.35
40	Forming	200	0.75
50	Piercing	200	0.35
60	Re-Forming	200	0.2
70	Angle Forming	175	0.4
80	Piercing	300	0.2
90	Hitting Embossing Side	300	0.2
100	Piercing	200	0.4
110	Hitting, Deburring	500	0.25
		<b>TOTAL</b>	<b>3.6</b>

		COST(RS)
Sheet Size	600 x 2410 x 2.5	-
No. of components / Sheet	12	-
Input Weight(gm)	28320	790.128
Weight of 1 component(gm)	2100	58.59
Output Weight (gm)	25200	703.08
Scrap(gm)	3120	15.6
Scrap Cost / Kg	-	5
MATERIAL COST/ KG	-	27.9

MATERIAL COST/ COMPONENT= RS. 65.84

SCRAP VALUE / COMPONENT = RS. 1.30

YIELD = [Output Wt. / Input Wt.] x 100

YIELD = 88.98%

PAGE 4 OF 12

S. NO. : 04

PART NAME : STOPPER PLATE

PART NO. : 111 04 104

MATERIAL : IS: 513 GR D

SUPPLIER NAME: PRESSCOM PRODUCTS PVT. LTD.

OPERATION NO.	PROCESS/ OPERATION	PRODUCTIVITY / HR
10	Blanking	500
20	Forming	500

Sheet Size	140 x 1250 x 3
No. of components / Sheet	45
Input Weight(gm)	4121.25
Weight of 1 component(gm)	66
Output Weight (gm)	2970
Scrap(gm)	1151.25

YIELD = [Output Wt. / Input Wt.] x 100

YIELD = 72.07%

PAGE 5 OF 12

S. NO. : 05

PART NAME : SPRING RETAINER

PART NO. : 111 05 103

MATERIAL : IS: 1079 GR D

SUPPLIER NAME: PRESSCOM PRODUCTS PVT. LTD.

OPERATION NO.	PROCESS/ OPERATION	PRODUCTIVITY / HR
10	Shearing	-
20	Blanking	400
30	Piercing	600
40	Forming	450

Sheet Size	137 x 1250 x 4
No. of components / Sheet	50
Input Weight(gm)	5377.2
Weight of 1 component(gm)	66
Output Weight (gm)	3300
Scrap(gm)	2077.2

**YIELD = [Output Wt. / Input Wt.] x 100**

**YIELD = 61.4 %**

PAGE 6 OF 12

S. NO. : 06

PART NAME : S/A RETANER

PART NO. : 111 04 109

MATERIAL : IS: 1079 GR-D

SUPPLIER NAME: PRESSCOM PRODUCTS PVT. LTD.

OPERATION NO.	PROCESS/ OPERATION	PRODUCTIVITY / HR
10	Blanking	600
20	Forming	300
30	Piercing	300

Sheet Size	24 x 1250 x 3
No. of components / Sheet	30
Input Weight	706.5
Weight of 1 component	23 gms
Output Weight	690 gms.
Scrap	16.5 gms.

**YIELD = [Output Wt. / Input Wt.] x 100**

**YIELD = 97.6%**

PAGE 7 OF 12

S. NO. : 07

PART NAME : ROLLER PLATE

PART NO. : 111 04 111

MATERIAL : St 42 IS: 1079

SUPPLIER NAME: PRESSCOM PRODUCTS PVT. LTD.

OPERATION NO.	PROCESS/ OPERATION	PRODUCTIVITY / HR	CONV. COST(RS)
10	Shearing	-	0.05
20	Blanking	600	0.2
30	Piercing	500	0.07
	Deburring	-	0.03
	<b>TOTAL</b>		<b>0.35</b>

		COST(RS)
Sheet Size	40 x 1250 x 4	-
No. of components / Sheet	32	-
Input Weight(gm)	1570	34.54
Weight of 1 component(gm)	47.5	1.045
Output Weight (gm)	1520	33.44
Scrap(gm)	50	0.25
Scrap Cost / Kg	-	5
<b>MATERIAL COST/ KG</b>	-	<b>22</b>

MATERIAL COST/ COMPONENT= RS. 1.4

SCRAP VALUE / COMPONENT = RS.0.00781

YIELD = [Output Wt. / Input Wt.] x 100

YIELD = 96.8 %

PAGE 8 OF 12

S. NO. : 08

PART NAME : SPRING CASE

PART NO. : 111 05 103

MATERIAL : IS: 513 GR D

SUPPLIER NAME: PRESSCOM PRODUCTS PVT. LTD.

OPERATION NO.	PROCESS/ OPERATION	PRODUCTIVITY / HR	CONV. COST(RS)
10	Blanking	250	0.5
20	Piercing - I	300	0.5
30	Embossing	150	0.3
40	Forming - I	300	0.5
50	"L" Forming	300	1
60	Forming - II	250	1
70	Side Piercing	250	0.75
80	2 Side Hitting	150	-
		<b>TOTAL</b>	<b>4.55</b>

		COST(RS)
Sheet Size	302 x 1300 x 3	-
No. of components / Sheet	3	-
Input Weight(gm)	9245.73	237.615261
Weight of 1 component(gm)	2800	71.96
Output Weight (gm)	8400	215.88
Scrap(gm)	845.73	4.651515
Scrap Cost / Kg	-	5.5
<b>MATERIAL COST/ KG</b>	-	<b>25.7</b>

MATERIAL COST/ COMPONENT= RS.81.47

SCRAP VALUE / COMPONENT = RS.1.55

YIELD = [Output Wt. / Input Wt.] x 100

YIELD = 90.9 %

PAGE 9 OF 12

S. NO. : 09

PART NAME : WASHER (DIA. 30)

PART NO. : 111 25 120

SUPPLIER NAME: PRESSCOM PRODUCTS PVT. LTD.

OPERATION NO.	PROCESS/ OPERATION	PRODUCTIVITY / HR
10	Blank cut with Piercing	600

Sheet Size	34 x 1250 x 2
No. of components / Sheet	37
Input Weight(gm)	667.25
Weight of 1 component(gm)	9
Output Weight (gm)	333
Scrap(gm)	334.25

$YIELD = [Output\ Wt. / Input\ Wt.] \times 100$

YIELD = 50 %

PAGE 10 OF 12

S. NO. : 10

PART NAME : SUPPORT PLATE

PART NO. :116 05 110

MATERIAL : IS: 1079 GR O

SUPPLIER NAME: JAYALAKSHMI ENGG. WORKS

OPERATION NO.	PROCESS/ OPERATION	PRODUCTIVITY / HR
10	Strip Shearing	-
20	Angle Cutting	300
30	Blanking	1000
40	Piercing & Trimming	600
50	Tumbling	600

Sheet Size	100 x 1250 x 4
No. of components / Sheet	20
Input Weight(gm)	3925
Weight of 1 component(gm)	179.31
Output Weight (gm)	3586.2
Scrap(gm)	338.8

**YIELD = [Output Wt. / Input Wt.] x 100**

**YIELD = 91.4 %**

PAGE 11 OF 12

S. NO. : 11

PART NAME : BASE PLATE LOWER ( TAFE)

PART NO. : 116 07 110

MATERIAL : IS: 513 GR DD

SUPPLIER NAME: IEEL

OPERATION NO.	PROCESS/ OPERATION	PRODUCTIVITY / HR	CONV. COST(RS)
10	Blank Shearing	333	1
20	'V' - Cutting	333	0.35
30	Embossing	333	1.25
40	Width Trimming	333	1.25
50	Length Trimming	272	0.35
60	Corner Chamfering	181	0.4
70	'U' - Forming	227	1.25
80	Piercing	272	0.35
90	Deburring	-	0.25
	Restriking & sizing	-	1.25
	Oiling	-	0.75
		<b>TOTAL</b>	<b>8.45</b>

		COST(RS)
Sheet Size	332 x 1120 x 4	-
No. of components / Sheet	4	-
Input Weight(gm)	11675.776	<b>288.3916672</b>
Weight of 1 component(gm)	2005	<b>49.5235</b>
Output Weight (gm)	8020	<b>198.094</b>
Scrap(gm)	3655.776	<b>18.27888</b>
Scrap Cost / Kg	-	<b>5</b>
<b>MATERIAL COST/ KG</b>	-	<b>24.7</b>

MATERIAL COST/ COMPONENT= RS. 72.1

SCRAP VALUE / COMPONENT = RS. 4.6

YIELD = [Output Wt. / Input Wt.] x 100

YIELD = 68.7%

**MATERIAL AND CONVERSION COSTS FOR  
SHEET METAL COMPONENTS IN TAFE SEAT**

PAGE 12 OF 12

<b>PART NO.</b>	<b>PART NAME</b>	<b>NET. WT. (Kgs)</b>	<b>MAT. COST( Rs)</b>	<b>CONV. COST(Rs)</b>	<b>YIELD</b>
111 02 103	Seat pan	1.66	66.96	8.75	69%
111 03 103	B/R Pan	1.195	39.91	9.25	89%
111 04 103	Carrier Plate	2	65.84	3.6	88.98%
111 04 104	Stopper Plate	0.066	-	-	72.07%
111 04 108	Spring Retainer	0.066	-	-	61.40%
111 04 109	S/A Retainer	0.023	-	-	97.60%
111 04 111	Roller Plate	0.0475	1.4	0.35	96.80%
111 05 103	Spring Case	2.8	81.47	4.55	91%
111 25 120	Washer(dia. 30)	0.009	-	-	50%
116 05 110	Support Plate	0.179	-	-	91.54%
116 07 110	Base Plate Lower	2.45	72.1	8.45	68.70%

**A7: CONCLUSION FOR PROCESS MAPPING  
[ PROPOSED CHANGES ]**

PAGE 1 OF 4

S. NO. : 01

PART NAME : SEAT BASE PAN

PART NO. : 111 02 103

MATERIAL : IS: 513 GR DD

SUPPLIER NAME: ESTEE AUTO PRODUCTS LTD.

**PROPOSAL :**

The sequence of operations can be changed as below:

OPERATION NO.	PROCESS/ OPERATION
10	Shearing
20	Trimming
30	Piercing & Final Forming
40	Deburring

1. This reduces the no. of operations from 6 to 4.

S. NO. : 02

PART NAME : BACK REST PAN

PART NO. : 111 03 103

MATERIAL : IS: 513 GR DD

SUPPLIER NAME: ESTEE AUTO PRODUCTS LTD.

**PROPOSAL :**

The sequence of operations can be changed as below:

OPERATION NO.	PROCESS/ OPERATION
10	Shearing
20	Trimming
30	Piercing & Final Forming
40	Deburring

1. This reduces the no. of operations from 6 to 4.

PAGE 2 OF 4

S. NO. : 03

PART NAME : CARRIER PLATE

PART NO. : 111 04 103

MATERIAL : IS: 1079 GR-DD

SUPPLIER NAME: PRESSCOM PRODUCTS PVT. LTD.

**PROPOSAL :**

The sequence of operations can be changed as below:

OPERATION NO.	OPERATIONS
10	Shearing
20	Corner Notching
30	Embossing
40	Piercing
50	Forming
60	Angle Forming
70	Hitting, Deburring

1. This reduces the no. of operations from 11 to 7.

S. NO. : 04

PART NAME : STOPPER PLATE

PART NO. : 111 04 104

MATERIAL : IS: 513 GR D

SUPPLIER NAME: PRESSCOM PRODUCTS PVT. LTD.

**PROPOSAL :**

The blank size and the sheet size can be changed to the following size.

SHEET SIZE	115 X 1250X 3
NO. / SHEET	50
BLANK SIZE	113.5 X 25X 3
I/P WT. (gm)	3385.3125
WT. OF 1 COMPONENT(gm)	66
O/P WT.(gm)	3300

NEW YIELD : 97.47%

PAGE 3 OF 4

S. NO. : 05

PART NAME : SPRING RETAINER

PART NO. : 111 05 103

MATERIAL : IS: 1079 GR D

SUPPLIER NAME: PRESSCOM PRODUCTS PVT. LTD.

**PROPOSAL :**

<b>SHEET SIZE</b>	<b>135 X 1150 X 4</b>
<b>BLANK SIZE</b>	<b>135 X 20 X 4</b>
<b>I/P WT.</b>	<b>4874.85</b>
<b>O/P WT.</b>	<b>3300</b>
<b>SCRAP</b>	<b>1574.85</b>

**NEW YIELD : 67.69%**

S. NO. : 08

PART NAME : SPRING CASE

PART NO. : 111 05 103

MATERIAL : IS: 513 GR D

SUPPLIER NAME: PRESSCOM PRODUCTS PVT. LTD.

**PROPOSAL :**

The sequence of operations can be changed as below:

<b>OPERATION NO.</b>	<b>OPERATIONS</b>
10	Blanking
20	Piercing
30	Embossing
40	Forming - I
50	"L" Forming
60	Forming - II
70	2 Side Hitting

1. This reduces the no. of operations from 8 to 7.

PAGE 4 OF 4

S. NO. : 11

PART NAME : BASE PLATE LOWER ( TAFE)

PART NO. : 116 07 110

MATERIAL : IS: 513 GR DD

SUPPLIER NAME: IEEL

**PROPOSAL :**

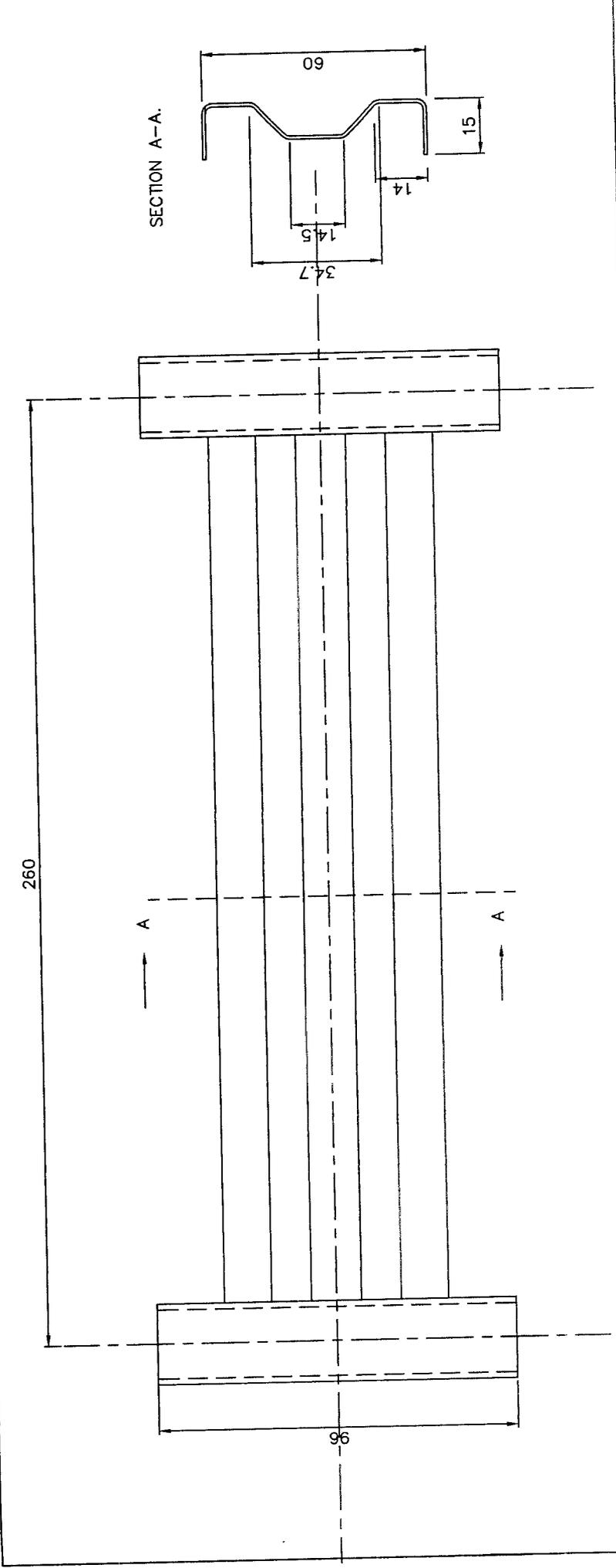
The sequence of operations can be changed as below:

OPERATION NO.	OPERATIONS
10	Blank Shearing
20	Width & Length Trimming
30	V - cutting & corner chamfering
40	Embossing
50	U - Forming
60	Piercing
	Deburring
	Restriking & sizing
	Oiling

1. This reduces the no. of operations from 9 to 6.

# **APPENDIX - B**

**B1: PROTO DRAWINGS  
AND  
PRO-E MODELS**



HARITA GRAMMER LTD.		ALL DIMENSIONS ARE IN mm.	
SCALE	TITLE	SHEET	DRG. No.
	ASSY. SWING ARM	1 OF 1	001
(PRESSED PART VERSION)			

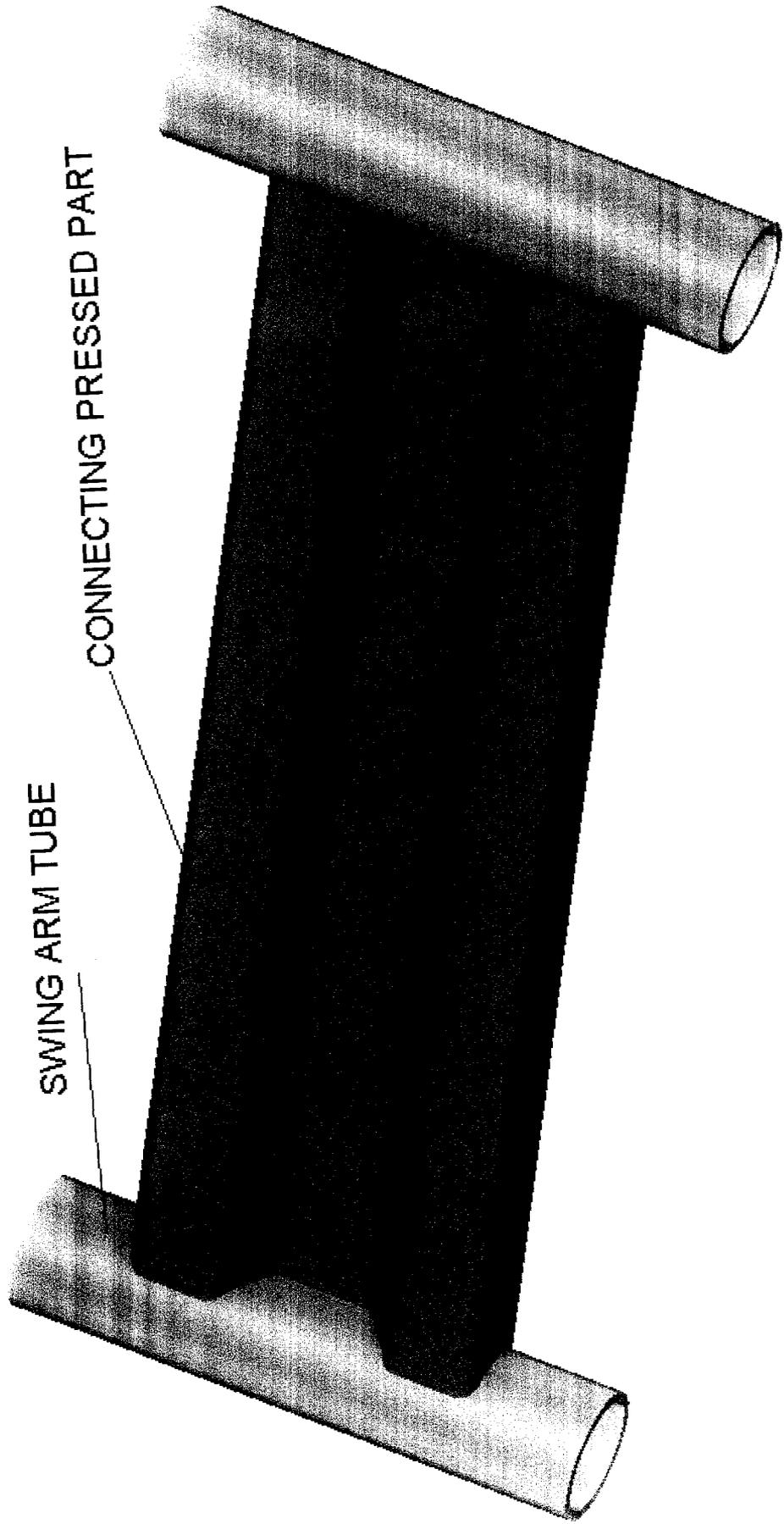
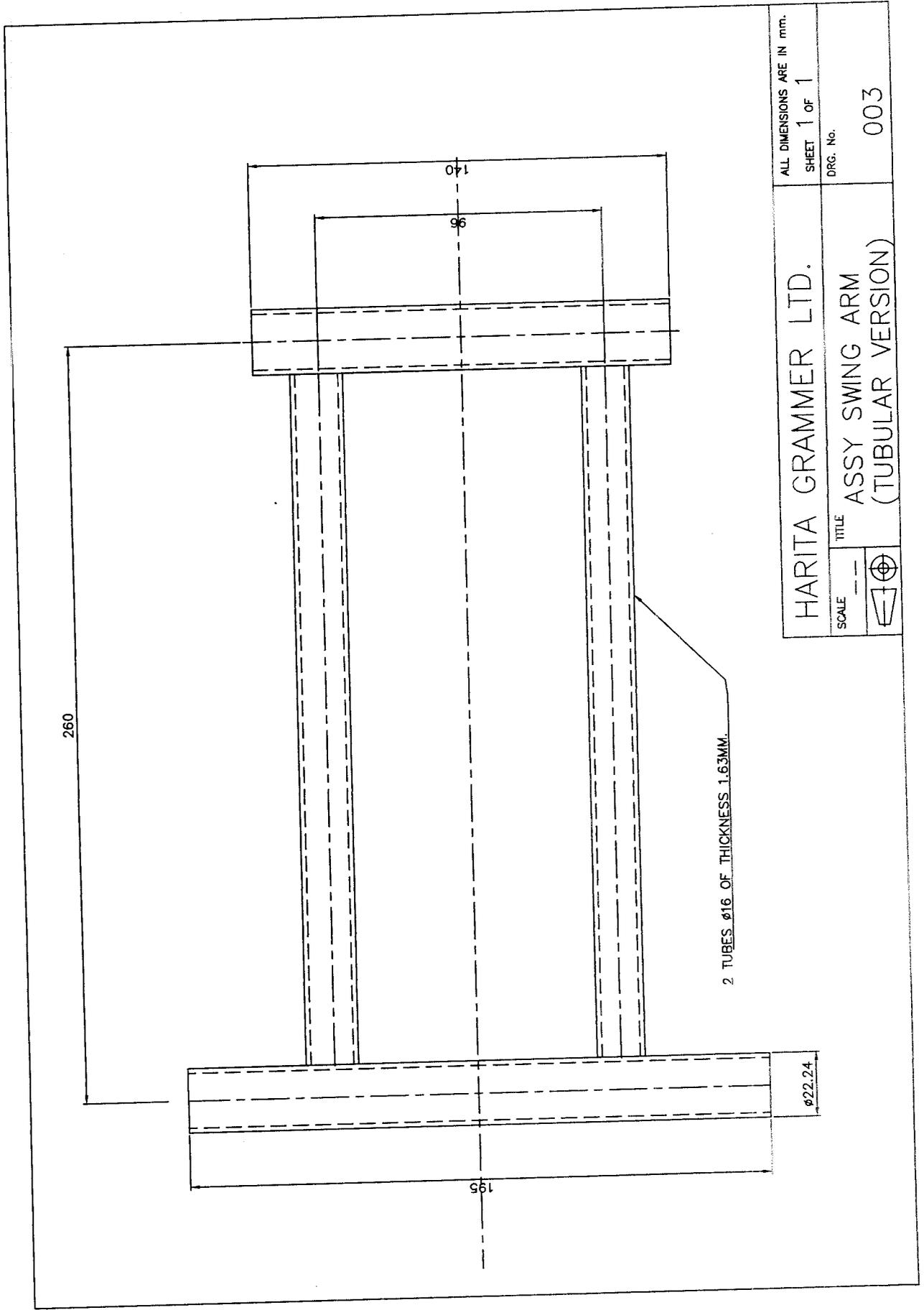
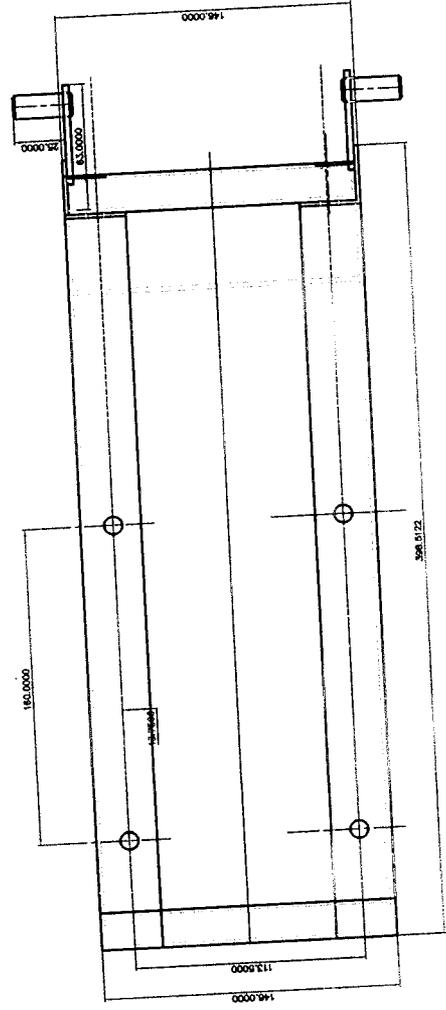
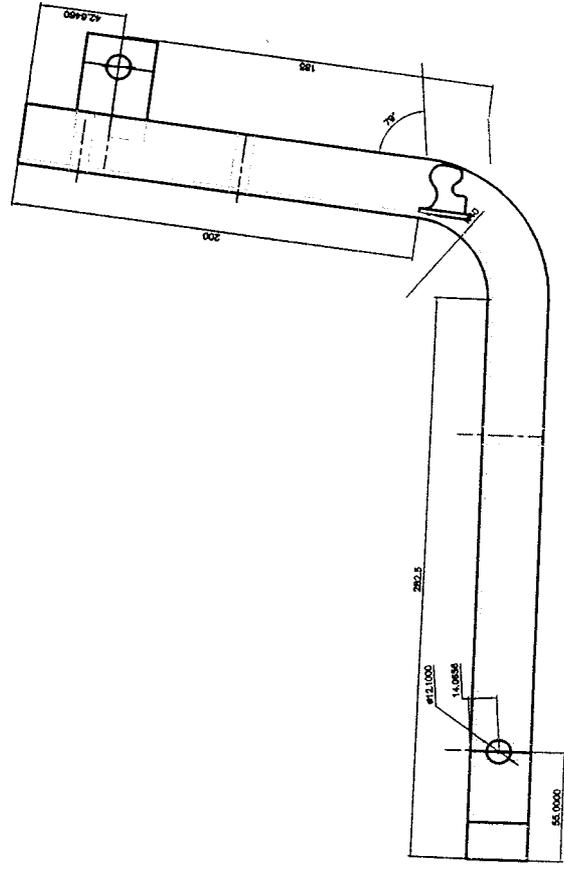
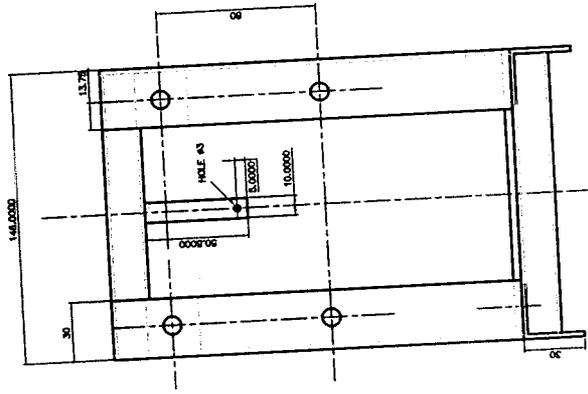


FIG. B.1.002.ASSY. SWINGARM

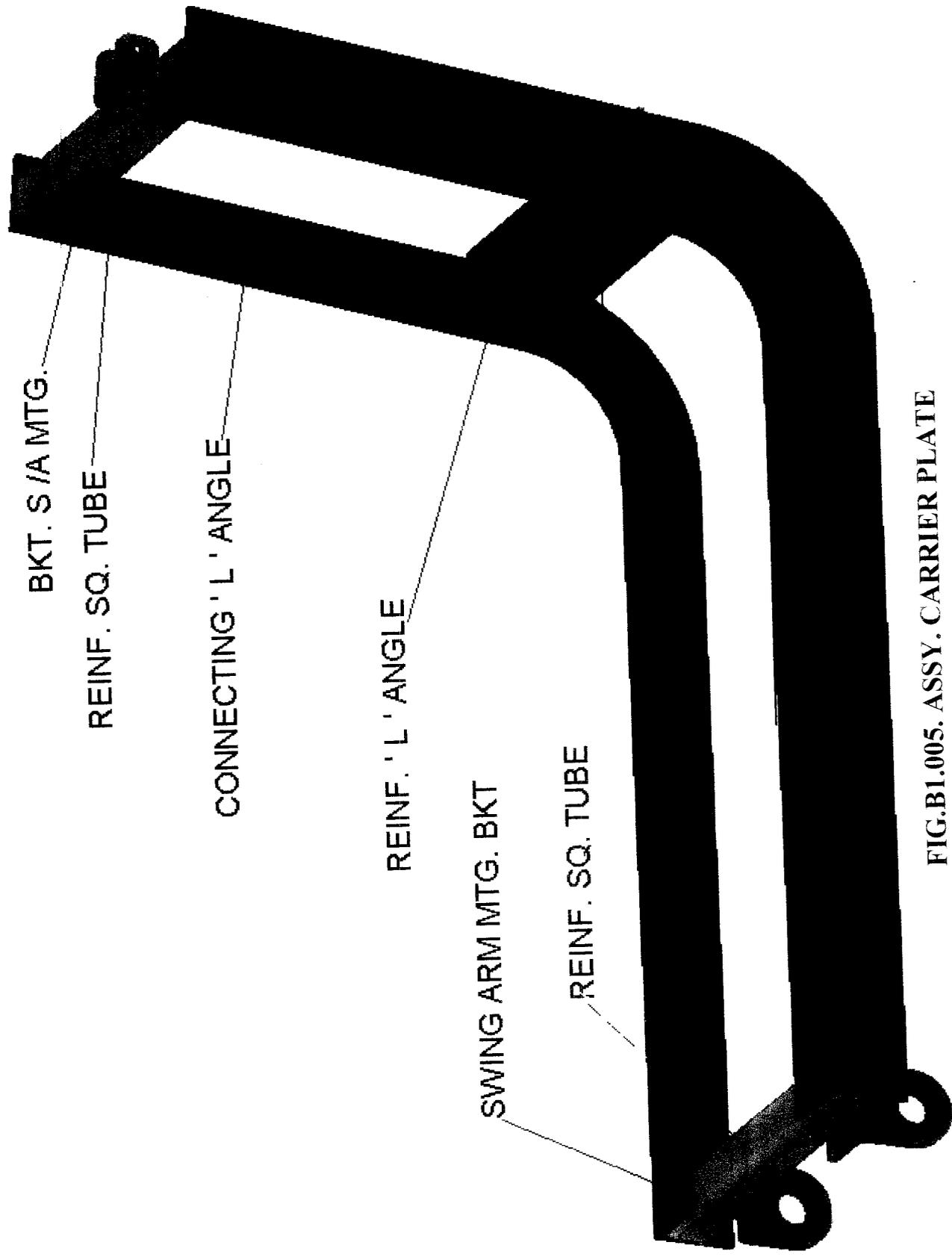




ASSY: L' ANGLE CARRIER PLATE  
 THICKNESS 10.00mm.  
 SCALE: 1:1  
 L' CHANNEL: 30\*75\*5

2 NO. TUBE REINFORCEMENTS OF  $\phi 10$  , LENGTH 165MM AND 2MM THICK AT THE ENDS.  
 1 SWIP REINFORCEMENT OF SIZE 10\*10 3MM , LENGTH 165MM AND 2MM THICK AT THE ENDS.

HARITA GRAMMER LTD.		ALL DIMENSIONS ARE IN MM.	
TITLE		SHEET 1 OF 1	
SCALE		DRG. No.	
ASSY: CARRIER PLATE (L' ANGLE VERSION)		004	



BKT. S /A MTG.

REINF. SQ. TUBE

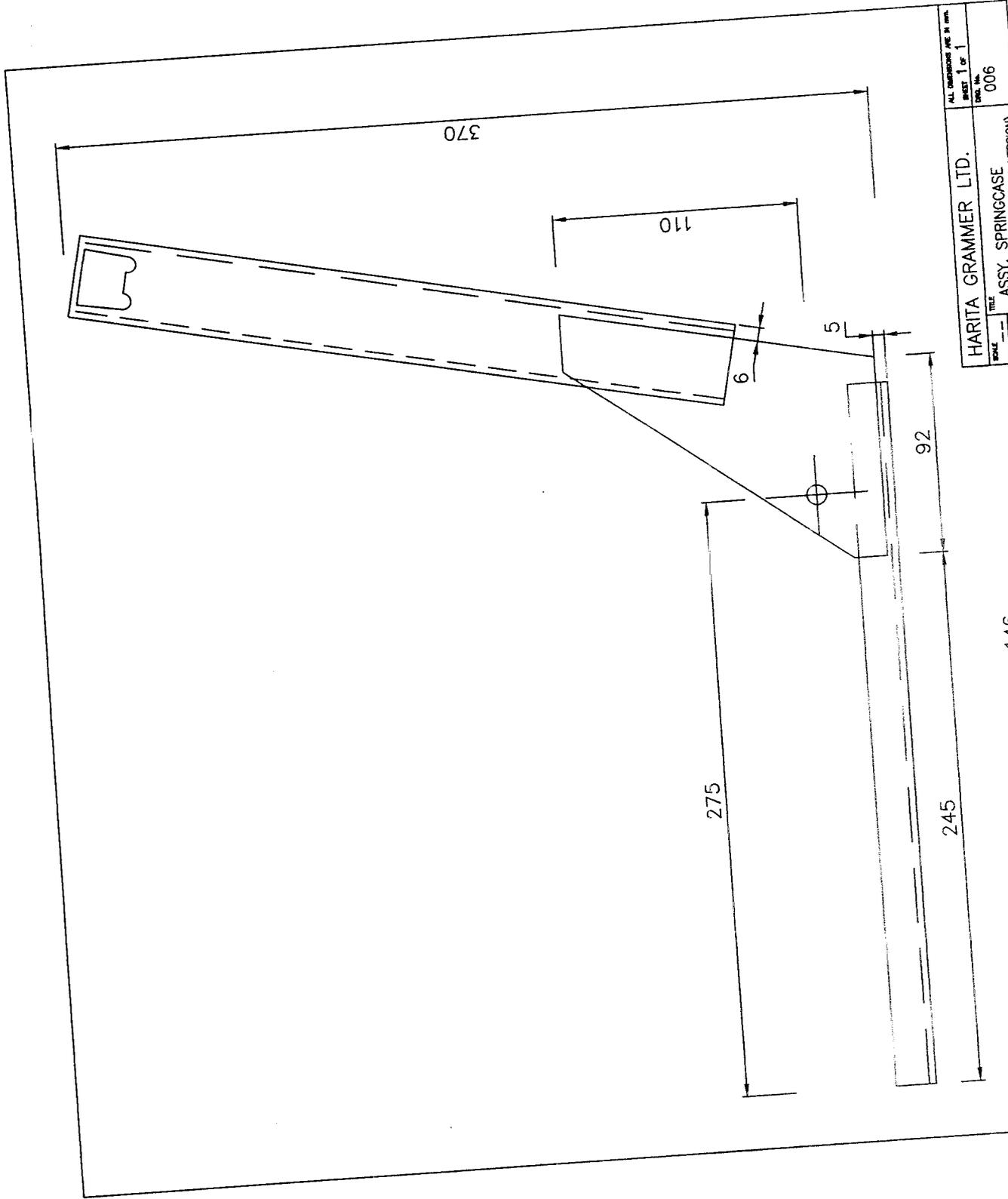
CONNECTING ' L ' ANGLE

REINF. ' L ' ANGLE

SWING ARM MTG. BKT

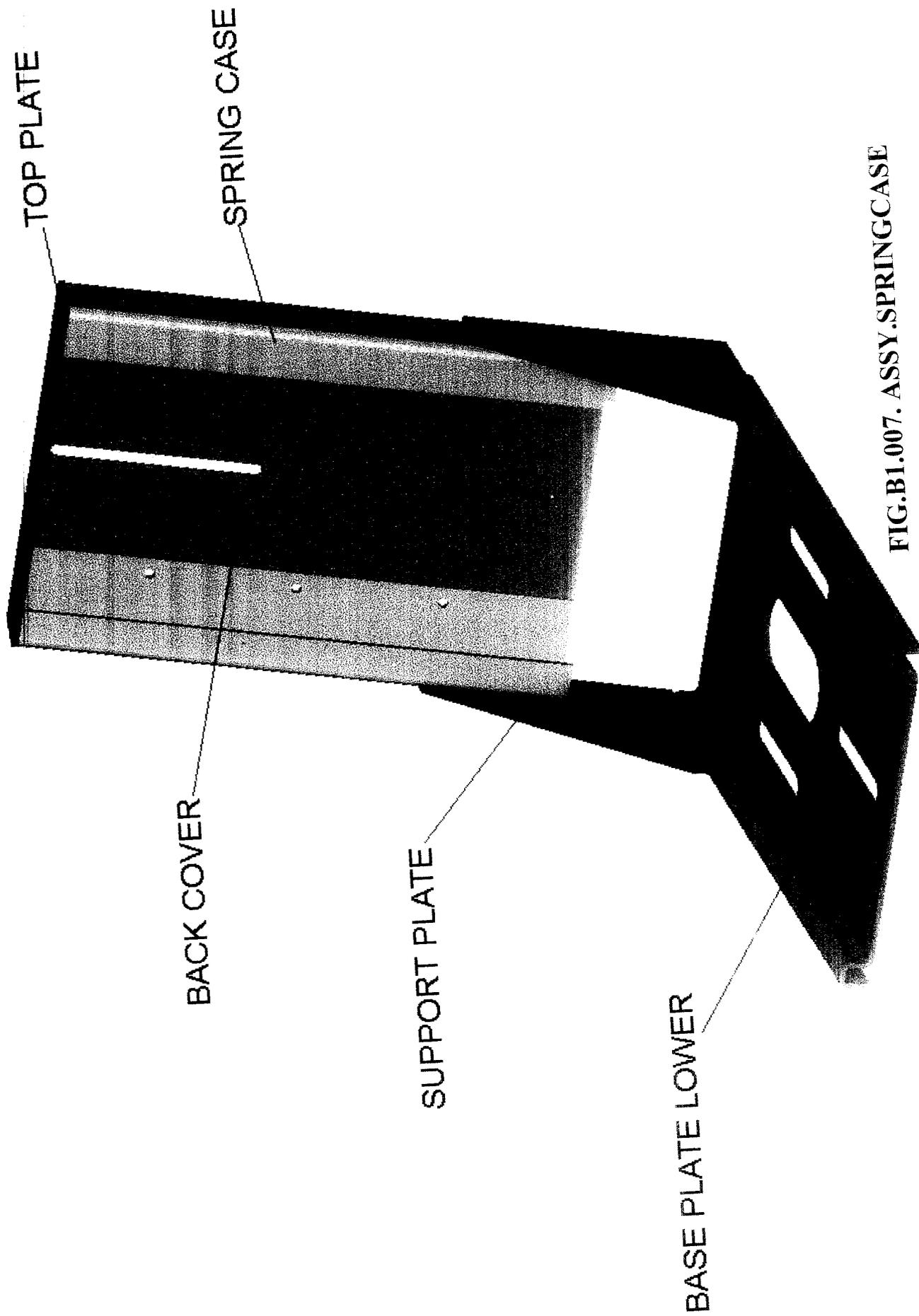
REINF. SQ. TUBE

FIG.B1.005. ASSY. CARRIER PLATE  
( ' L ' ANGLE VERSION )



ALL DIMENSIONS ARE IN MM.	
SHEET 1 OF 1	
DATE	006
HARITA GRAMMER LTD.	
ASSY. SPRINGCASE	
(ROLLER & BACKCOVER VERSION)	

146



TOP PLATE

SPRING CASE

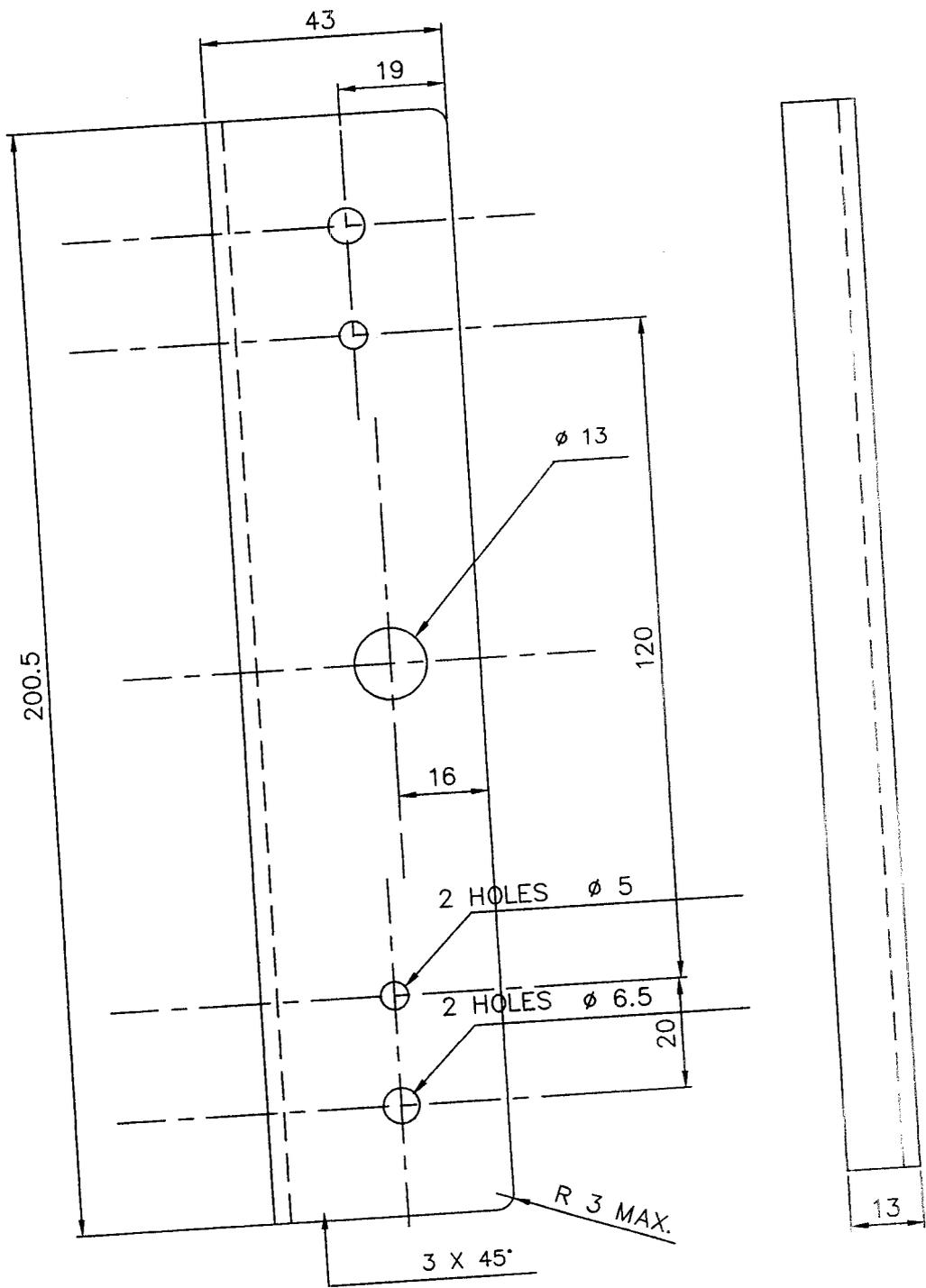
BACK COVER

SUPPORT PLATE

BASE PLATE LOWER

FIG.B1.007. ASSY.SPRINGCASE



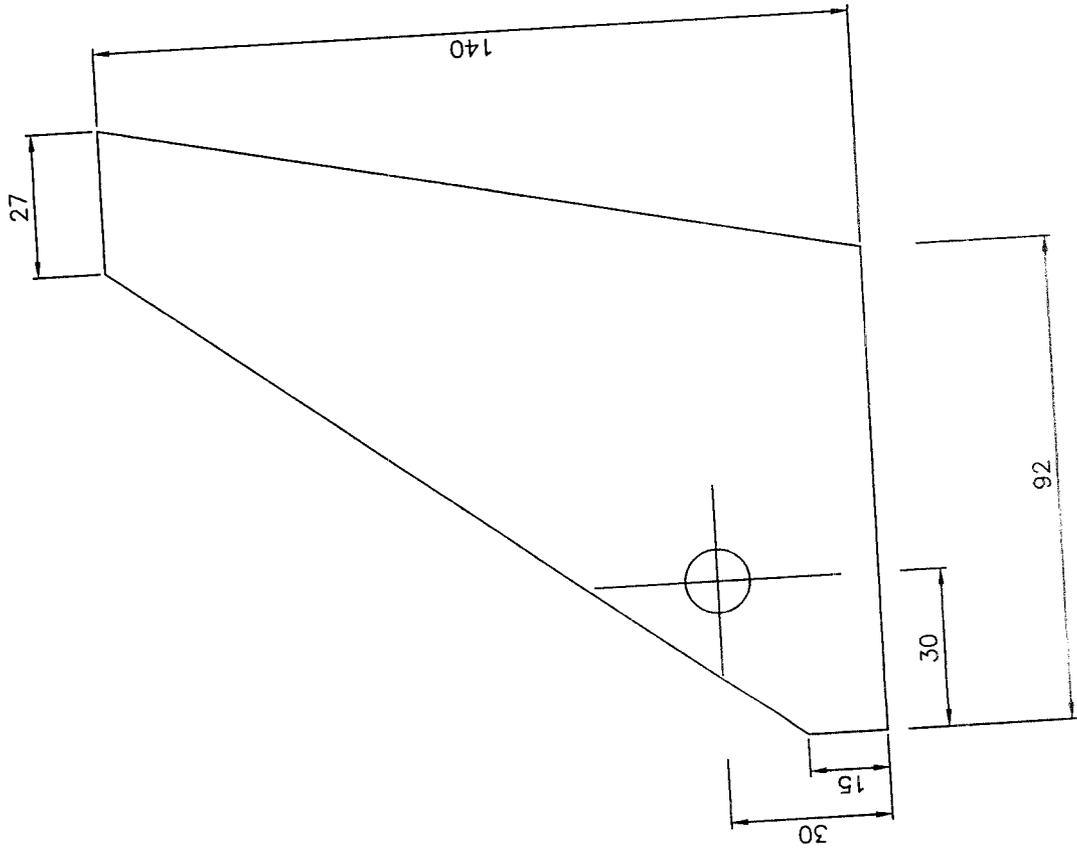


**NOTE:**

THICKNESS  $t=3\text{MM}$ .

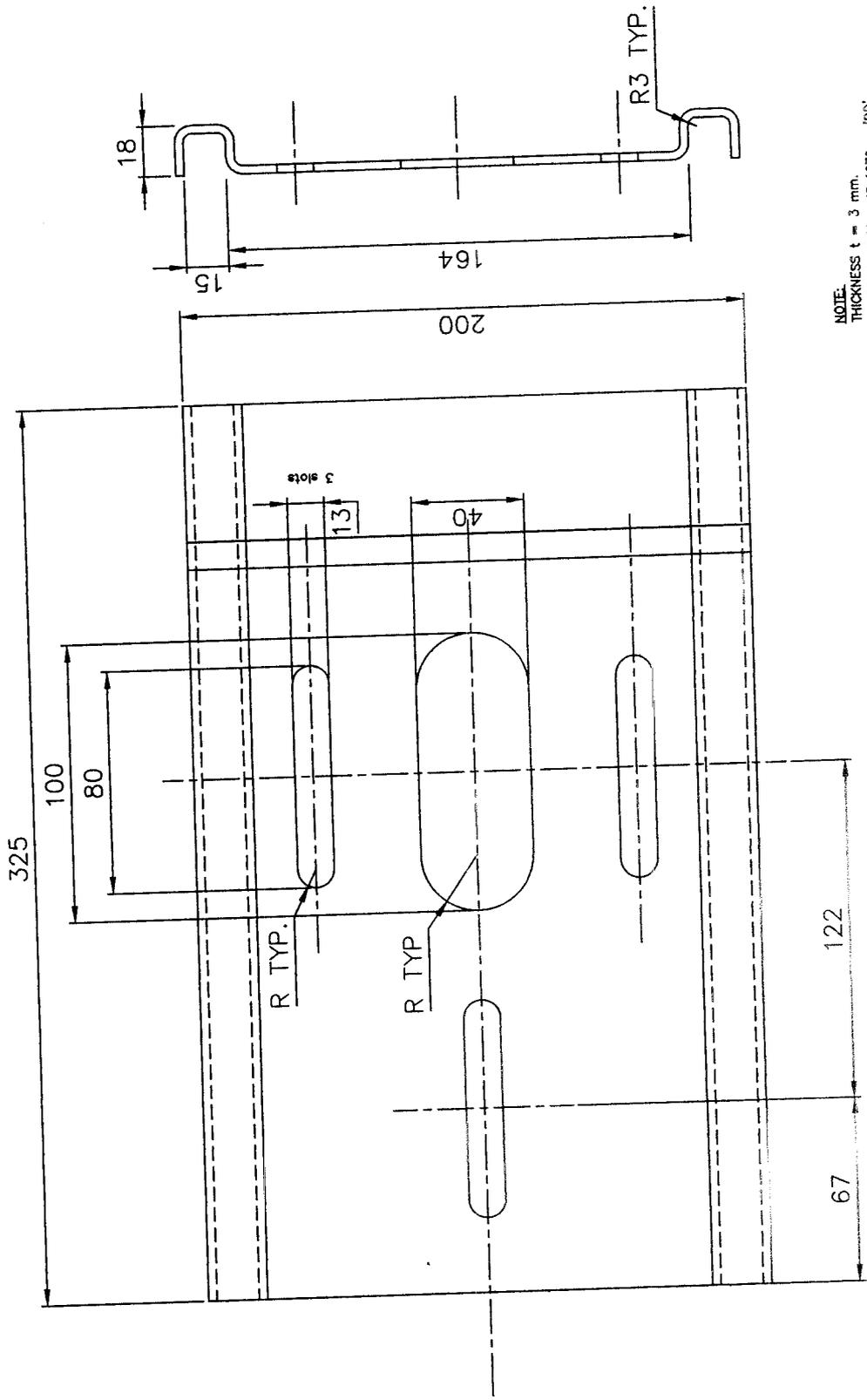
MATERIAL SPEC. : IS 1079 - 'DD'

HARITA GRAMMER LTD.		ALL DIMENSIONS ARE IN mm.
SCALE	TITLE	SHEET 1 OF 1
	SPRINGCASE TOP PLATE (FOR ROLLER VERSION)	DRG. No.
		009



SHEET THICK 4mm.

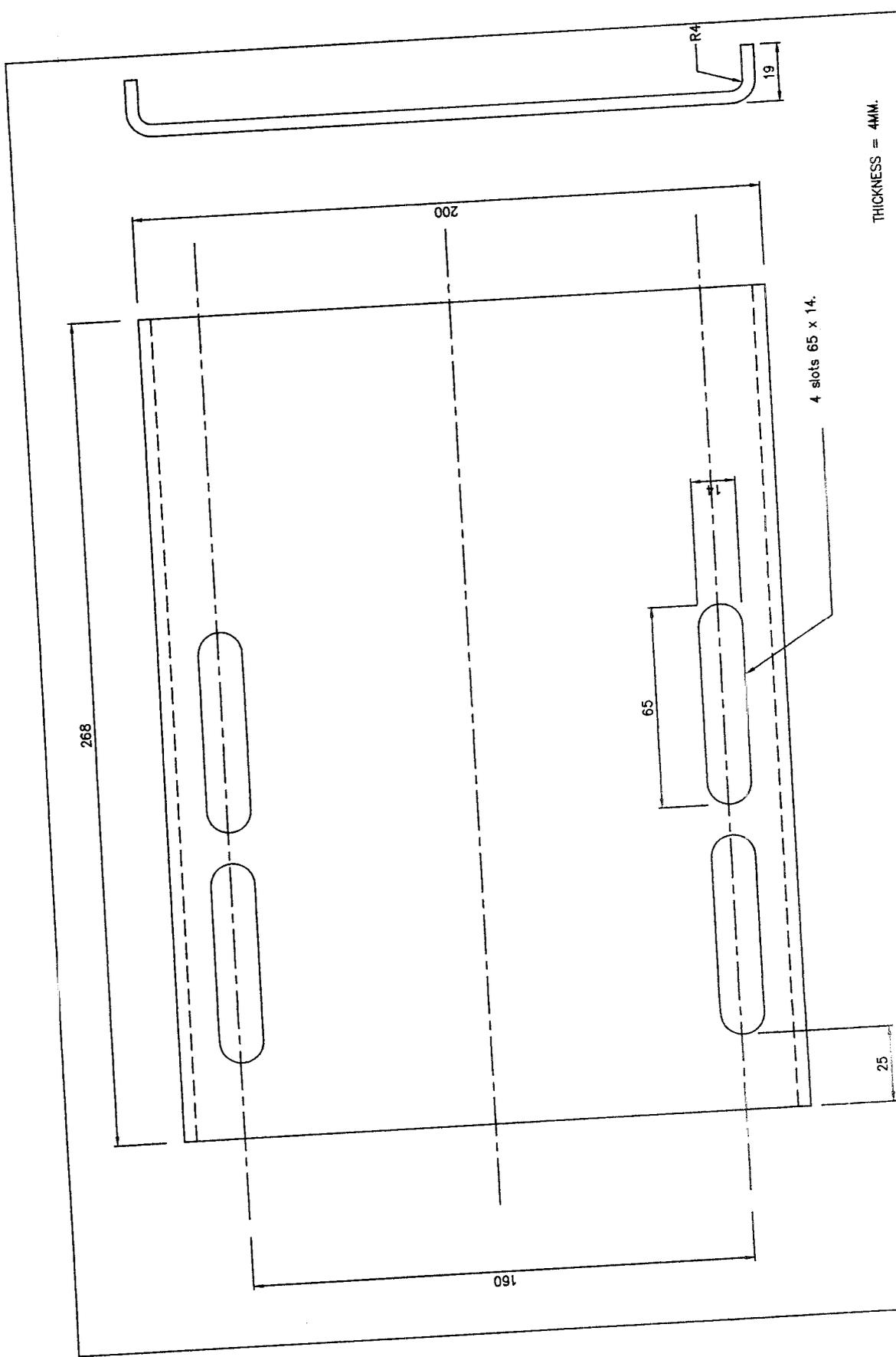
HARITA GRAMMER LTD.		ALL DIMENSIONS ARE IN MM.	
		SHEET 1 OF 1	
		DWD. No. 010	
SCALE	TITLE		
	SUPPORT PLATE		



NOTE:  
 THICKNESS  $t = 3$  mm.  
 MATERIAL SPEC. : IS 1079 ... '00'

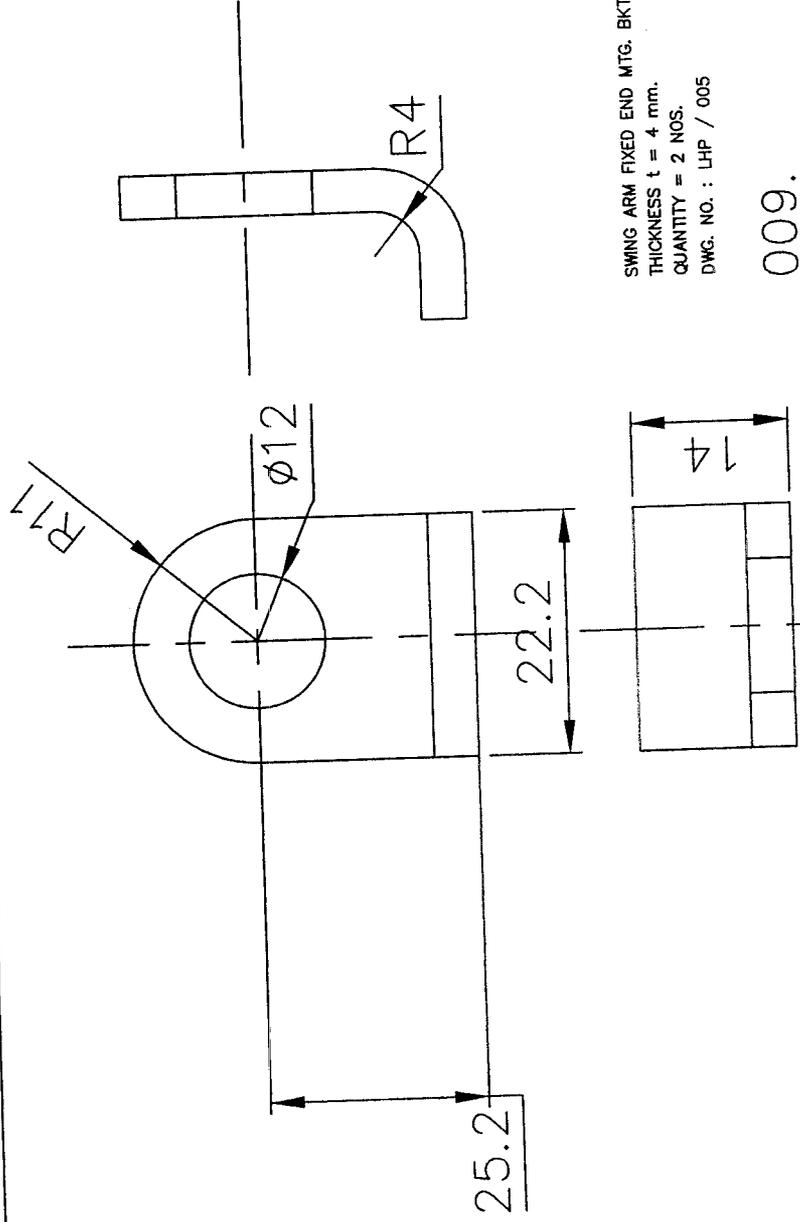
151

HARITA GRAMMER LTD.		Scale: 1:1
BASE PLATE LOWER		011
FOR THE LOW HP		

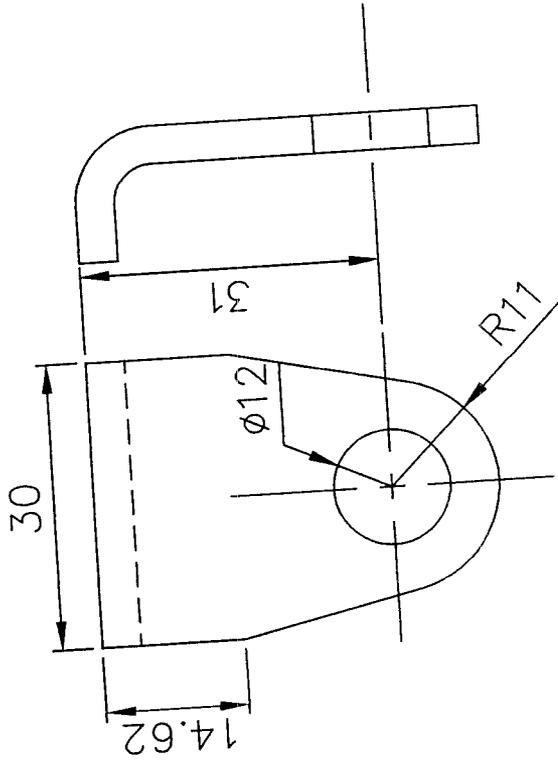


THICKNESS = 4MM.

HARITA GRAMMER LTD.		ALL DIMENSIONS ARE IN (MM).	
TITLE		SHEET 1 OF 1	
BASE PLATE LOWER ( FOR EICHER STANDARD SEAT )		DRG. No. 012	
SCALE			

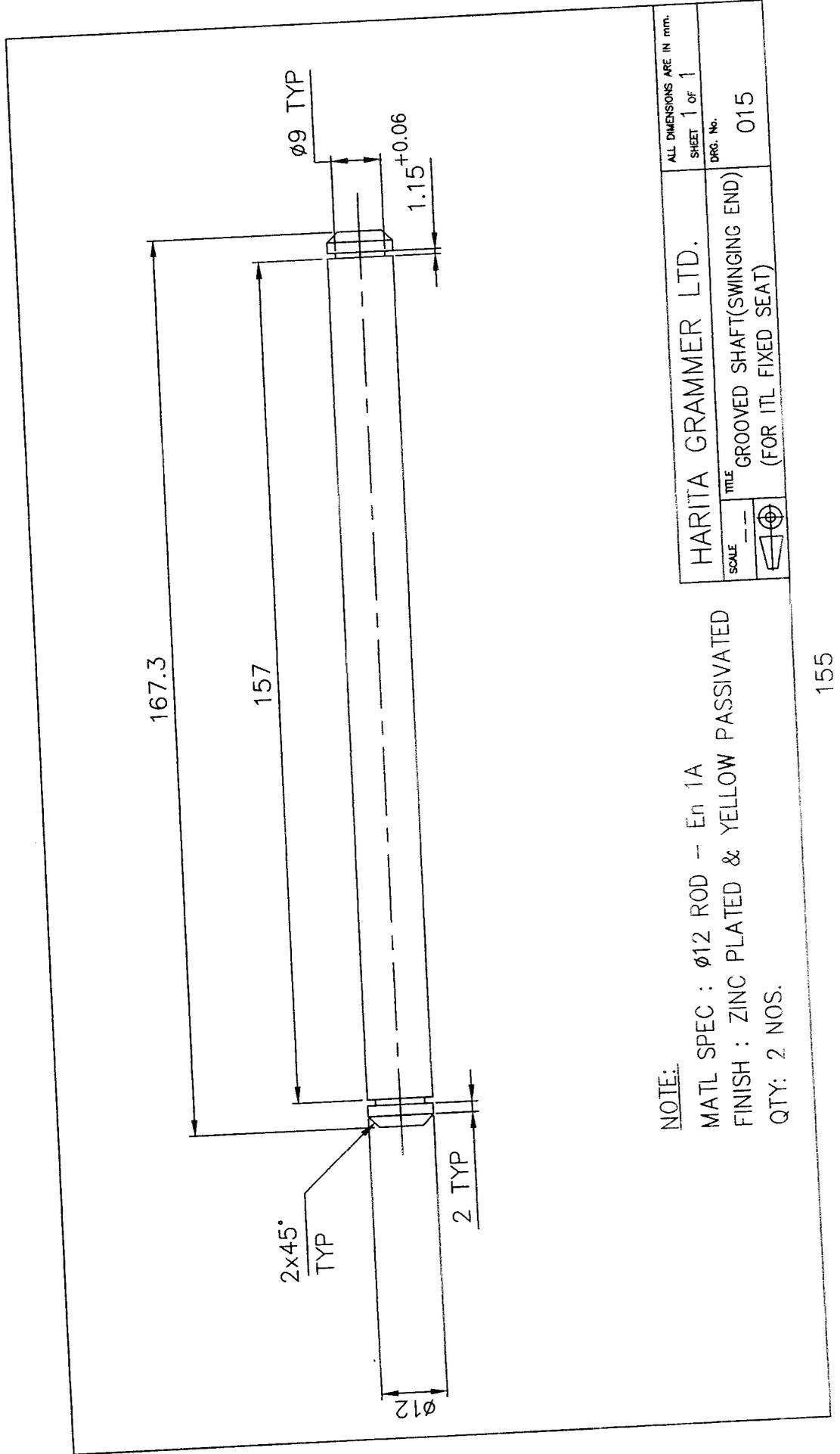


HARITA GRAMMER LTD.		ALL DIMENSIONS ARE IN mm.
TITLE		SHEET 1 OF 1
SCALE	SWING ARM BKT (FIXED END)	DRG. No. 013



NOTE:  
 THICKNESS  $t = 4$  mm.  
 QUANTITY = 2 NOS.

HARITA GRAMMER LTD.		ALL DIMENSIONS ARE IN mm.	
SCALE	TITLE	SHEET	DRG. No.
	SWING ARM BKT (MOVING END)	1 OF 1	014

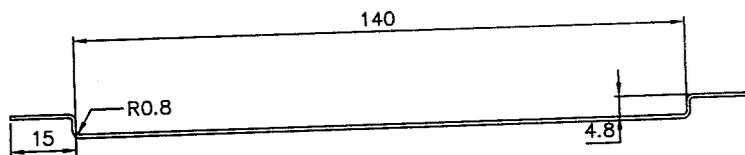
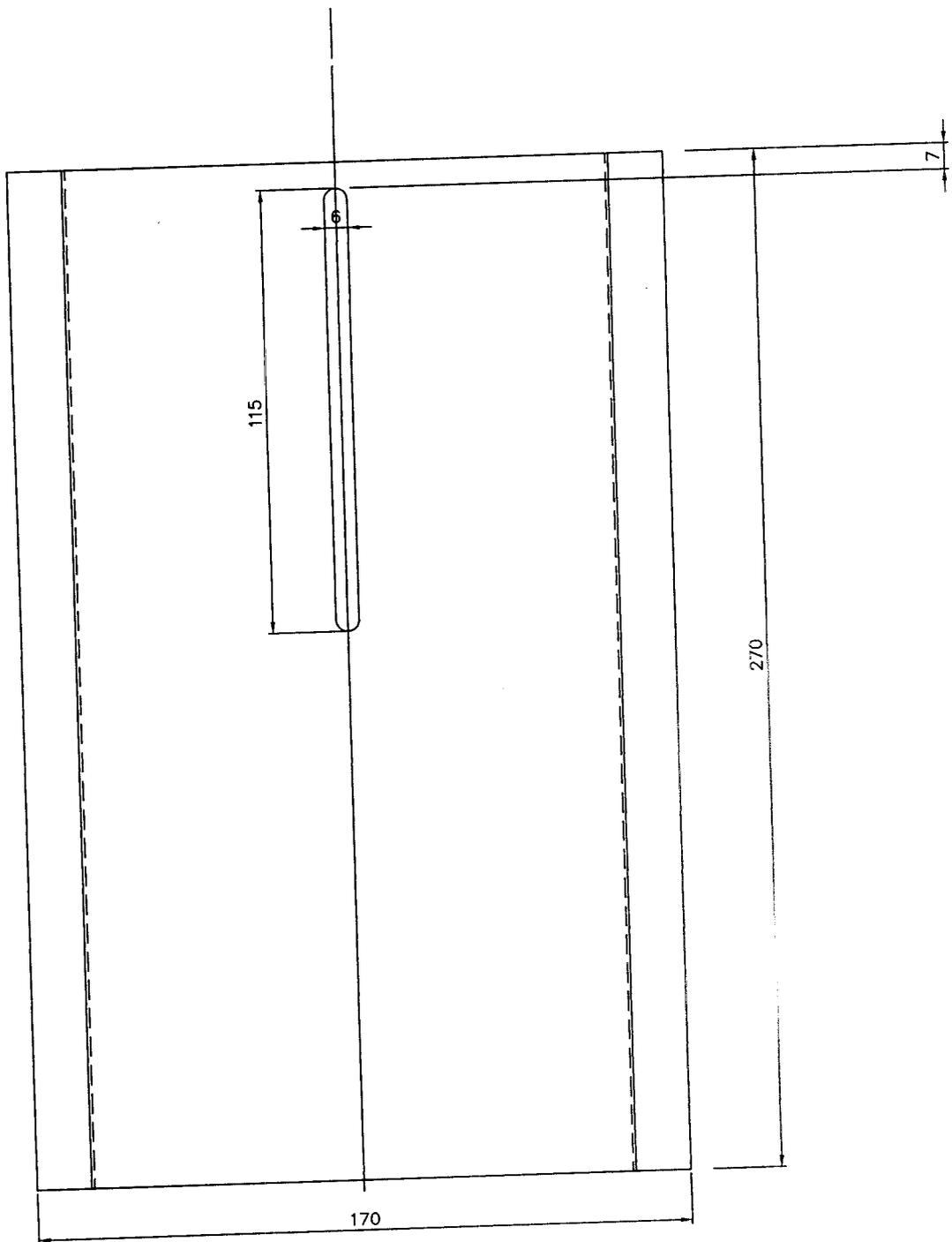


NOTE:

MATL SPEC :  $\phi 12$  ROD -- En 1A

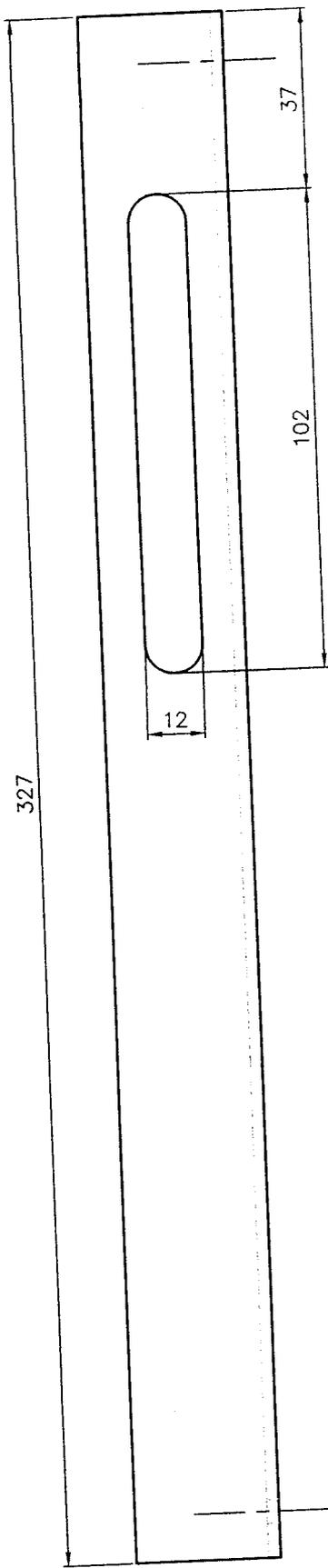
FINISH : ZINC PLATED & YELLOW PASSIVATED

QTY: 2 NOS.

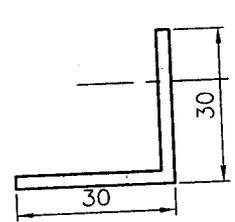
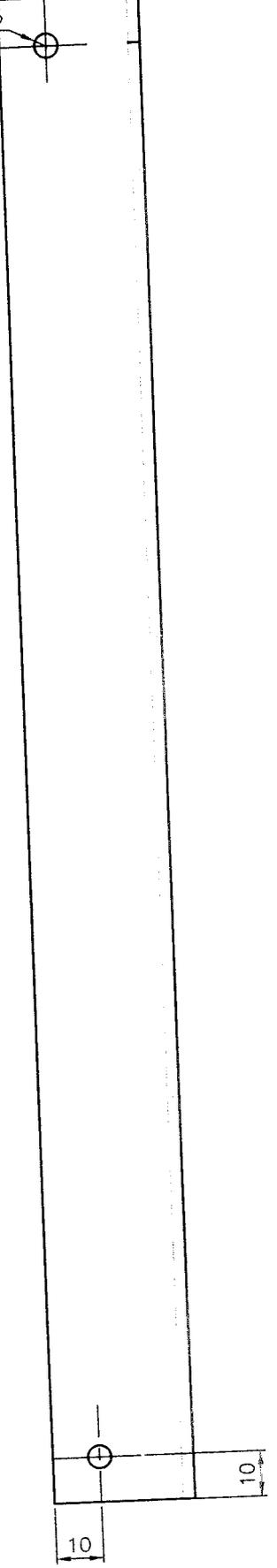


NOTE:  
Thickness  $t=0.8\text{mm}$

HARITA GRAMMER LTD.		ALL DIMENSIONS ARE IN mm.
SCALE	TITLE	SHEET 1 of 1
---	SPRINGCASE BACKCOVER	DRG. No.
		016

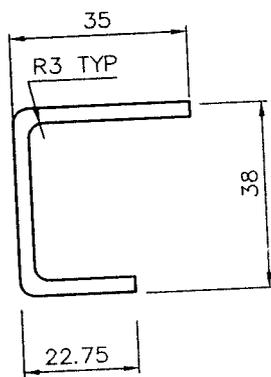
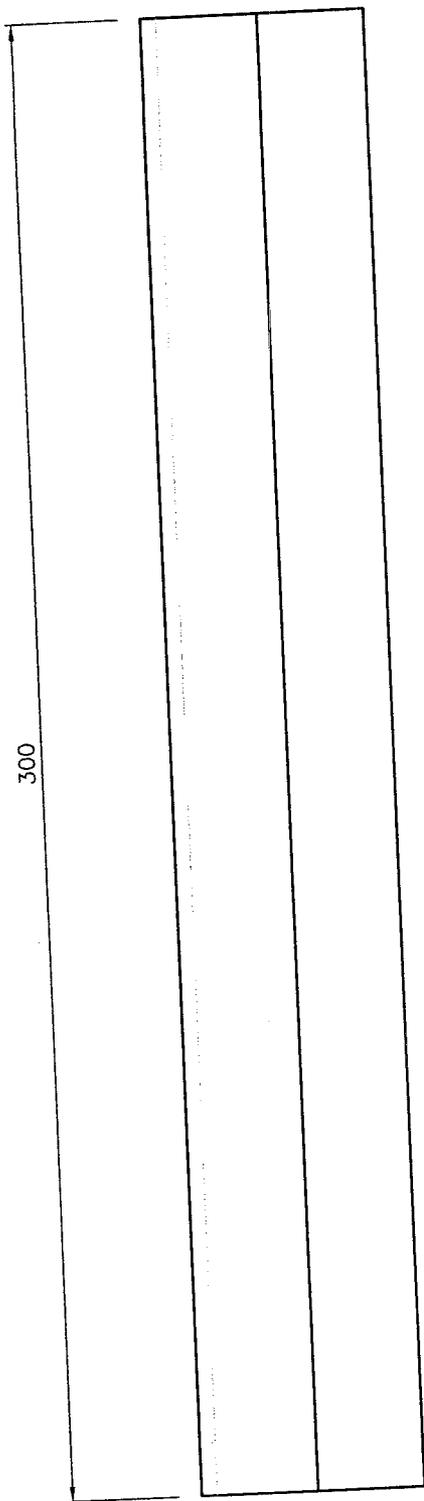


2 HOLES  $\phi 8$

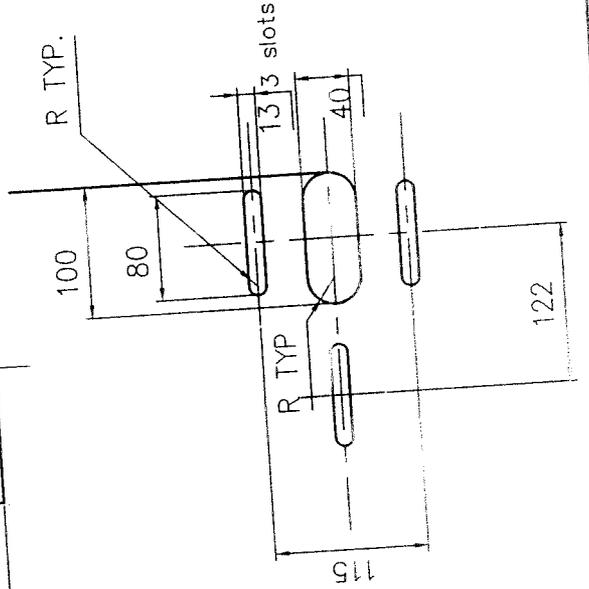
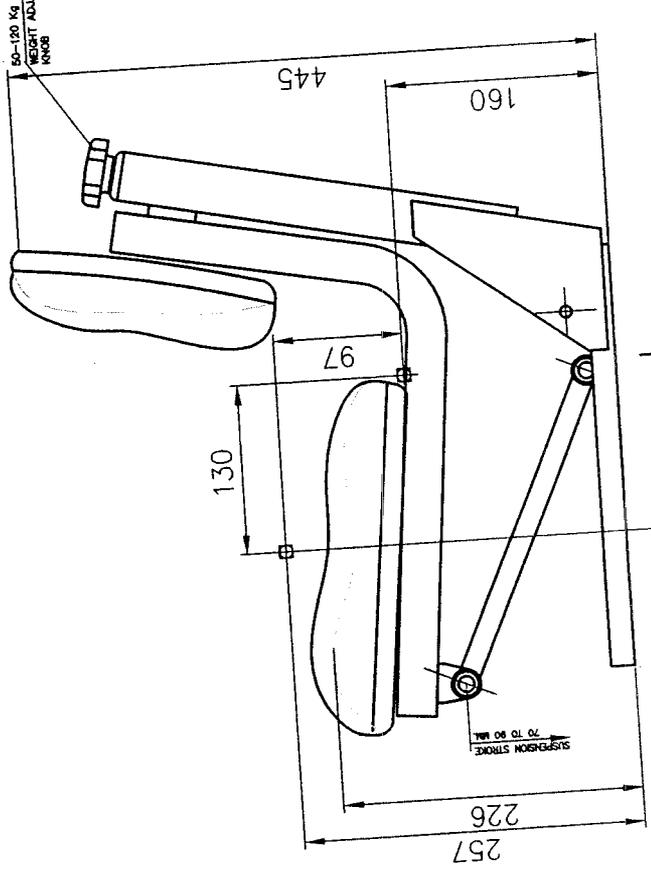
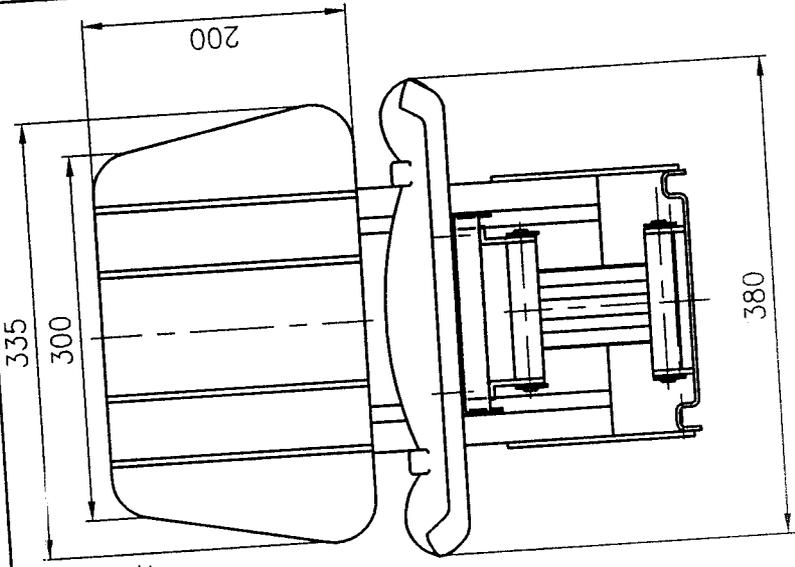


**NOTE:**  
 THICKNESS  $t=2.5\text{MM}$ .  
 QTY = LH/RH

HARITA GRAMMER LTD.		ALL DIMENSIONS ARE IN MM.	
TITLE "L" ANGLE WITH SLOTS (FOR SLOTTED SPRINGCASE)		DRAW. No. 0017	
SCALE	---	SHEET 1 OF 1	



HARITA GRAMMER LTD.		ALL DIMENSIONS ARE IN mm.
SCALE	TITLE	SHEET 1 of 1
	'U' CHANNEL FOR SPRINGCASE WITH ROLLERS)	DRG. No. 018



**NOTE:**

1. FOAM-IN-PLACE PU MOULDED CUSHION FOR SEATBASE & BACKREST IN BLACK COLOUR PVC CLOTH.
2. GENERAL TOLERANCE ON SEAT ASSY +/- 10MM
3. SURFACE TREATMENT OF METAL PARTS: ZINC PHOSPHATED & BLACK POWDER COATED.

ALL DIMENSIONS ARE IN MM.

SHEET 1 OF 1

DRG. No.

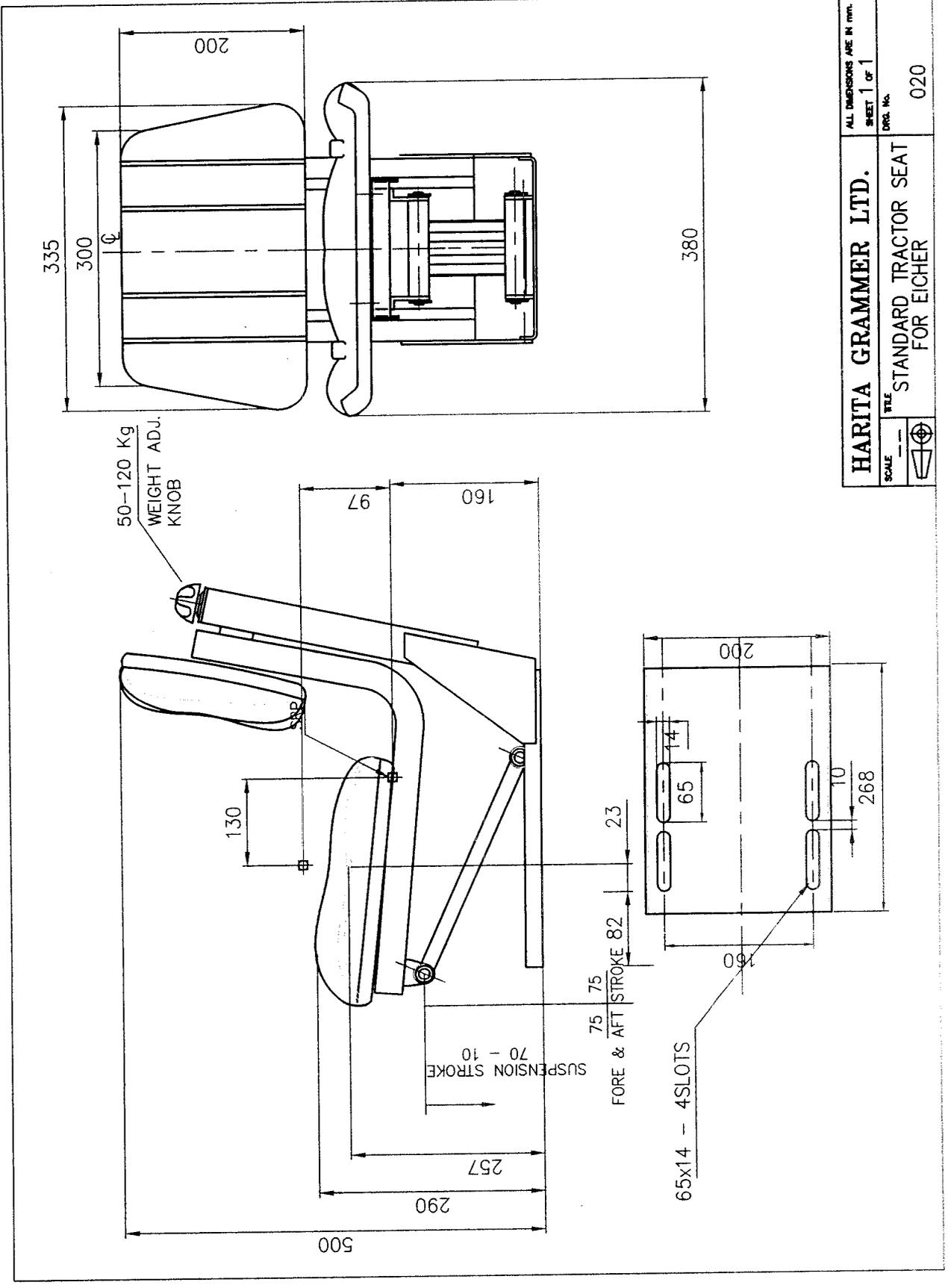
019

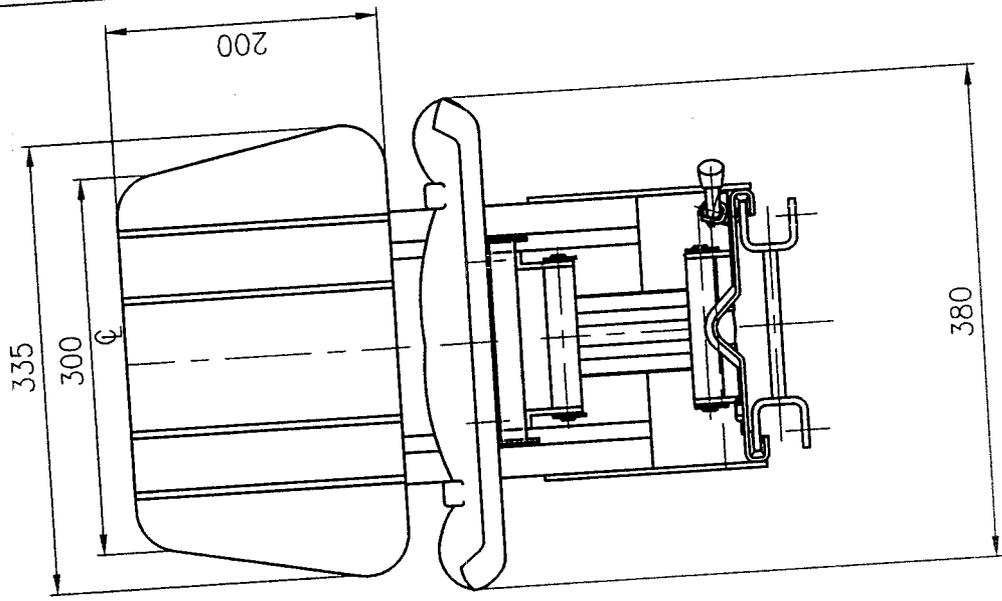
**HARITA GRAMMER LTD.**

**TITLE STANDARD TRACTOR SEAT FOR IFL**

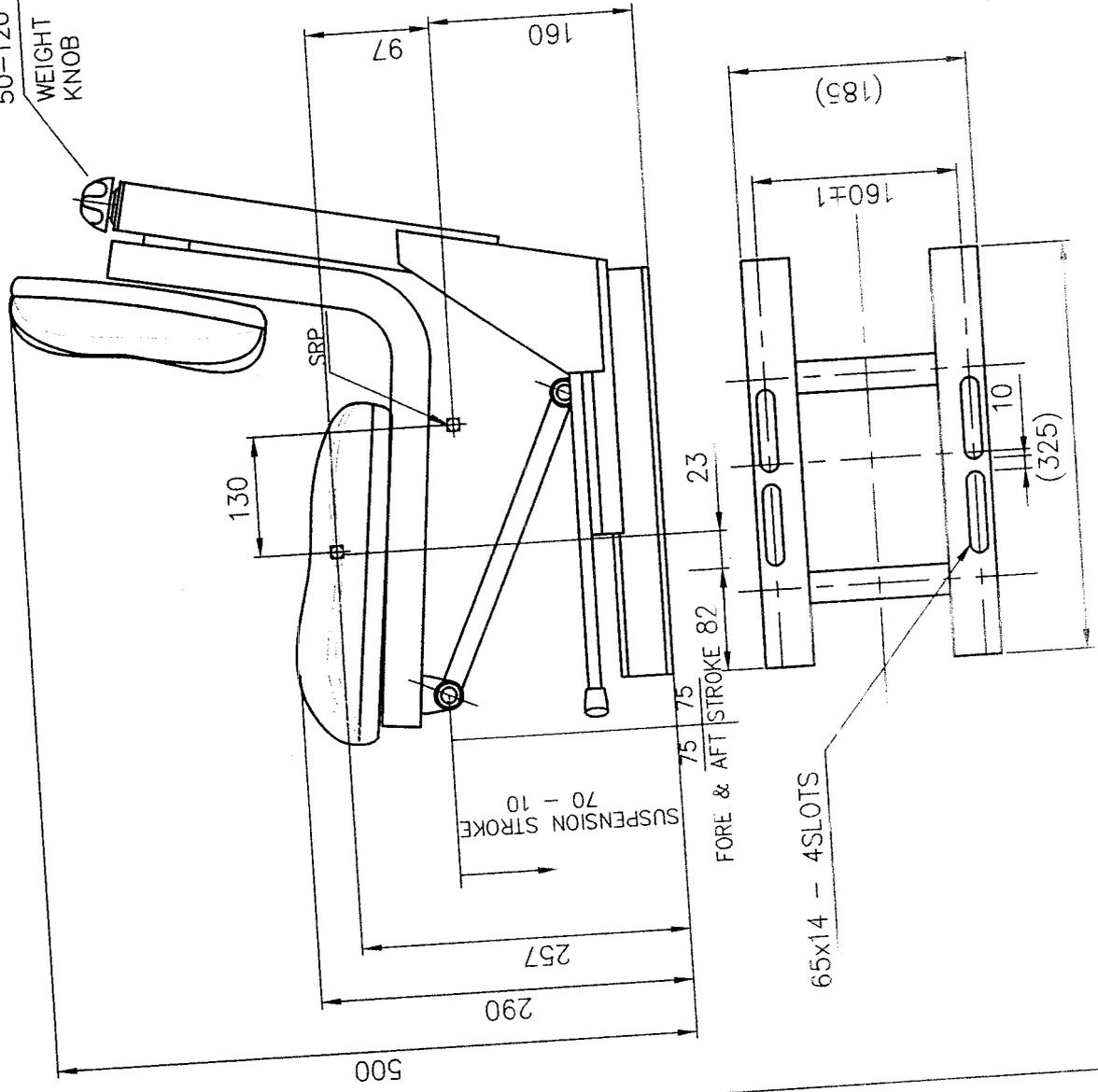
SCALE







50-120 Kg  
WEIGHT ADJ.  
KNOB



ALL DIMENSIONS ARE IN MM.  
SHEET 1 OF 1  
DRG. No. 021

**HARITA GRAMMER LTD.**

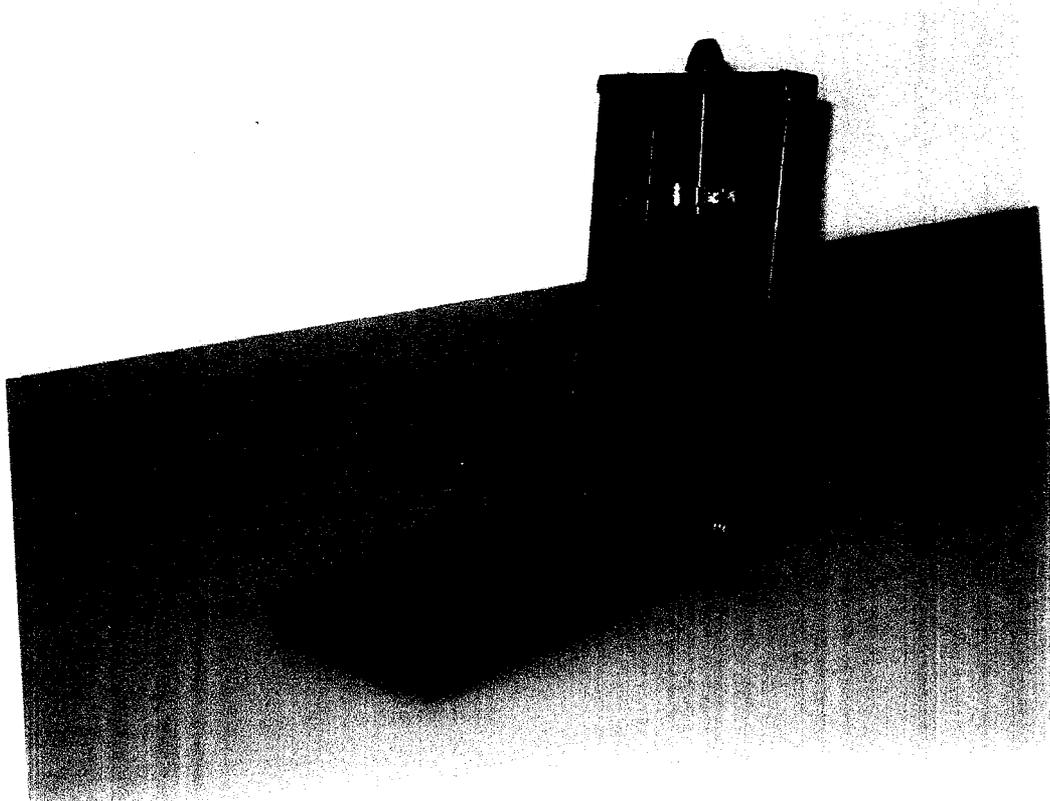
TITLE DELUXE TRACTOR SEAT  
WITH FORE & AFT.FOR EICHER

SCALE

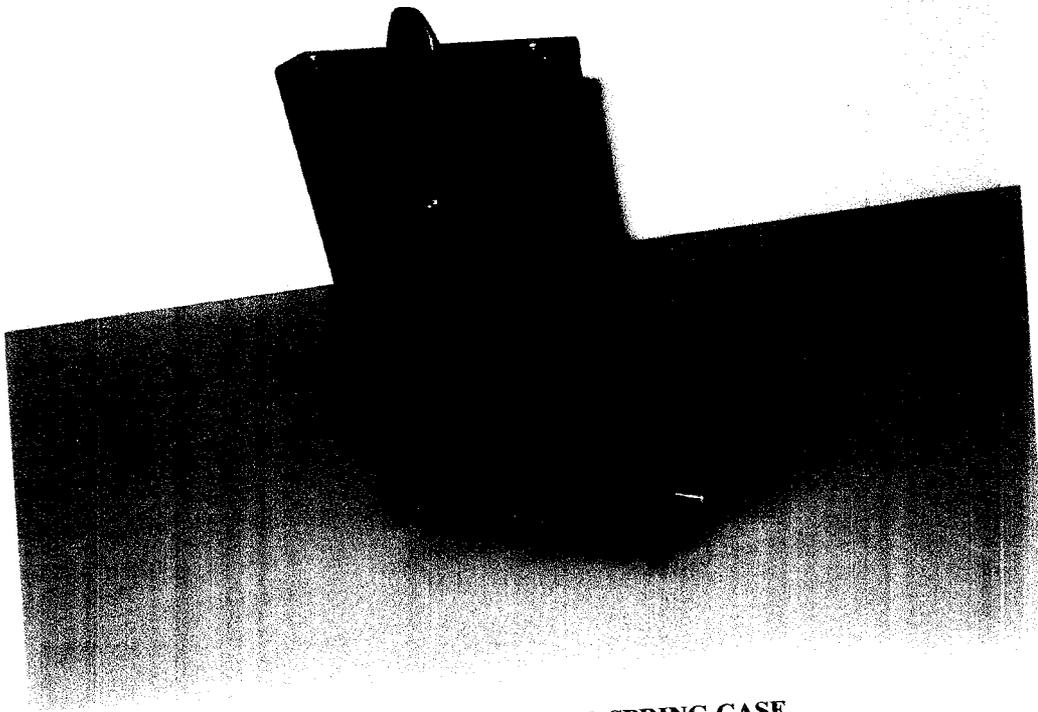
**B2: PHOTOGRAPHS OF  
SAMPLE SEAT**



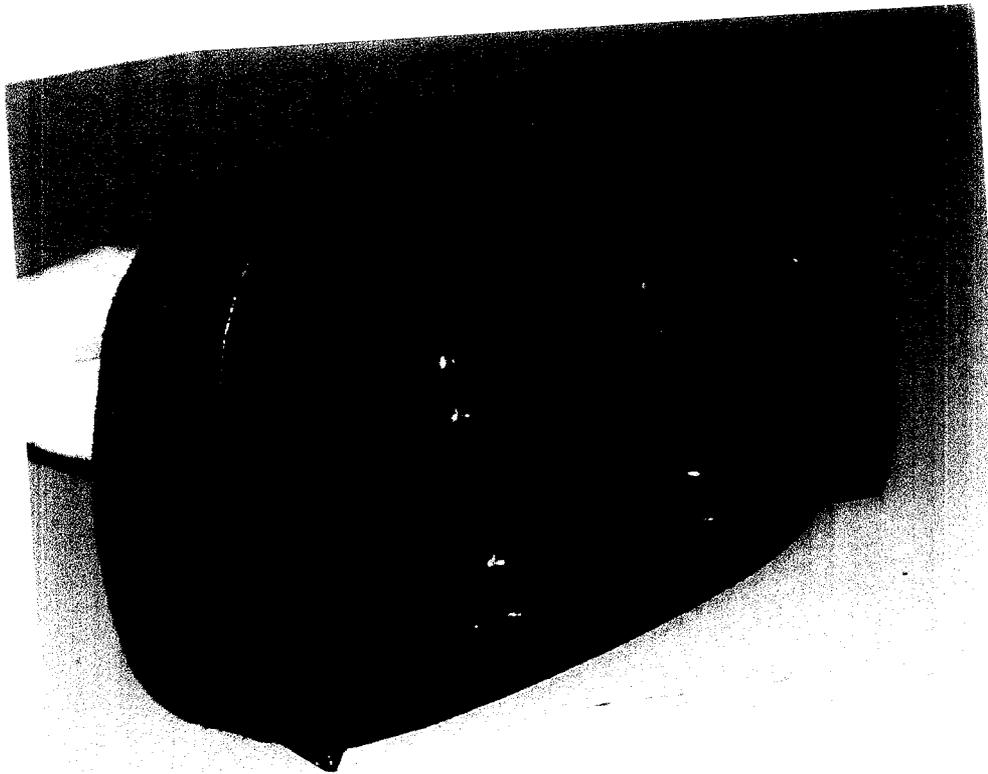
**Fig. B 2.1. ASSY. CARRIER PLATE.**



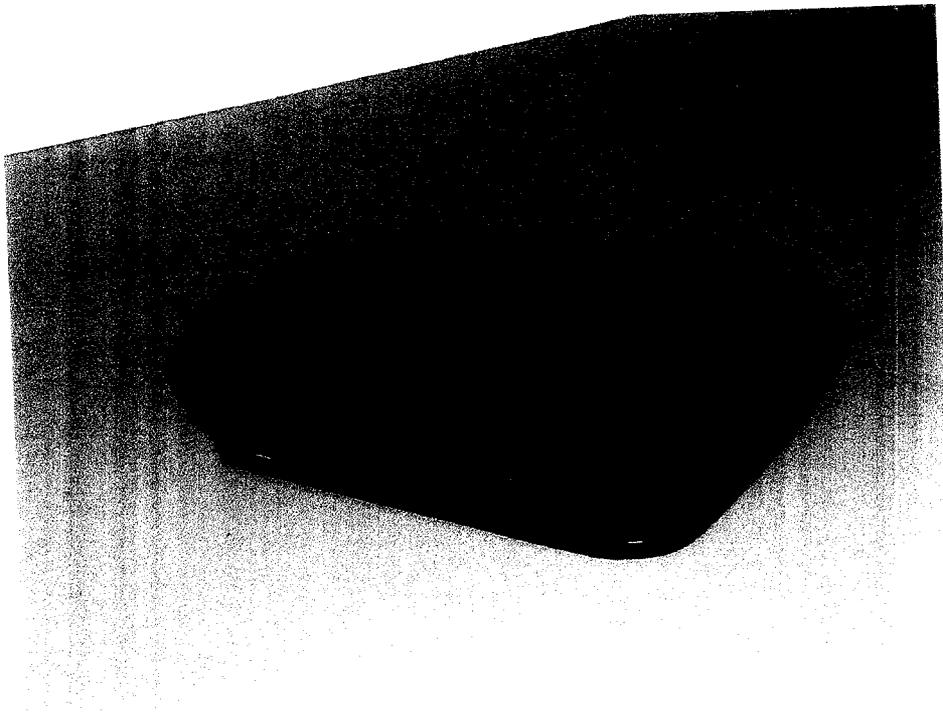
**Fig.B 2.2. ASSY. SPRING CASE.**



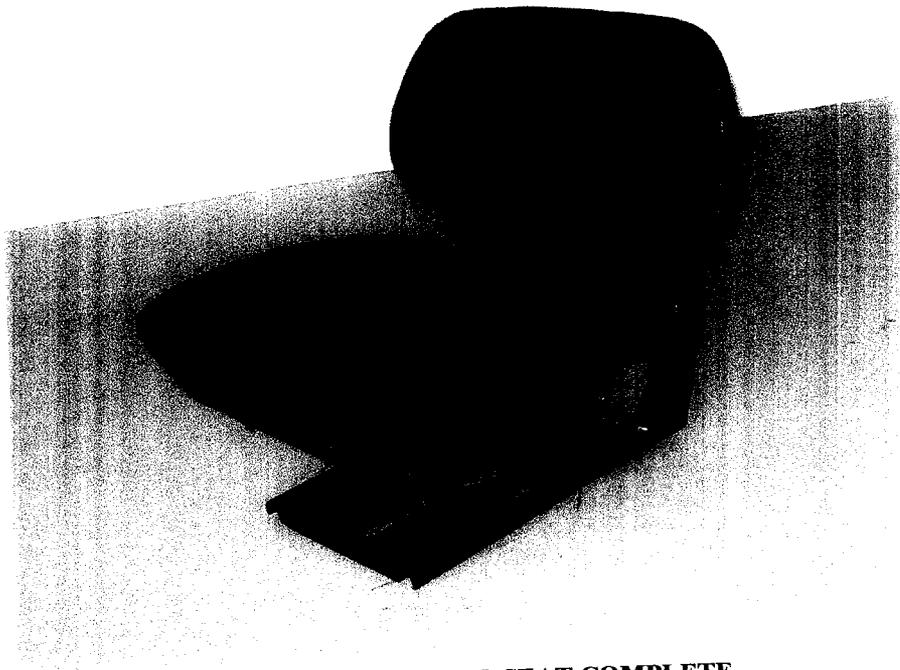
**Fig. B 2.3. ASSY. SPRING CASE.**



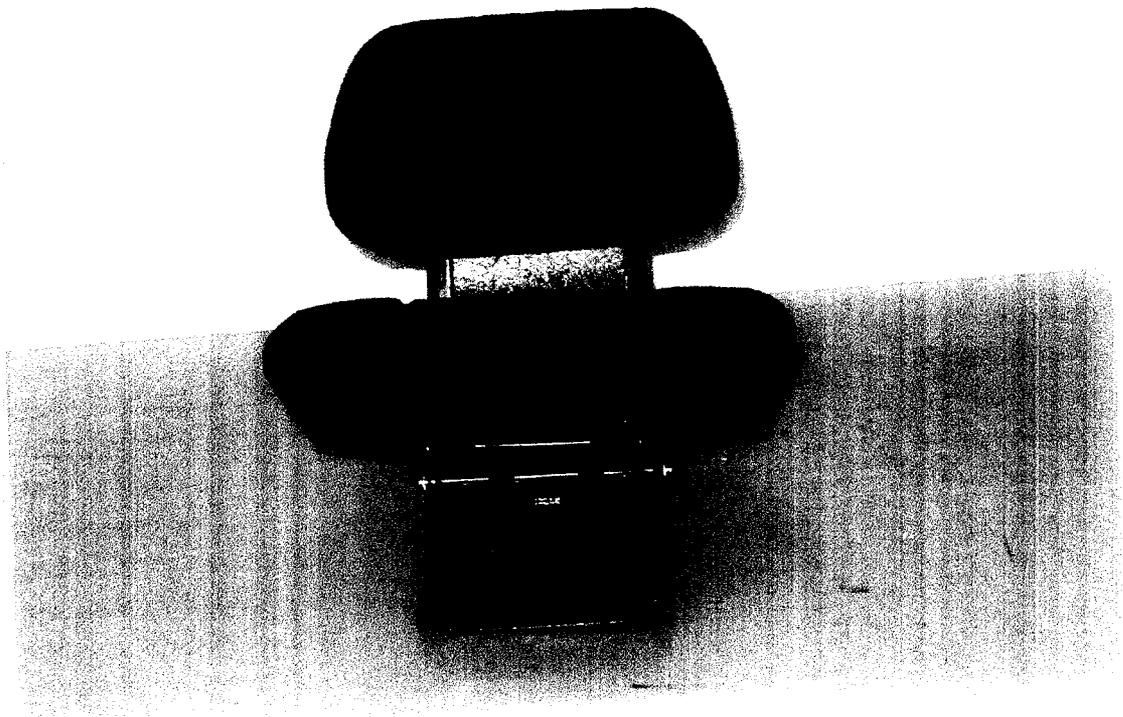
**Fig. B 2.4. ASSY. BACKREST.**



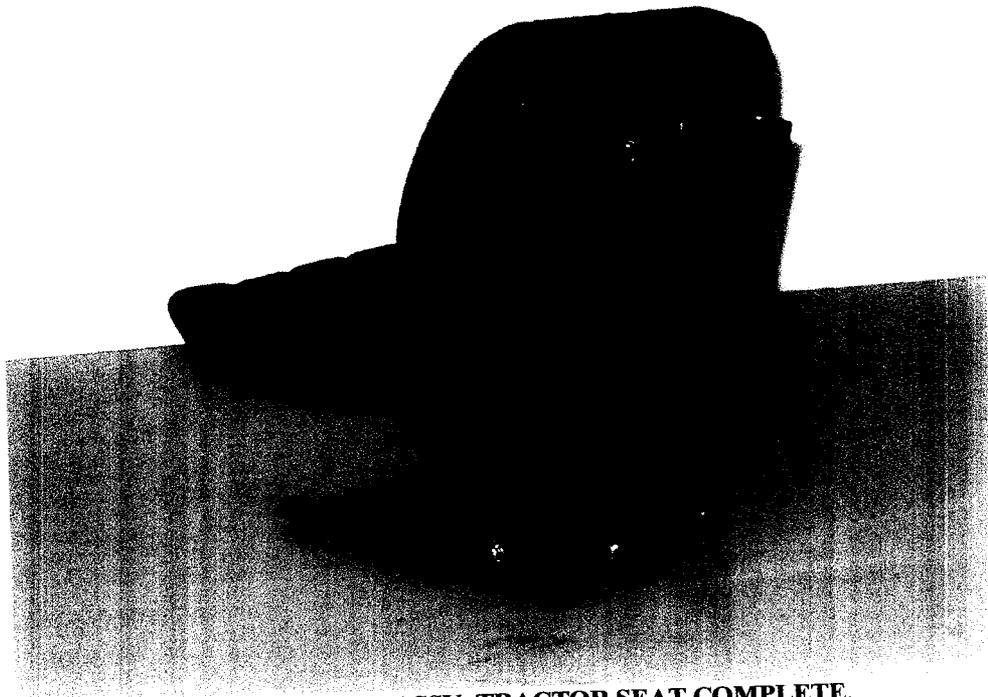
**Fig. B 2.5. ASSY. SEATBASE.**



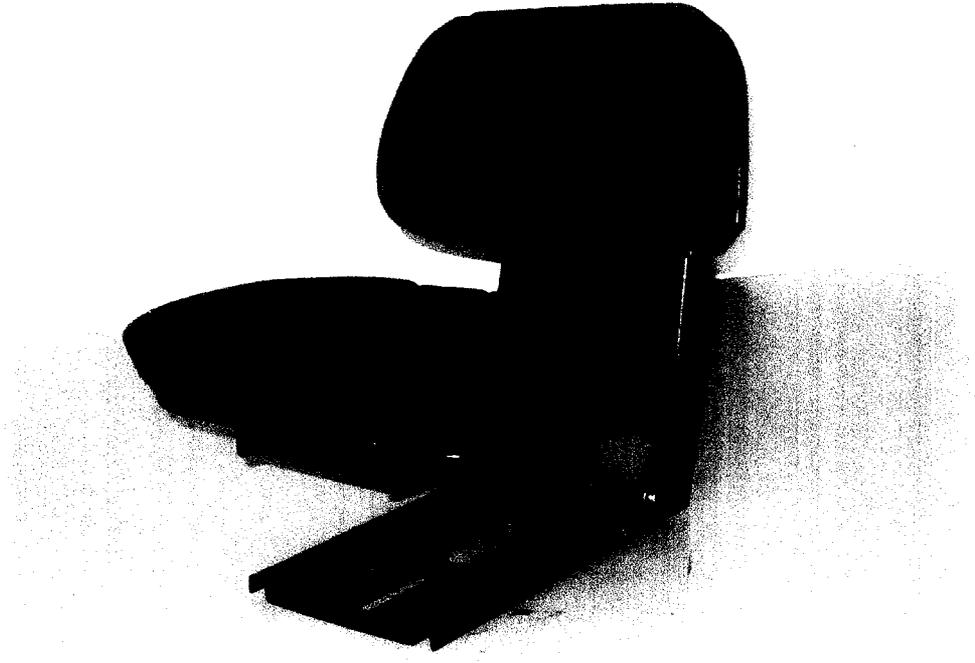
**Fig.B 2.6. ASSY. TRACTOR SEAT COMPLETE.**



**Fig.B 2.7. ASSY. TRACTOR SEAT COMPLETE.**



**Fig.B 2.8. ASSY. TRACTOR SEAT COMPLETE.**



**Fig. B2.9. ASSY. TRACTOR SEAT COMPLETE.**

# **B3: TEST REPORT 1**

# TEST REPORT

1. OBJECTIVE OF TEST : To assess the durability of the structure .

2. ITEM UNDER TEST : PART No : -

DESCRIPTION : Low hp Tractor Seat .

3. No. OF ITEMS UNDER TEST : 1

4. DETAILS OF SPECIFICATION :

CHECK FOR

a) cycles : 600  
b) Direct loading with  
Pneumatic cylinders.

- Structural failures

5. TEST EQUIPMENT USED : Universal test rig / vertical overload & lateral load

6. FREQUENCY / CYCLING (IF VARIABLE) : As per test spec.

7. LOADING CONDITION : -

8. STARTED DATE & TIME : 29/10/00 @ 10.00 a.m.

9. ACTUAL DATE & TIME OF COMPLETION : 31/10/00 @ 9.00 a.m.

10. TEST CONDUCTED BY :

FOLLOWED BY (2nd SHIFT) :

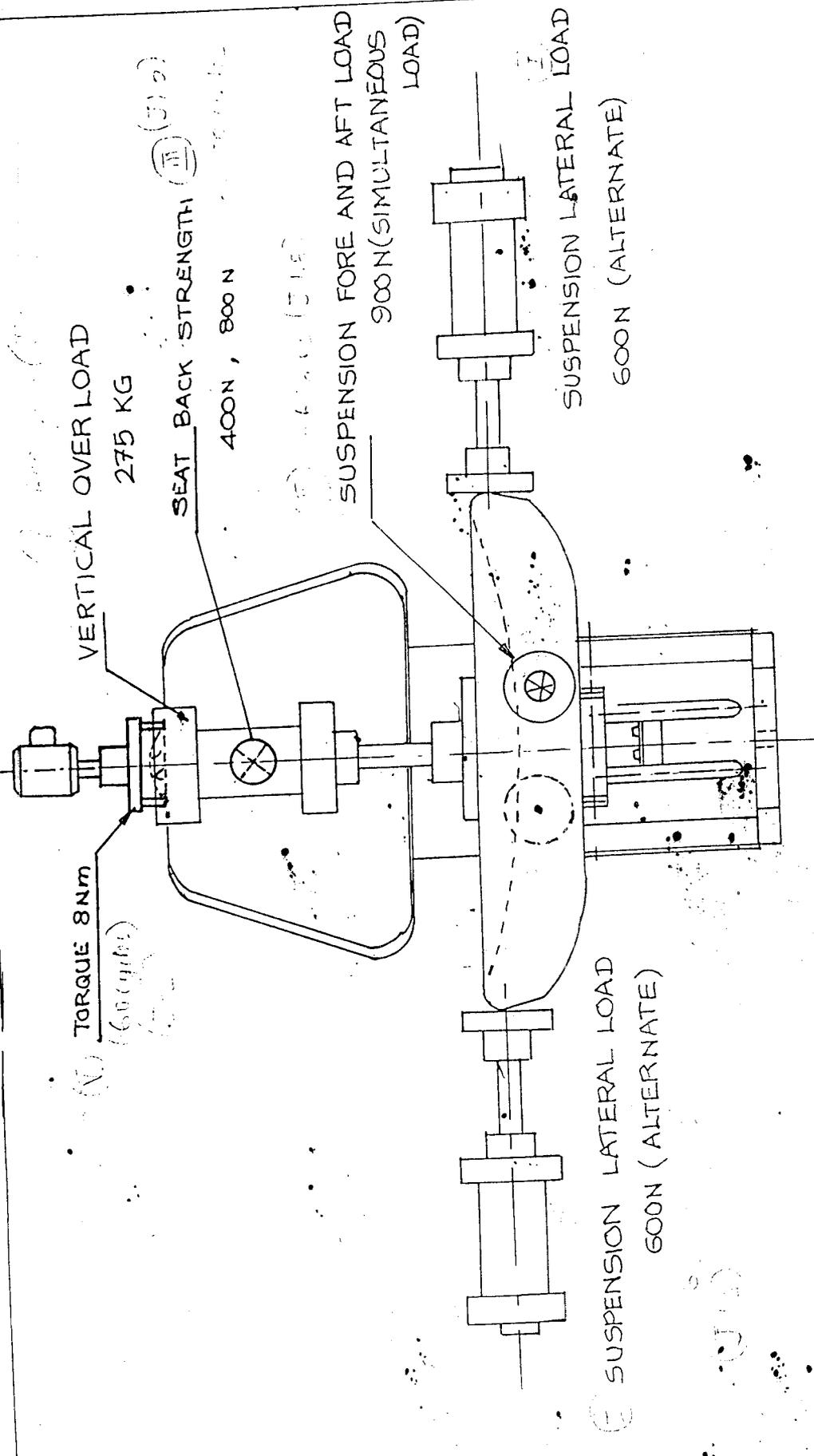
} R & D Prototype.

11. RESULT: No failures observed . Seat junctions normally .



TESTER SIGNATURE

R.V. Dharmadaran  
APPROVED BY (R & D)



TORQUE 8 Nm  
(60 g/hrs)

VERTICAL OVERLOAD  
275 KG

SEAT BACK STRENGTH  
400N, 800 N

SUSPENSION FORE AND AFT LOAD  
900N (SIMULTANEOUS  
LOAD)

SUSPENSION LATERAL LOAD  
600N (ALTERNATE)

SUSPENSION LATERAL LOAD  
600N (ALTERNATE)

# **B4: TEST REPORT 2**

1. OBJECTIVE OF TEST : To access the Seat for wear on rollers, shock absorbers, springs + other moving parts

2. ITEM UNDER TEST : PART No : — DESCRIPTION : Low hp Tractor Seat

3. No. OF ITEMS UNDER TEST : 1

4. DETAILS OF SPECIFICATION :

TEST SPECIFICATION	CHECK FOR
<p>a) Frequency : 2 Hz. cycles : 6,00,000 weight on s/B : 90 kg</p>	<p>- Structural failures - Functioning of suspension mechanism</p>

5. TEST EQUIPMENT USED : Vibration test rig

6. FREQUENCY / CYCLING (IF VARIABLE) : As per test spec.

7. LOADING CONDITION : As per enclosed sketch

8. STARTED DATE & TIME : 29.10.00 @ 9.00 a.m

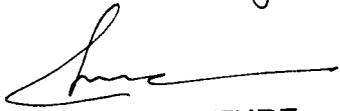
9. ACTUAL DATE & TIME OF COMPLETION : 5.10.00 @ 5.00 P.m

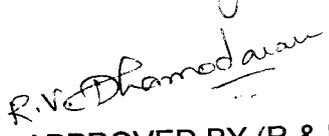
10. TEST CONDUCTED BY :

FOLLOWED BY (2nd SHIFT) :

} R & D Prototype.

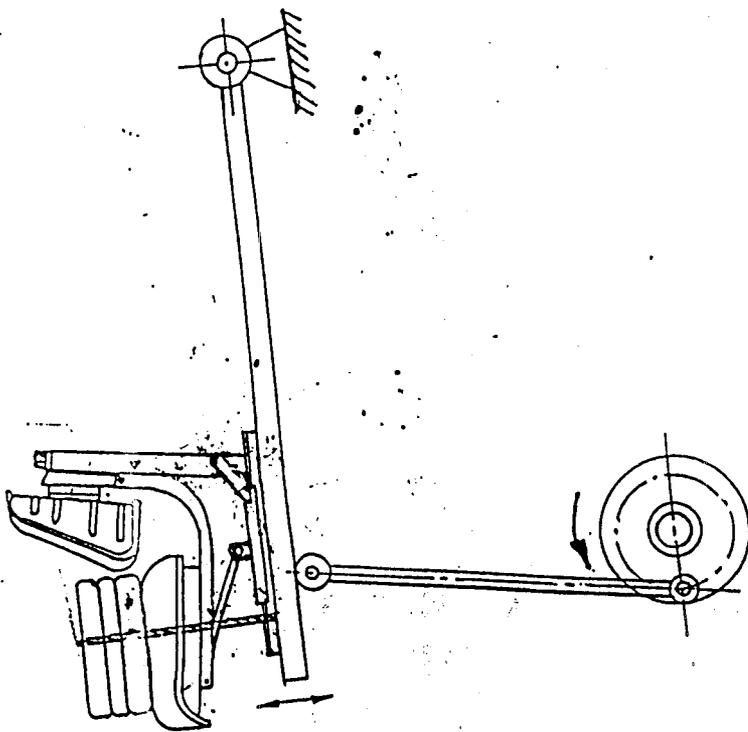
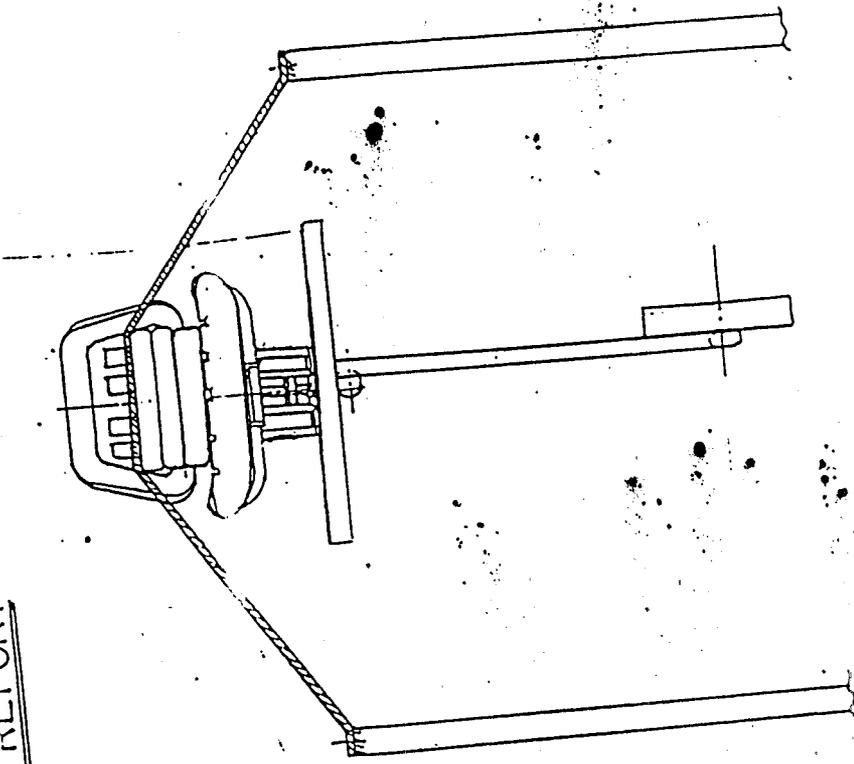
11. RESULT: No failures observed. Seat functions normally.

  
TESTER SIGNATURE

  
APPROVED BY (R & D)

HARITA GRAMMER LTD

ENCLOSURE TO VIBRATION TEST REPORT



**B5: DESIGN FAILURE MODE  
AND  
EFFECTS ANALYSIS**

HGL

APPENDIX B5

F/R&D/010/02

POTENTIAL  
FAILURE MODE AND EFFECT ANALYSIS  
[DESIGN FMEA]

DF/01

FMEA Number

Page 1 of 1

Prepared by LSP

FMEA Date(orig) 04.12.2000 (Rev)

Design Responsibility R&D

Key date 02.12.2000

ASSY. SEAT COMP.

Model year(s)/Vehicle(s) 2000/ ITL LOW HP

Core Team LSP/IJN

Core Team LSP/IJN

System	Function	Potential Failure Mode	Potential Effect(s) of Failure	Severity	Causes	Potential Cause(s) Mechanism(s) of failure	Occurrence	Current Design Controls	Detection	RPN	Recommended Action(s)	Responsibility & target Completion Date	Action Results			
													Actions Taken	Severity	Occurrence	RPN
* Maintain correct SIP	Seat Assy.	Low/High SIP	Poor accessibility of seat controls lead to discomfort to the driver.	5		Inadequate design verification.	3	* CAD drg verification *Fitment trials.	3	45	None.					
*Assy. Spring case.		Unable to assemble shock absorber.	Leads to: * Assy. Rejection *Line stoppage	5		Inadequate clearance between s/case & baseplate.	2	*Design Reviews. *Cad drg. Verification.	2	20	None					

\* Criteria for reducing the ranking

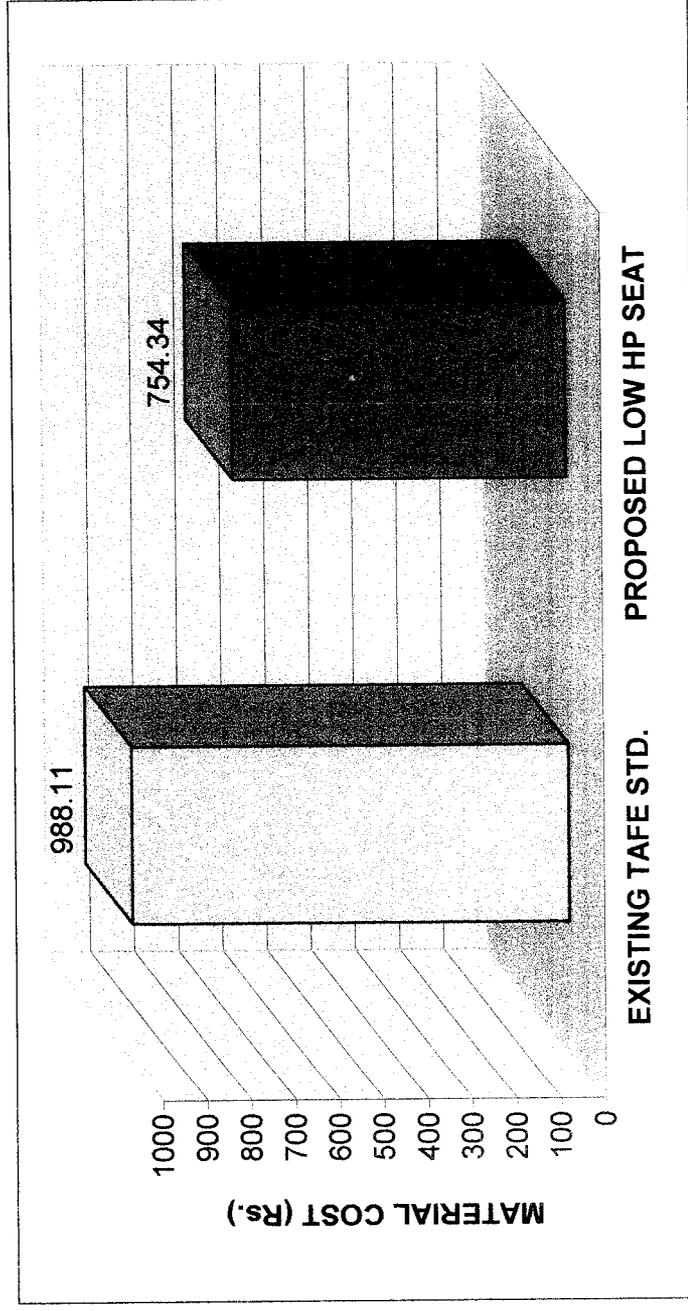
- An increase in design validation / verification actions could result in a reduction in detection ranking only
- A reduction in occurrence ranking can be effected only by removing or controlling one or more of the causes / mechanisms of the failure mode through design revision
- Only a design revision can bring about a reduction in severity ranking

# **APPENDIX – C**

## **RESULTS**

**COMPARISON OF PROPOSED DESIGN WITH EXISTING SEAT**

S.NO.	PARTICULARS	EXISTING TAFE STD. SEAT	PROPOSED LHP SEAT	SAVINGS
1	TOTAL MATERIAL COST(Rs.)	988.11	754.34	233.77
2	TOTAL SEAT WEIGHT(KG.)	15.15	11.15	4.00
3	TOTAL PART COUNT	150.00	99.00	51.00
4	TOTAL PART VARIETY	58.00	47.00	11.00
5	SEAT BASE CUSHION WEIGHT(KG)	0.52	0.40	0.12
6	BACK REST CUSHION WEIGHT(KG)	0.33	0.25	0.08



**FIG.C.1. COMPARISON OF MATERIAL COST**

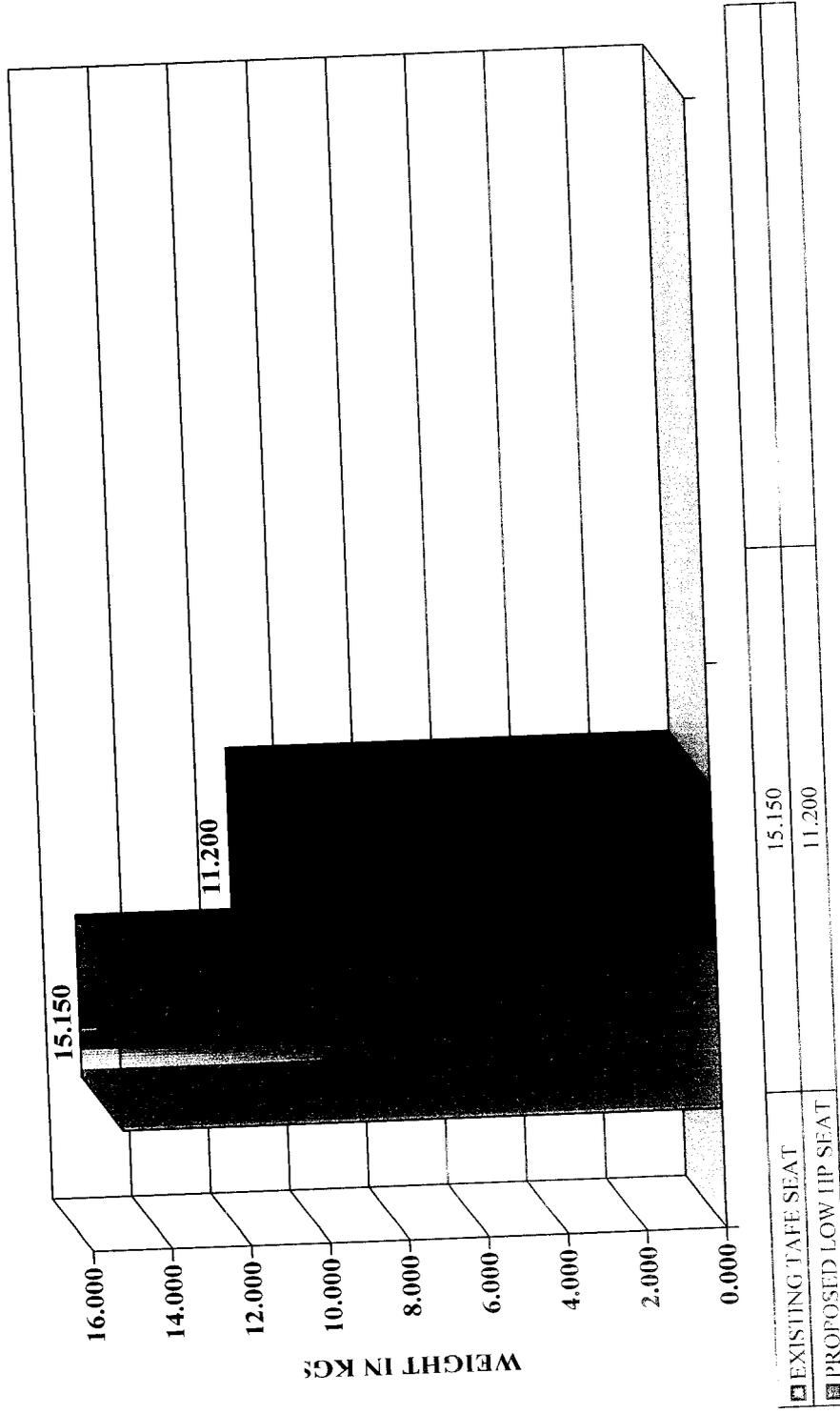


FIG.C.2. COMPARISON OF TOTAL SEAT WEIGHT

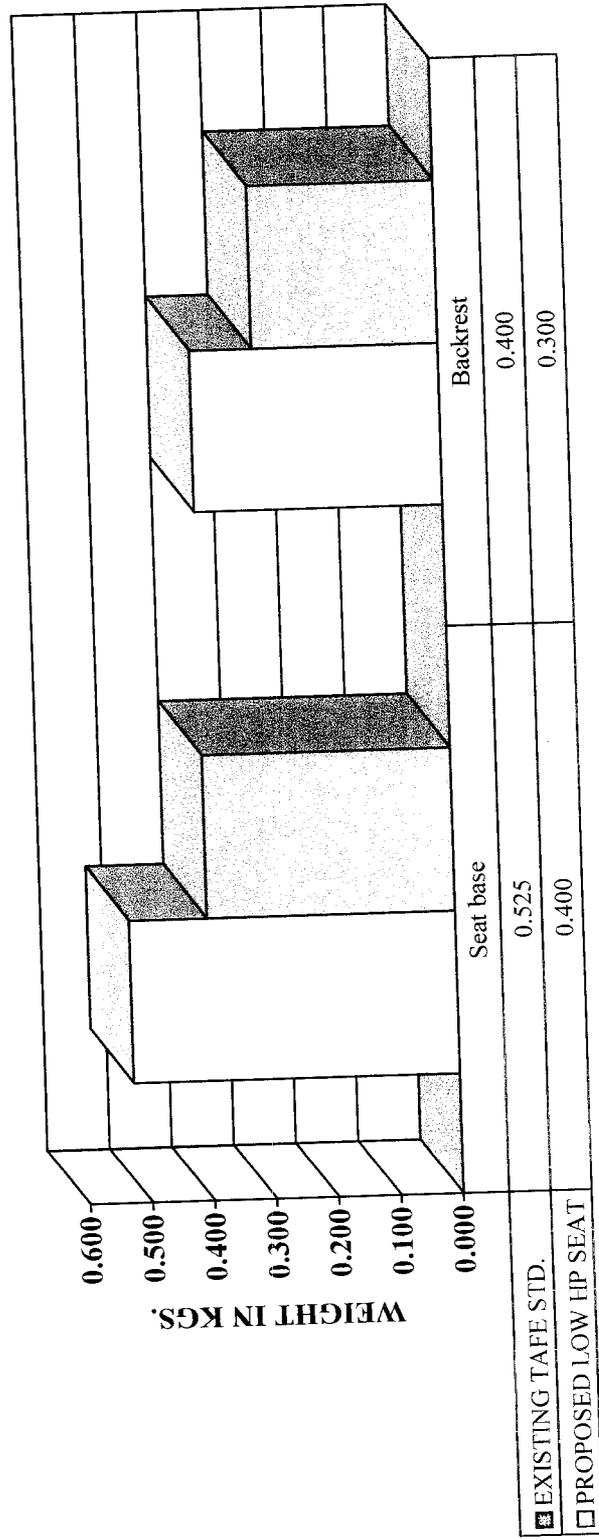


FIG.C.3. COMPARISON OF CUSHION WEIGHT

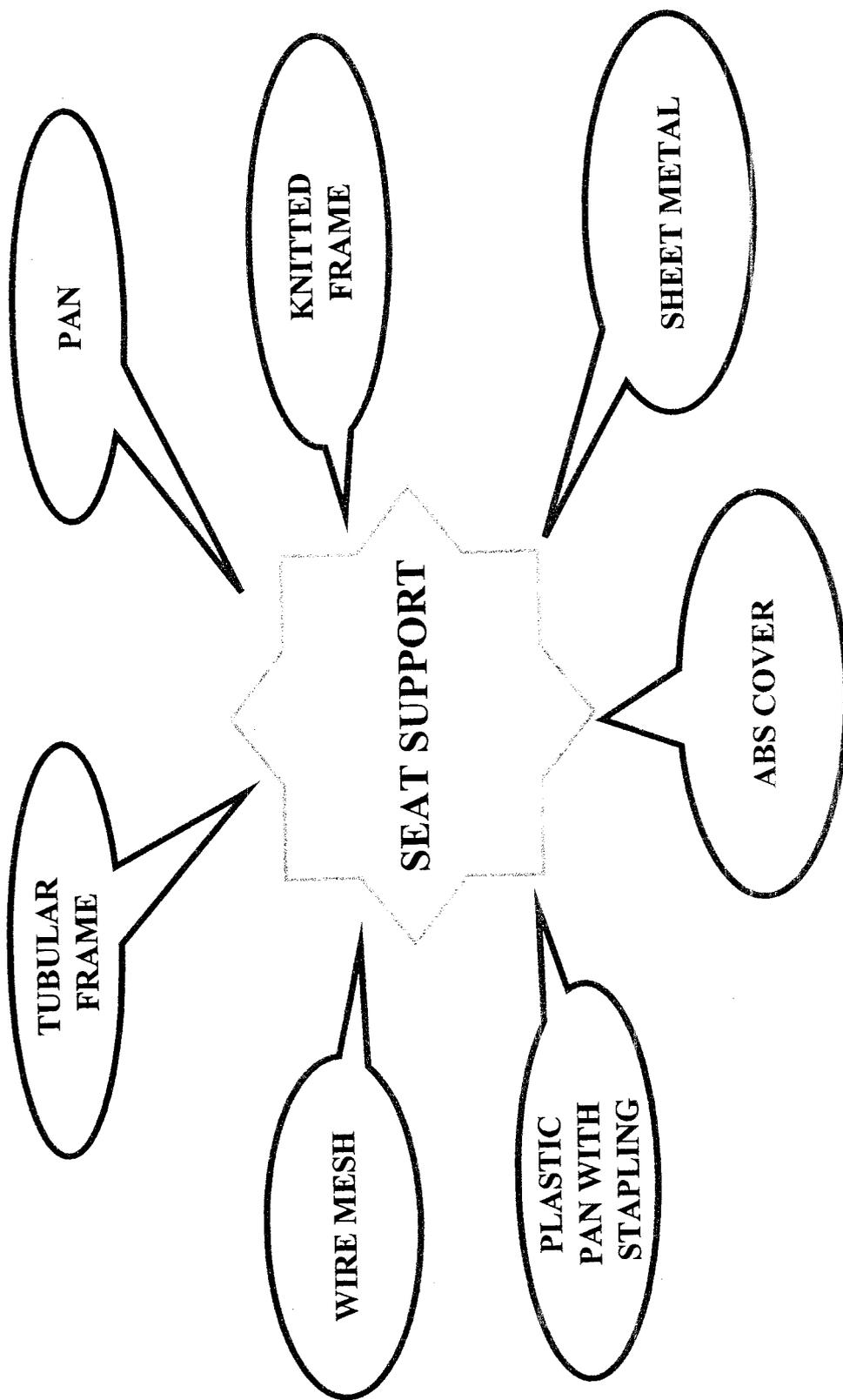


FIG.C.4. ALTERNATE MATERIALS FOR SEAT SUPPORT IN TRACTOR SEATS.

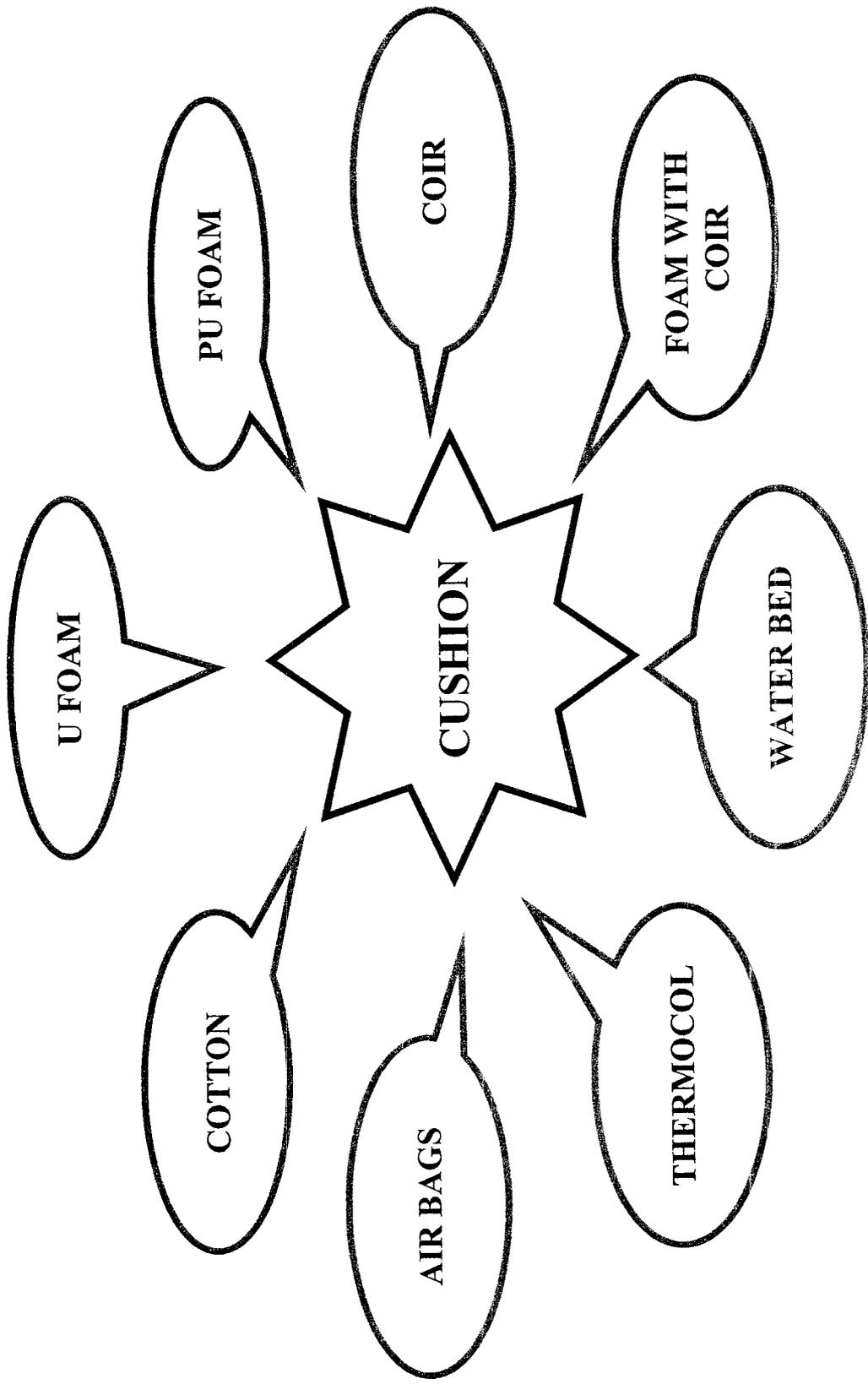


FIG.C.5. ALTERNATE MATERIALS FOR CUSHION IN TRACTOR SEATS.