UNIVERSITY OF COCHIN

B.Tech. Course

IN

RUBBER PROCESSING AND TECHNOLOGY

PROJECT REPORT

ON

A Small Scale Unit

TO

Manufacture Rubber Rail Pads in Kerala

DISSERTATION

Submitted by

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In partial fulfilment of

B.Tech. degree.

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FOREWORD

This project report is prepared and submitted in the form of a dissertation unlike projects to procure loans to start new industries. The primary mission is the partial fulfilment of an academic technical degree. This, I believe, justifies the inclusion of information on technical aspects. I do not claim this report to be exhaustive and complete in all respects. However, I hope that this will serve as a guideline to start and operate the project.

I express my thanks to all persons who helped in my endeavour and in particular to Mr. C.M. George, Project Officer; Mr. E.V. Thomas, Deputy Director; Mr. M. K. Balagopalan Nair, Chemical Engineer; and Mr. P. U. George, Cost Accountant of Rubber Board and Rubber Research Institute of India.

KOTTAYAM. 9
15th March 1977.

P. T. Thomas

C O N T E N T S

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SECTION. A.

INTRODUCTION

A. 1. General

The drive for higher speeds on the one hand and for low maintenance costs on the other is forcing Railways more and more to turn their attention to the laying of high quality tracks. The Rail Pad with its controlled resilience, electrical insulation for track circuited signalling and extreme durability is a necessary aid in this search for higher track standards.

A. 2. History

The history of rubber Rail Pad goes back to forty five years. Netherlands Railways experimented with them as early as 1929. French National Railways (SNCF) which started using concrete sleepers during the postwar period put down 11 million pads in the seven years 1948-1955. The introduction of concrete sleepers in the UK led to the publication of the first British Railways tentative specification for rubber pads in 1957 and the laying of some 2 million pads by 1959. In Japan rail pads were first introduced in 1953. Figures for seven years 1961-67 show steep upward trend from over 2,600,000 in 1961 and over 3,400,000 in 1964, to 5,000,000 in 1967.

World demand for rubber pads on concrete sleepers is said to be accelerating at a rate of 20% a year; but the rate of course varies largely from country to country.

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In India, use of rubber pads for concrete sleepers started about five years back. These were found satisfactory and now extension of trials are being done.

A.3. Object of the Project

In this scheme the proposed unit intends to manufacture 6,00,000 numbers of Grooved Rubber Rail Pads per annum.

A.4. Product Description

Grooved Rubber Rail Pad is made of natural or synthetic rubber, properly compounded, and individually moulded rectangular in shape with shallow Vee grooves on top and bottom faces.

A.4.1. Classification

Based on the intended use there are two sizes of rail pads.

(1) Grooved Rubber Pad for Prestressed Concrete sleeper for B.G. 52 kg. B.S.No. 90 R - R.D.S.O/T-382

(2) Grooved Rubber Pad for R.C.C. two block sleeper to Drg. No. R.D.S.O/T-472 & R.D.S.O/T-476.

A.5. Uses of Rail Pads

Rail Pads are used by the Indian Railways for inserting between rails and bearing plates or between rails and supports. Thus the two main uses are

a) As a pad directly between the foot of a flat bottom rail and a concrete sleeper.

b) As a pad between the foot of a flat bottom rail and a cast iron base plate.

The pads, fitted between rail and sleeper, or in some cases at the rail-base plate and base plate-sleeper interference, protect the sleeper and the foot of the rail, add resilience

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to track laid on concrete and provide electrical insulation for track circuited signalling systems.

A.5.1. Reasons for using Rubber Rail Pads

i) Where concrete sleepers are used rail pads provide between rail and sleeper the resilience necessary to absorb rapidly alternating stresses caused by the 'progression wave' effect of train axles passing along the track.

ii) In conjunction with elastic clip rail fastenings rail pads permit the track a degree of controlled vertical give and take combined with very high longitudinal and lateral friction. This is particularly valuable in conjunction with welded rail, where the friction between rail and fastening prevents thermal expansion and rail creep. It also helps to maintain accurate track gauge, making for fewer rail joints and a smoother, safer and higher speed ride.

A.6. Evaluation of Prospects

The prospects for Rail Pads can be assessed from the following factors.

i) Expansion and modernisation of the Indian Railways.

ii) Replacement frequency of rail pads.

i) Expansion and modernisation of the Indian Railways.

The Indian Railway System is the largest in Asia and the fourth largest in the world. During 1974 they ran daily 10,800 trains, covering a distance of about 10 lakh Kms, operated 7,079 stations, carried over 73 lakh passengers and about 5.5 lakh tonnes of freight. There is a steady progress in the increase of Kms. of running track, as indicated by the following table.

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Year		Running track (Km)
1950 - 51	..	59,315
1960 - 61	..	63,602
1965 - 66	..	68,375
1969 - 70	..	71,251
1971 - 72	..	73,225
1973 - 74	..	74,104

The present trend of Indian Railways is modernisation and improvement in the standards of track for higher speeds on trunk routes and important mainlines. The improvement in the standards of track has enabled Delhi-Howrah and New Delhi-Bombay Rajdhani Express trains to run at speeds of 130 & 120 Km per hr respectively. Concrete sleepers and continuous welded track are the two large scale permanent way developments towards higher speeds and low maintenance costs. In this modernisation Concrete sleepers, with its complete lack of resilience and poor electrical insulation for track circuited signalling necessitates the use of Rubber Rail Pads.

When Metropolitan Transport Project of Indian Railways is implemented in the near future, there will be massive requirement of rail pads, since rail pads are absolutely necessary for the ballastless track, to cut down noise and vibration.

The requirement of rail pads for one mile of track is about 4,224 numbers (2,112 sleepers per mile and two rail pads for one sleeper). This clearly indicates the massive requirement of rail pads in the coming years.

Contd.....5

Considering the fact that Indian Railways have one of the world's largest railroad networks and the continued Governmental interest in expanding and modernising the Railways, it is certain that NR Grooved Rail Pads will be used in largest quantities in future.

ii) Replacement frequency

The replacement frequency is at present too early to comment. However in the coming years some percentage of replacement of the installed pads can be expected.

Considering all these factors it can be concluded that there is ample scope for starting a new unit for the manufacture of 6,00,000 nos. of rail pads per annum.

SECTION B

MARKET SURVEY

B.1. CUSTOMER

The Indian Railways is the sole customer of rail pads. Each zone of Indian Railway make their own arrangements to procure Rail Pads for their purpose.

a) Consumption

The yearwise consumption of Rail Pads in South Eastern Railway Calcutta is given below.

1972 - 73	..	50,000. Nos.
1973 - 74	..	25,604 "
1974 - 75	..	30,612 "
1975 - 76	..	99,230 "

Contd....6

In 1976-77, 186,000 are ordered for supply to this Railway.

The specific statistics relating to yearwise consumption of rail pads in the other zones of Indian Railways are not available though enquiries are made. However, according to Research Designs & Standards Organisation, Indian Railways (R.D.S.O) approximate present annual consumption of natural rubber per annum for Rail Pads is 100 tonnes. Taking a polymer content of 51%, the present annual consumption of Rail Pads in Indian Railways comes about 195 tonnes. About 5 to 6 lakhs Rail Pads were being procured for the last five years and due to extension of trials, procurement at present is in the order of abour 15-20 lakhs pads this year (1976-77)

b) Production

No specific statistics regarding production of rail pads are available. Being a moulded item, it can be expected that a number of units are engaged in the production of rail pads.

B.2. Prices and effect of changes in prices on demand.

The price per piece of rail pad may vary from zone to zone of Indian Railways. The current price per piece in South Eastern Railway is Rs. 2.20. A small increase or decrease in price will affect large scale orders as prices are to be quoted by the manufacturer, when submitting tenders to the Railways.

B.3. Competitive Situation

At present there is no substitute or competitive product for Rubber Rail pads since they only meet the service requirements.

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It is anticipated that in the near future there will be no substitute or competitive product replacing rubber rail pads.

B.4. Specific market

Rail Pads are used by different zones of Indian Railways. Hence they are to be supplied to the controller of stores of each zone.

B.5 Marketing Channels

Rail Pads being an ordered item it has to be delivered at site. Transportation by rail is adopted.

SECTION. C.

PRODUCTION REQUIREMENTS

C.1. Location

The selection of location of any industrial undertaking is influenced by the following factors.

i) A plant is relatively immobile

ii) The impact of location on operating costs may vary upto 25% or even 50% between locations.

The specific factors relating to the proposed unit are given below.

i) Proximity to high volume raw materials

ii) Availability of skilled and unskilled labour.

iii) Availability of water and power

iv) Facilities for transportation by rail

v) Proximity to market.

As rail pads are to be supplied to different zones of Indian Railways, the unit can be located in Kerala where raw materials are available in plenty. Also availability position of power water and skilled labour are good.

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The factory can be located in backward districts of Kerala Trivandrum, Trichur etc. so that incentives provided by Government, such as reduction in taxes can be enjoyed. Selection of location in an Industrial Estate in Kerala offers the following advantages.

i) Built up area available at a nominal rate

ii) Undue delay in getting power connection can be avoided

iii) Transport and communication facilities.

iv) Facilities available for training labour.

Considering all the above factors the unit is proposed to be located in an Industrial Estate in Kerala, preferably one near to a railway station.

C.2. Land and Building Requirements

For finalising the selection of the type of shed in the Industrial Estate the following considerations are taken into account.

i) The minimum built up area required for each machinery.

ii) Layout plan to be adopted.

iii) Provision of space for keeping the maximum amount of inprocess inventories characteristic of process layout.

Based on the considerations the following areas are adopted.

i)	Raw material storage & Compounding	..	300 Sq.ft.
ii)	Mill room and Stock preparation	..	300 "
iii)	Laboratory	..	200 "
iv)	Moulding	..	450 "
v)	Boiler	..	150 "
vi)	Deflashing finishing etc.	..	250 "

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vii)	Packing, Warehouse etc.	..	500 Sq.ft.
viii)	Office, amenities and other facilities	..	650 "
	Total built up area	..	2,800 Sq.ft.

Type of shed in Industrial Estate is chosen taking into consideration future expansion.

C.3. Plant Layout

The important considerations in fixing plant layout are

i) Minimum material handling

ii) Continuous flow of the materials inside the plant.

iii) Storage capacities and their location

iv) Future expansion.

The proposed layout is shown in Appendix II.

C.4. Requirements of Main Raw Materials

The total estimated production for two shifts working per annum including process losses is 80 tonnes. The break up of production is as follows.

i)	Grooved Rubber Pad - RT.382	..	3,00,000 Nos.
	Compound requirement	..	27,000 Kg
	(Wt. of one piece approximately 90 gms)		
ii)	Grooved Rubber Pad - RT 476	..	3,00,000 Nos.
	Compound requirement	..	45,000 Kg.
	(Wt. of one piece approximately 150 gms)		
	Provision for process losses etc.	..	8,000 Kg.
	Total compound requirement	..	80,000 Kg.

Contd.....10

Total requirements of all types of raw materials based on a selected formulation is given in Annexure II.A. The important classes of raw materials used are listed below.

C.4.1. Polymer

For the estimated production, the unit requires 40,930 Kgs. of Natural Rubber. NR is available from the local market readily.

C.4.2. Fillers The following fillers are used.

Fillers		Annual Consumption
SRF black	..	24,560 Kgs.
China Clay	..	8,185 "

C.4.3. Curing Systems The accelerators required are 1) CBS ii) TMT. Zinc Oxide - Stearic acid activation system is used. The annual consumption and price of these chemicals and other materials sulphur, antioxidant oil, paraffin wax etc. are listed in annexure II.A.

C.4.4. Terms of Purchase of Raw Materials.

All negotiations related to purchase of raw materials are done through banks. On a margin money of 30%, the bank will advance 70% for the purchase of materials. The amount has to be paid back from sales within 70 days with interest.

C.5. Machinery Selection

The selection of machinery is of prime importance since maximum utilization of machinery gives better return for the money spent. The selection of each machinery is based on the following considerations.

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i) The targeted capacity

ii) The accepted standard dimensions of the product.

iii) The type of production

iv) Its effect on the utilization of other machinery.

The following machinery are selected.

Sl.No.	Item	No.
1	Mixing mill 12" x 30"	
	30 H.P. Motor with reduction gear	1
2	Presses	
	a) 24"x24"x4D - Hydraulic Press	1
	b) 18"x18"x4D Hydraulic Press	1
3	Boiler 150 Kg/hr	1

The details of machinery and other equipments are given in Annexure I.A.

C.5.1 Terms of Purchase of Machinery

i) Quotations are invited and satisfactory quotations are confirmed.

ii) Price quoted are exclusive of packing, transportation, sales tax, excise duty etc.

iii) 30% of the price should be paid in advance and the remaining at the time of purchase.

iv) Purchaser has the right for inspecting the machinery.

v) Waranty against manufacturing defects is assured.

vi) Liabilities passes onto customer immediately after despatch and shortages should be notified within one week.

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C.6. Manpower Requirements

The total manpower requirements are classified as

i) Administrative Staff

ii) Technical Staff

iii) Labourers.

C.6.1. Administrative Staff

The head of the administrative Staff is the Manager. He should be a technologist as well so that the post of a separate technologist can be eliminated.

Job description	Total Staff per Shift	No. of Shifts	Total staff per day
1. Manager Cum Technologist	1	1	1
2. Sales Officer	1	1	1
3. Accountant/Typist	1	1	1

C.6.2. Technical Personnel: Two production Supervisors look after the production. Besides there is one laboratory technician entrusted with testing of raw materials, in process materials and finished products.

Job description	Total Staff per Shift	No. of Shifts	Total staff per day
1. Production Supervisor	1	2	2
2. Lab Technician	1	1	1

C.6.3. Labour Requirement

The Labourers are involved in the actual production operation. The distribution of labour by classes for various jobs is given below.

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Job Description	Total labour per shift/job			No. of Shift	Total labourers/ day
	S	SS	US		
Compounding			1	2	2
Mixing Mill	1	1		2	4
Blank Preparation			2	2	4
Press Operation	2			2	4
Trimming			1	2	2
Packing & Despatch			1	1	1
Boiler attendant	1			2	2

C.7. Utilities

C.7.1. Water Requirements per day

Water consumption in mixing	6,000 Ltrs.
Boiler	1,500 "
Water consumption for employees amenities	1,500 "
Total water requirements	9,000 "

C.7.2. Power Requirements

Total power consumption is as follows.

		H.P.
i)	12" x 30" mill ..	30
ii)	24"x24" Hydraulic Press ..	3
iii)	18" x 18" Hydraulic Press ..	2
iv)	Boiler 150 kg/hr. ..	3
v)	Fan light and others ..	2
	Total ..	40

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So maximum Kilowatt consumption /hr.	29.84 KWh.
Assuming a load fact or of 0.7 power xihsyn consumed/hour	20.86 Kwh.
∴ Total power consumption per day	338.76 "
ie.	334 KWh.
Power consumption per annum	1,00,200 Kwh.
Power cost per annum @ Rs.0.15/Kwh	Rs. 15,030

C.7.3. Steam requirement

Total steam generation per annum.	3,15,000 Kg.
Steam production per litre of furnace oil	10 Kg.
Total oil consumption per annum	31,500 litres.
∴ Total oil consumption per day	105 litres.

SECTION. D.

PROCESS OF MANUFACTURE

The separate processing steps in the manufacturing operation of Grooved Rubber Rail Pads are described below. The principal steps are

1. Compounding
2. Mixing, Maturing & Warming
3. Blank Preparation
4. Moulding
5. Finishing, Inspection & Testing
6. Typing Packing and Despatch.

A Flow Diagram of the process is given in Appendix I.

D.1. Compounding

The rubber and the ingredients are weighed out as per the predetermined formula and batch weight.

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The factors influencing the selection of a typical formulation are

i) Vulcanisate properties required

ii) Price

iii) Processability

The service performance demanded on the rail pads by Indian Railways is covered by Railway Specification UIC 864. The principle requirements of rubber rail pads are that they should;

i) Have the correct load deflection characteristics

ii) Have a high electrical resistinity

iii) Have good resistance to set and creep.

iv) Have good ageing resistance.

An outline of the principles involved in arriving at suitable formulation to produce rail pads of specified service performance in both vulcanised and unvulcanised states are given below.

i) Specified minimum hardness.

ii) Scorch safety

iii) Mouldability

iv) Shrinkage

v) Sufficient mechanical strength.

Among the polymers NR is the best compromise. NR compounds of suitable quality are proving satisfactory in service. Good ageing resistance and low compression set properties are essential since the rail pads once put on the track has to give service for considerable time.

Contd....16

For imparting high electrical resistivity and specified hardness SRF black is used. China Clay, a cheap non-black filler is included to reduce costs.

D.2. Mastication and Mixing

Natural Rubber should be masticated before mixing. When the nerve disappears, addition of ingredients can be started. Mastication takes 4-6 minutes.

For a 12" x 30" mill the batch size is 14-16 kg. and mixing time varies between 20-30 minutes depending on the type of mix. First masticate the rubber alone followed by the addition of anti-oxidant, activators, fillers, process oil and accelerators. Sulphur is added at the end of the mixing cycle. Cold water is passed through the rolls of the mill to prevent overheating which may result in scorching.

Batch size and order of addition of compounding ingredients are shown in Appendix III.

D.2.1. Maturing

The sheeted out stock is matured for a period of 24 hours. Maturing helps to get uniform dispersion of black, fillers, other ingredients and reduce variation from batch to batch and within each batch.

D.2.2. Prewarming

After maturing the stock is prewarmed on the same mill until the compound regains its plasticity. Proper uniform warming makes stock preparation easy and reduce 'grain' effect. 5 minutes warming is usually given.

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D.3. Blank Preparation

The prewarmed stock is sheeted out from the mill and blanks are cut to the correct size of the mould as that of individual so that the mould is correctly filled and wastage due to overflow or rejects due to underfilling of the mould are avoided. Blanks are kept on clean table.

D.4. Moulding and Vulcanisation

Moulding is the operation of shaping and vulcanising the plastic rubber coumpound by means of heat and pressure in a mould of appropriate form. Depending on the ways of introducing the material into the cavity there are

i) Compression mouldings ii) Transfer moulding

iii) Injection moulding

Selection of method depends on (1) Quantity of production (2) Shape of product (3) Capital investment.

In this Scheme, compression mouldings using individual moulds is adopted.

D.4.1. Moulding Dperation

The mould surface is cleaned and mould release agent applied. Either Silicone emulsion, soap or detergent are used as mould release agents. Mould dried and heated to the specified curing temperature. Mould opened and blanks placed in the mould cavity, then mould closed pressure during the cure is in the range of 75-150 kg/cm^2 After 8 minutes the press is opened, mould taken out and cured pieces taken out for finishing operation. The process repeats

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D.5. Deflashing: Methods of deflashing are

i) Hand Trimming ii) Mechanical Deflashing

In this scheme hand trimming is adopted in order to save further capital requirement.

D.6. Inspection & Testing

The trimmed articles are inspected for visual defects such as porosity, blisters etc and samples are taken randomly and sent to the laboratory for routine checking. The details of the test done are described in quality control.

D.7. Packing and despatch

Those items which passes the inspection are sent to the warehouse. The railpads are packed in wooden boxes, each containing 1,000 numbers in packages of 100 pieces. Manufacturers name, date of manufacture, product description are given on the packet.

D.8. Process Loss:

Rail Pads being a moulded item, losses during manufacture are high. However every attempt is made to reduce the losses to economic level.

The losses may vary from 8 - 10%. This includes

(i) fly losses during transportation, handling, weighing and compounding.

ii) During mixing - fly losses of carbon black

iii) Stock preparation and cutting losses.

iv) Scorched compounds.

v) Mould flashes

vi) Scraps -

Contd.....19

D.9. Common Moulding defects

	Reasons
i. Porosity	Under cure, moisture in fillers improper dispersion of Sulphur & Accelerators.
ii. Trapped air	Compound too soft, Unsuitable blanks, Improper mould design.
iii. Difficulty in removing from the mould.	Inefficient mould lubrication. Improper compound design.

D.10. Quality Control

Quality is the surest foundation of success in an Industrial venture. Extensive quality control is practised beginning from the incoming raw materials through the inprocess materials to the finished product. The control measures adopted are outlined below.

D.10.1. Acceptance Test

Acceptance tests are done on all raw materials to ensure quality.

i) Polymer: Random samples are selected and tested for moisture content, dirt content etc.

ii) Fillers : Fillers are tested for grit, purity etc.

iii) Accelerators, antidggradants and stearic acid

Random samples are selected and tested for Melting point, solubility in suitable Solvents, and in some cases chemical analysis.

D.10.2. In-process Quality Testing

The following tests are proposed

i) Specific Gravity: Specific gravity of each batch is tested after press-curing small strip samples and conformity to the

compound Sp.gr. noted.

ii) Hardness: The hardness of the above strip is measured ensure proper addition of fillers.

D.10.3. Product Testing

Quality control of finished product may be done using statistical Quality Control measurers. Samples are withdrawn at random intervals and subjected to the following tests, described in Indian Railway. Specification UIC 864.

Specification

i) Hardness ii) Tensile strength iii) Elongation at Break iv) Ageing Tests v) Thermoplasticity test

vi) Coefficient of elasticity at 100% vii) Electrical resistance

Crushing curve Tests are done in Railway Lab, by sending samples to them.

D.10.4. Groove Indian Railway Specification - UIC 864 for Grooved Rubber Rail Pads

Marks : Each Rail Pad must bear the following in raised characters 8 mm high placed in a recess on one of its surfaces.

i) A mark of letters - manufacturers identity

ii) The last two figures of the year of manufacture.

Finish : The Rail Pads must have cleanly cut sides and no defects; they must have smooth surfaces and the grooves must be unobstructed at the ends along their whole length.

Tolerances: Length - 5 mm

Width - ±0

- 2 mm

Dimensions of the grooves + 0

and thickness of + 0.5 mm.

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A complete series of tests must be carried out for each batch of 10,000 parts or less.

Selection and preparation of test piece: The rail pads shall be grouped together in batches manufactured at the same time as such other. The samples are selected in such a way that they are representative of the batches.

D.10.4.1. Hardness Test

The hardness of three complete rail pads shall be measured, either with a Shore A Durometer or by the D.I.C. method. (The hardness shall be measured between the grooves and at least 1 cm. from the sides of the sole plates in atleast five different places; the sole plate must be placed flat on another of similar type which is itself resting on a very smooth table or surface).

Hardness minimum 65 shore A.

D.10.4.2. Crushing Curve : Two rail pads are placed between two rigid metal plates and measurement of the thickness variation is carried out by means of two comparators. After positioning the rail pads, deformations with 5, 10, 15 and 20 tons are noted and crushing curves prepared.

D.10.4.3. Breaking and Tensile qualities

Measuring of the breaking and tensile qualities

a) on a new test piece

b) on a test piece aged artificially for 96 hrs. in an oven at 100°C after relaxation at ambient, temperature for a period of 24 to 48 hours.

Tensile test piece cut from rail pads in such a way that groove coincides exactly with the centre line of the test piece.

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Tensile strength	kg/cm^2	120 min.
Elongation at break	%	250 min.
Age at 100° ± 2°C, 96 hrs.		
T.S.	kg/cm^2	100 min; 70% retention min.
E.B.	%	180 min. 60% "

D.10.4.4. Coefficient of Elasticity at 100%

The Coefficient of Elasticity at 100% is the tensile power, in kg/cm^2 of initial section, necessary to gradually increase the original distance of 50 mm between the marks of the test piece to 10 mm.

Modulus at 100%, kg/cm^2 50 max. 30 min.

After ageing at 100 ± 2°c for 96 hrs, modulus at 100% must not differ by more than 40% from the original value.

D.10.4.5. Thermoplasticity test:

a) Tension set

Measurement of the deformation occuring to a tensile test piece subjected to a stretching of 50% for 24 hrs. in an oven at 100 ± 2°C. Taken out, the test piece kept stretched for atleast 30 minutes and freed. The deformation occuring is measured between 24 & 48 hours after its removal from the oven.

Tension set Max. - 25%

b) Compression set

A round pastile 37 mm in dia. is cut, subjected to a compression of 50% in the device for 24 hrs. at 100 ± 2°C.

The deformation is measured between 24 and 48 hrs. after its removal from the oven.

Compression set 30% max.

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D.10.4.6. Electrical Resistance

The measurement shall be obtained from two rail pads one of ~~xxxh~~ which has been immersed in distilled water for 48 hrs. at ambient temperature. The measurings shall be carried out with a voltage of between 200 and 250 volts after a charge lasting 60 seconds.

The electrical resistance must not be less than 100 megohms for either of the test pieces.

D.11. Waste Disposal

Flashes, scraps etc. can not reworked. Hence they are sold for reclaiming.

D.12. Product Diversification

With the available machinery,other moulded goods such as Automobile Bushes, O rings, M.C. Sheets etc. can be manufactured at additional expenses only that of moulds. Or the unit can go for other moulded goods required by Indian Railways such as coupling washer, Rolling rings, Gland packing rings etc.

SECTION. E.

SELLING AND DISTRIBUTION

E.1. Pricing Policy.

The procurement of Rail Pads by Indian Railways is by way of inviting tenders or quotations open to national competition. The following factors are considered in arriving at a competative price.

i) Cost of Production
ii) Freight costs and other handling costs.

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iii) Other sales expenses.

iv) Delay in getting money from the customer.

The price quoted in this scheme is less than that of the current price (Rs. 2.10 against the current price of Rs. 2.20 per piece). This will put the firm in an advantageous position for capturing further orders.

E.2. Distribution arrangements

The firm shall have to supply rail pads at site of the different zones of Indian Railways. Transportation will be done through train. With this distribution arrangement the firm could fulfill any order within reasonable period.

SECTION. F.

CAPITAL REQUIREMENTS

The financial aspect of the unit can be given under the following heads.

1. Fixed Capital Requirement.
2. Working Capital Requirement
3. Gross Capital Requirement
4. Total manufacturing cost
5. Sales Expenses.

F.1. Fixed Capital Requirements

It is the sum of the expenses incurred for plant, machinery and preoperative expenses that can be capitalised. Preoperative expenses are accounted for the costs incurred during the idle time of plant and machinery before regular production starts. The estimated Fixed Capital requirement is as follows.

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		₹
i)	Plant and Machinery	3,58,000
ii)	Pre-operative Expenses	19,200
iii)	Miscellaneous Fixed Costs.	11,000
	TOTAL	3,88,200

Details of Fixed Capital are shown in Annexure I.

F.2. Working Capital Requirement

The working capital requirement depends on

i) The duration for which raw material inventory has to be kept so as to ensure uninterrupted production.

ii) The duration involved in manufacturing, marketing and selling.

iii) The duration for which finished goods should be stocked to ensure uninterrupted supply to the market.

iv) The duration between the selling of the goods and the payment to be received.

The costs involved during this interval is called Working Capital. The Working Capital is taken as the total variable expenditure involvolved during a fixed period (in this case three months) and are classified are as follows:

		₹
i)	Raw materials, cost of purchase, transportation etc.	5,37,000
ii)	Manufacturing costs.	
	a) Cost of utilities	52,800
	b) Salaries and wages.	1,66,500
iii)	Other overheads.	47,000
		8,02,700
	Working Capital	2,01,000

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Details of working capital components are given in Annexure II

F.3. Gross Capital Requirement

It is the sum of the fixed capital requirement and working capital requirement and is the total investment on the scheme. Details are given in Annexure III.

F.4. Total Manufacturing Cost.

It consists of all the direct and indirect cost involved in the manufacturing operation. Annual manufacturing cost maybe classified as follows.

i) Raw material cost

ii) Personnel Cost - Salaries and wages.

iii) Utilities - Total cost incurred on Power, water and Steam.

iv) Overhead expenses - Expenses incurred on maintenance of machinery, administrative expenses etc.

v) Other Fixed Cost - Consists of a) Factory Depreciation

b) Interest on term loan c) Interest on Working Capital.

The annual costs involved in these heads are as follows.

		₹
i)	Raw Materials cost.	5,37,000
ii)	Personnel cost.	1,66,500
iii)	Utilities.	52,200
iv)	Overhead expenses.	47,000
v)	Other Fixed costs.	1,04,000
	Total cost of Production	9,06,700
	Rounded of	9,07,000

Details are given in Annexure IV.

Contd...27

F.5. Sales Expenses

These expenses can be broken down into

i) Freight and handling cost.

ii) Transit Insurance.

iii) Other sales expenses.

Details are shown in Annexure V

SECTION G

FINANCING PLAN

The finance requirements of any industry are very high and an enterpreneur can not meet by himself all the expenses. The Government has several financing schemes for helping small scale Industrial Enterpreneurs. These include.

G.1. State Financial Corporation

Loans of upto 10 lakhs for a period of 12 years can be obtained from this institution. They provide 100% of machinery cost, 75% of building cost and 40% of working capital at 7-10% interest.

G.2. Kerala Employment Promotion Corporation

They provide 95% of the cost involved in the purchasing, servicing, taxes, insurance and transportation of all machinery and equipments as a loan on an interest of 7%.

G.3. Kerala State Small Industries Corporation

Machinery worth upto Rs. 10 lakhs can be obtained on a Hire Purchase Scheme on a marginal money deposit of 20% (10% for technically qualified personnel) Repayment starts after two years and should be complete within 7 years. Interest is 7.5%.

Contd....28

G.4. Nationalised Banks

They provide entire working capital at 16% interest and loans for machinery on 25% margin money and 12% interest.

Other Institutions are National Small Industries Corporation, Industrial Development Bank of India, Unit Trust of India etc.

G.5. Financing Plan of the firm

The entire machinery costs are proposed to be taken as a loan from Kerala Financial Corporation. The entire Working Capital is intended to be taken from Nationalised Banks.

	Rs
i) K.F.C. Loan at @ 7.5% interest.	3,05,000
ii) Nationalised Banks - Loan at @ 16% interest	2,01,000
iii) Own Capital	83,200
TOTAL	5,89,200

SECTION H

PROFITABILITY

H.1 Rate of return on Own Capital

Own Capital	Rs. 83,200
Rate of return	= 107%

H.2. Rate of Return on Capital Employeed

Total Capital employed	Rs. 5,89,200
∴ Rate of return	15.10%

H.3. Percentage Profit on Sales Turnover

Percentage Profit on Sales Turnover is found to be 7.05%

H.4. Break Even Analysis

	Rs
Annual Fixed Costs.	1,89,650
Break-Even production	3,07,700 Nos.
ie. 51.28%	

contd....29

Details are given in Annexure VII.

SECTION I

ECONOMIC VIABILITY

I.1. Interest Commitments

	₹
a) 7.5% interest on term loan	23,400 ~~45,450~~
~~b~~ @ 16% interest on working capital	32,140
Total	55,540 ~~77,590~~
∴Total interest commitments.	~~77,590~~ 55,540

I.2. Ability to Pay back Borrowed Funds

The firm intends to use 85% of its surplus to pay back term loan and the rest is retained. Since part of the term loan is paid back the ability to pay back loans will be high in subsequent years.

I.3. Pay back Period

	₹
a) Annual Profit.	89,000
b) Depreciation	48,470
Available surplus (a + b)	1,37,470
Less Drawings.	20,610
Amount used for repayment.	1,16,860
Loan to be paid back	3,05,000
Pay back period	2.6 Years

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SECTION. J.

S O C I A L B E N E F I T S

J.1. To the enterpreneur

It gives i) Profit

ii) Opportunity to use his ideas

J.2. To the nation

It gives i) Larger employment with less investment.

ii) Increase in revenue earnings.

iii) More equitable distribution of the National Income.

SECTION. K

C O N C L U S I O N

The present scheme is a Small Scale one as per the definition. There is ample scope for expansion in the same lines of production or with multiple products with small capital investment. The project as such is sound, safe and prospectful.

The Project in a nutshell

i)	Fixed Capital	Rs. 3,88,200
ii)	Working Capital	Rs. 2,01,000
iii)	Total Capital	Rs. 5,89,200
iv)	Plant and Machinery	Rs. 3,58,000
v)	Location	An Industrial Estate in Kerala.
vi)	Building area	2,800 Sq.ft.
vii)	Labour force	19
viii)	Staff	6
ix)	Working shift/day	2
x)	Annual production	6,00,000 Nos. of Rail Pads

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ANNEXURES

ANNEXURE I. FIXED ASSETS

Annexure I.A: Plant and Machinery

Sl.No.	Item	No	Total Cost Rs
1	Mixing Mill 15"x30" mill. 30 H.P. Motor with reduction gear	1	80,000
2	Presses		
	a) 24"x24"x4D Hydraulic Press	1	65,000
	b) 18"x18"x4D Hydraulic Press	1	50,000
3	Moulds		
	a) Type I @ Rs. 500	18	9,000
	b) Type II @ Rs. 750	18	13,500
4	Boiler 150 Kg/hr with sofening plant & other accessories.	1	45,000
5	Lab. Equipments		
	a) Hardness Tester	1	1,000
	b) Tensile Testing machine	1	10,000
	c) Compression set apparatus	1	1,000
	d) Ageing Oven	1	8,000
	e) Other Lab. equipments		2,000
6	Weighing Balance		
	a) 50 Kg. DialBalance	1	3,500
	b) 0.5 Kg. dial balance	1	1,000
7	Tools and Miscellaneous equipments		1,000
	TOTAL		2,90,000

Contd....32

	Rs
5% for price escalation	14,500
Previous Total	2,90,000
Total	3,04,500
Installation, Transportation etc. at 10%	30,450
Sales tax @ 7.5%	22,840
Total cost for Plant & Machinery	3,57,790.
Rounded of	3,58,000

ANNEXURE I.B.

Preliminary & Pre-Operative Expenses

i)	Interest on loan Rs.3,05,00 @ 7.5% for 6 months	11,700
ii)	Travelling Expenses	2,000
iii)	Postage, Telegram, Telephone	1,000
iv)	Printing & Stationery	1,500
v)	Rent & Establishment	1,000
vi)	Other Miscellaneous expenses	2,000
		19,200

ANNEXURE IC

Other Fixed Assets

i)	Office Equipments	5,000
ii)	Furniture & Others	2,000
iii)	Fire fighting equipments.	2,000
iv)	Miscellaneous tools and equipment	2,000
	Total	11,000

Contd.....33

ANNEXURE I

TOTAL FIXED ASSETS

	₹
Plant and Machinery	3,58,000
Pre-Operative Expenses	19,200
Other Fixed Assets	11,000
Total Fixed Assets	3,88,200

ANNEXURE II

WORKING CAPITAL REQUIREMENTS

Annual Working Expenses

i)	Total Raw materials cost	5,37,000
ii)	Manufacturing Cost	
	a) Cost of utilities.	52,200
	b) Salaries and wages.	1,66,500
iii)	Administrative & Other overheads	47,000
	TOTAL	8,02,700
	Rounded off	8,03,000
	Working Capital (taken as 3 months Working Expenses)	2,01,000

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Components of Working Capital

ANNEXURE II.A.

Details of Working Expenses on Raw Material Consumption

Sl.No.	Material	Annual Consumption Kg	Price/ Kg. Rs.	Total Amount Rs.
1	Natural Rubber	40,930	7.00	2,82,910
2	Zinc Oxide	2,046	17.50	35,800
3	Stearic Acid	818.5	11.50	9,400
4	S.R.F. black	24,560	3.75	92,100
5	China Clay	8,185	0.40	3,274
6	Aromatic Oil	1,227	8.0	9,816
7	Paraffin Wax	409	8.0	3,472
8	PBN	409	36.0	14,720
9	CBS	347.8	40.0	13.910
10	TMT	61.4	26.25	1,612
11	Sulphur	1,021	2.20	2,246
			Total	4,69,260
			Rounded off	4,69,300
	Provision for price escalation @ 5%			23,465
			Total	4,92,765
∴	Annual Raw Materials cost			4,93,000
	Packing materials cost			32,000
	Cost of purchasing, Inspection transportation, warehousing etc. @ Rs.150/ton			12,000
			Total cost of Raw materials	5,37,000
∴	Raw Material cost per month			44,800

Contd.....35

ANNEXURE II.B.

Manufacturing Cost (Annual)	Rs
i) Cost of utilities.	52,200
ii) Salaries and wages	1,66,500
Total manufacturing cost.	2,18,700

ANNEXURE II.B.I

Cost of Utilities

a) **Steam:**	
Cost of 31,500 litres of furnace oil @ Rs. 1.10 / litre	34,650
Transportation cost @ Rs.0.05 per litre	1,575
b) **Water:**	
Cost of 2,700 Kilo litres of water @ Rs.0.33 per 1000 liters.	890
c) **Power**	
Cost of 1,00,200 Kwh @ Rs.0.15 per Kw	15,030
Total	52,140
Rounded off	52,200

ANNEXURE II.B.II

Salaries and Wages (Annual)

a) **Administrative & Technical Staff**

Sl.No.	Position	no. of Shift	Total Staff/ day	Monthly salary/ Staff Rs	Total Annual Salary Rs
1	Manager cum Technologist.	1	1	1,000	12,000
2	Sales Officer	1	1	600	7,200

Contd....36

				Rs	Rs
3	Accountant/Typist	1	1	500	6,000
4	Production Supervisors	2	2	500	12,000
5	Lab. Technician	1	1	450	5,400
			Total		42,600

b) Wages of Labourers (Annual)

Position	No of shift	Total Labourers per day	Wages per month Rs.	Total Wages Per annum Rs.
Skilled	2	8	450	43,200
Semiskilled	2	2	400	9,600
Unskilled	2	9	350	37,800
				90,600
Total Salaries & Wages (A+b)				1,33,200
Allowing 25% annual fringe benefits				33,300
Total Salaries & Wages (including benefits				1,66,500

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ANNEXURE II.C.

Administrative & Other Overheads (Annual)

		Rs.
i)	Repairs and maintenance of mechinery @ 5%	15,225
ii)	Travelling Expenses	3,000
iii)	Insurance @ 2% of fixed capital	8,000
iv)	Taxes etc.	500
v)	Audit fee	2,000
vi)	Legal charges	2,000
vii)	Stationery, Supplies and Printing	8,000
viii)	Postage, Telephone etc.	2,000
ix)	Rent of building @ Rs. 415 per month	5,000
x)	Miscellaneous	1,000
	Total overheads	46,725
	Rounded off	47,000

ANNEXURE. III

Gross Capital Requirement.

Total Fixed capital Requirement	3,88,200
Total working capital requirement	2,01,000
Gross Capital Requirement	5,89,200

Contd....38

ANNEXURE XIV

Total Cost of Production (Annual)

		Rs
i)	Raw Material Cost (Annexure II.A)	5,37,000
ii)	Utilities (Annexure II.B.I)	52,200
iii)	Salaries & Wages (Annexure II.B.2)	1,66,500
iv)	Administrative & other overheads (Annexure II.C)	47,000
v)	Other Fixed Costs (Annexure III.A)	1,04,000
	Total cost of production	9,06,700
	Rounded off	9,07,000

ANNEXURE III.A.

Other Fixed Costs

Factory Depreciation

a)	Depreciation on Machinery Rs.3.05,000 @ 15%	45,450
b)	Depreciation on other fixed costs and pre-operative expenses. (Rs. 30,2000@ 10%)	3,020
	Interest on term loan Rs. 3,05,000 @ 7.5%	23,400
	Interest on working capital Loan Rs. 2,01,000 @ 16%	32,140
	Total	1,04,010
	Rounded off	1,04,000

Contd.....39

ANNEXURE. V.

Annual Sales Turnover

		Rs
i)	Total Sales Income from 6,00,000 Rail Pads at the rate of Rs.2.10/piece	12,60,000
ii)	Additional sales income from 6,000 kg process Loss @ Rs.0.50/kg	3,000
	Total Sales turnover	12,63,000

ANNEXURE VI

Sales Expenses

i)	Freight & handling cost @ 10% of sales turnover	1,26,000
ii)	Transit Insurance @ 1% of sales turnover	12,600
iii)	Other Sales expenses such as furnishing bank guarantee etc. @ 3% Sales turnover	37,800
	Total Sales Expenses	1,76,400

ANNEXURE VII

Annual Sales Income & Profit

Total Sales Turnover	12,63,000
Less Sales Expenses	1,76,400
Annual Sales Income	10,86,600
Less cost of Production	9,07,000
Gross Profit	1,79,600
Provision for tax incidents @ 50%	89,800
Net Profit after taxation	89,800
Rounded off	89,000

Contd....40

ANNEXURE. VIII

Profitability Analysis

I. Rate of return on Own Capital	₹
Own Capital	83,200
Net Profit	89,000
∴ Rate of return on own capital	107%

II. Rate of Return on Capital Employeed	
Fixed Capital	3,88,200
Working Capital	2,01,000
Total Capital employed	5,89,200
Annual Net Profit	89,000
∴ Rate of return on capital employed	15.10%

III. Percentage Profit on Sales Turnover	
Annual Sales Income	12,62,000
Annual Net Profit.	89,000
Percentage Profit on Sales Turnover (after taxation)	7.05

IV. Break-Even Analysis

Breakeven quantity is that quantity which if produced and sold will give neither a profit nor a loss.

$$B.E = \frac{F}{P-V}$$

Where F = Annual Fixed cost

P = Price/unit of the product.

V = Variable cost/unit

P-V = Contribution.

Contd.....41

	₹
Sales turnover of the product	12,63,000
Price/unit of the product	2.105
Variable Cost	
Raw material cost	5,37,000
Direct labour	1,28,250
Utilities	52,200
Sales Expenses	1,76,400
Total Variable cost	8,93,850
∴ Variable cost/unit	1.488

Annual Fixed costs = (Cost of production + Sales expenses) - Total variable cost.

Cost of Production	9,07,000
Sales Expenses	1,76,400
Total	10,83,400
Less Total variable costs.	8,93,850
Annual Fixed Costs	1,89,650

$$\therefore \text{B.E} = \frac{\text{Annual Fixed Costs}}{\text{Contribution}} = \frac{1,89,650}{2.105 - 1.488}$$

$$= \frac{1,89,650}{.617} = 3,07,700 \text{ Nos.}$$

ie. 51.28%

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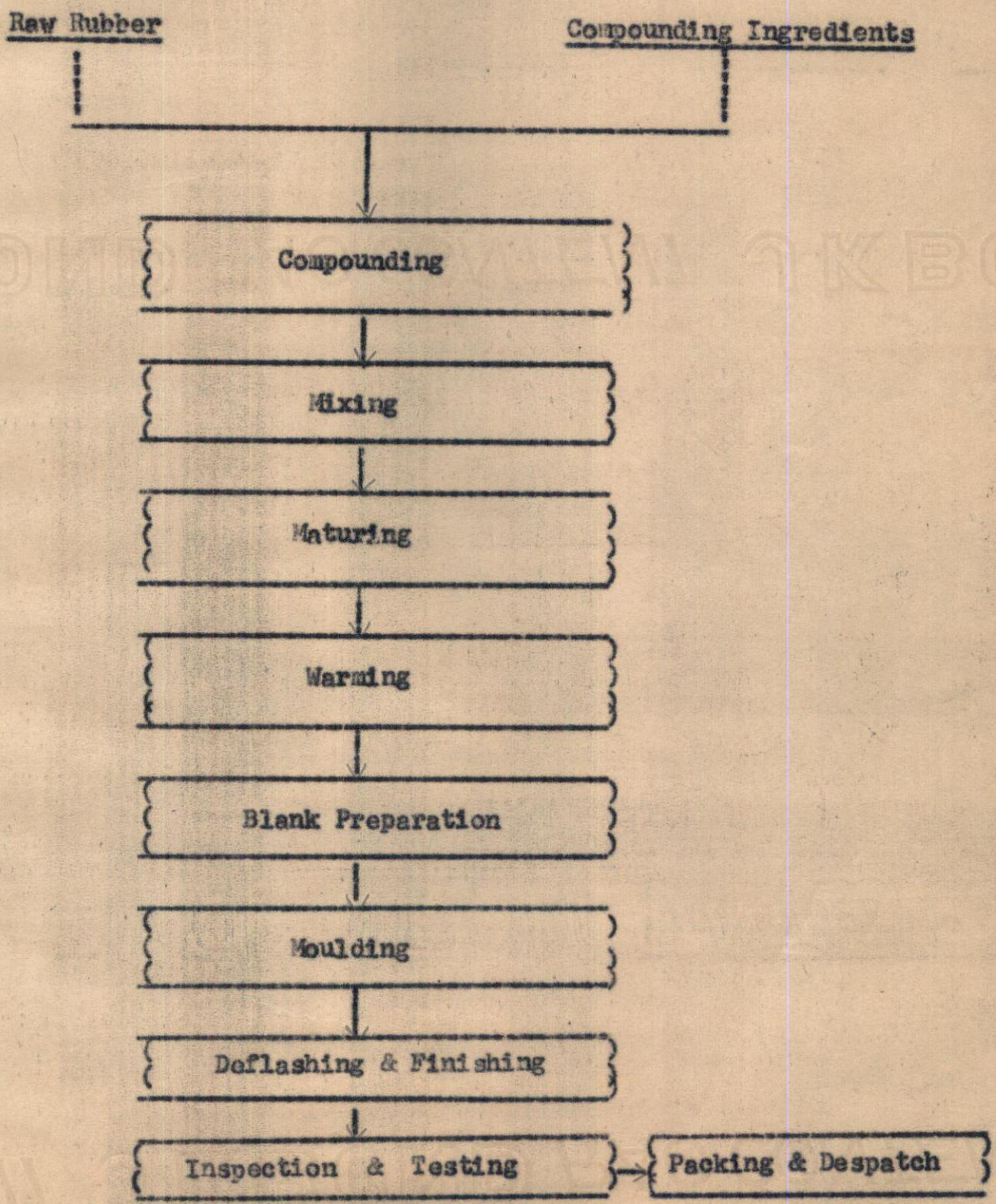
APPENDICES

APPENDIX.I

PROCESS FLOW SHEET



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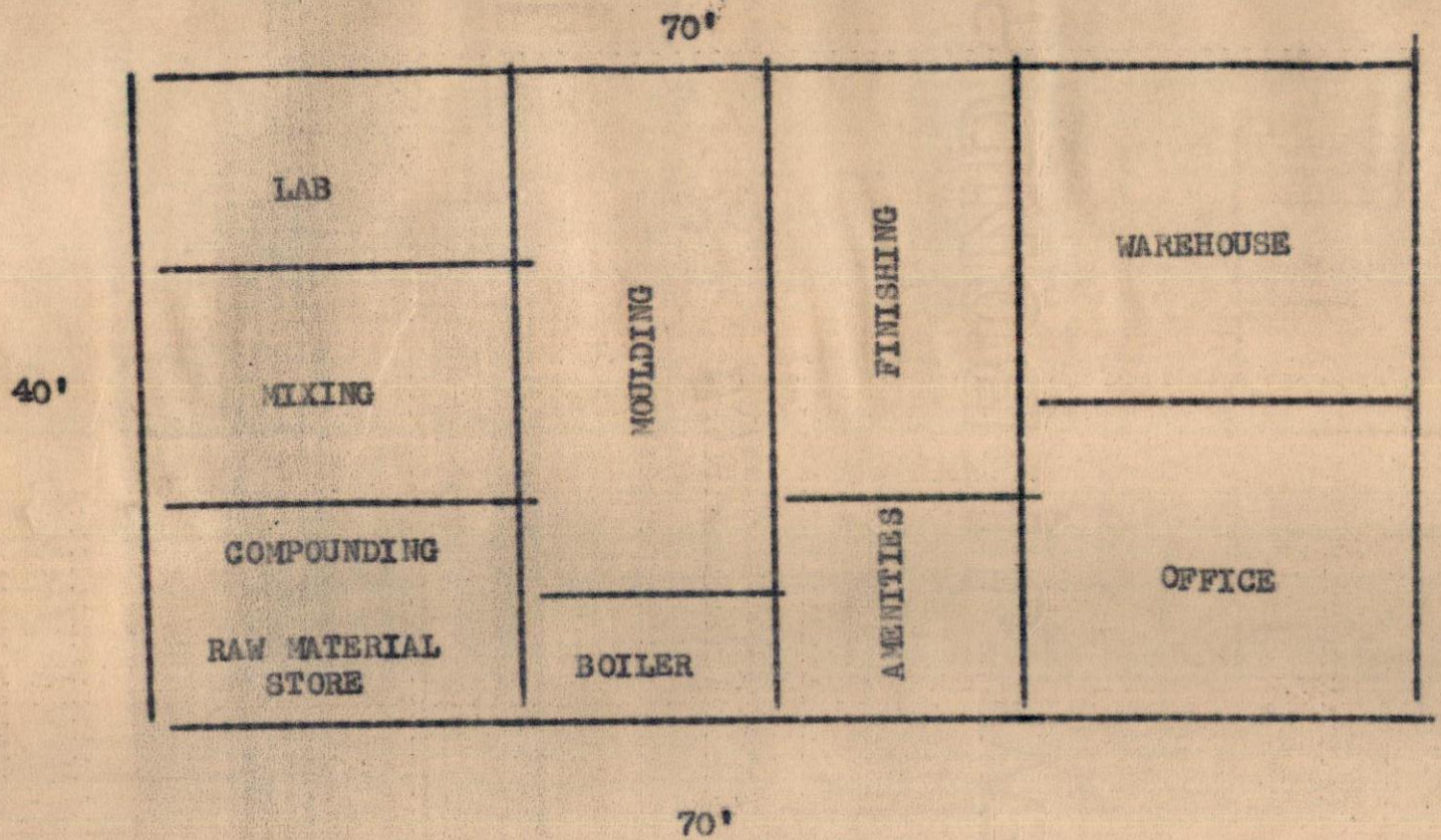

PLANT LAYOUT

APPENDIX. III

Compound Formulation for Rubber Rail Pads

Material	Parts/wt.	Batch wt. based on 15%
NR	100.00	7.674
PBN	1.0	0.076
ZnO	5.0	0.383
Stearic Acid	2.0	0.153
SRF	60.0	4.850
China Clay	20.0	1.532
Process Oil (Ar.)	3.0	0.230
Paraffin wax	1.0	0.076
CBS	0.85	0.065
TMT	0.15	0.009
S	2.50	0.191
Cure	8' at	153°C

APPENDEX IV

Total Staff & Labour Requirement

Category		Total Staff/day
1. Administrative Staff	..	3
2. Technical Staff	..	3
3. Labourers	..	19
Total	..	25

Contd....45

APPENDIX. V

List of Suppliers of Raw Materials and Machinery

Raw Materials

i) Natural Rubber : Available from the local market.

ii) Accelerator & Anti-oxidant

1. Alkali & Chemical Corporation of India Ltd.,
   Rishra, Dt. Hooghly, W. Bengal.
2. Bayer (India) Ltd.,
   82, Vir Nariman Road,
   Bombay. 1.
3. Mindia Chemicals Ltd.,
   Wakefield House, Ballard Estate,
   Bombay. 1.

iii) Sulphur

Asiatic Chemical Co.
71, Canning Street,
Calcutta. 1.

iv) Zinc Oxide

1. Anand Chemicals
   8 Horminan Circle, Fort,
   Bombay. 1.
2. Para Chemicals,
   Cochin. 11.

v) Carbon Black

United Carbon India Ltd.,
Backbay Reclamation, Bombay. 400 020.

vi) Process Oil

Esso Standard Eastern Inc.
17 J Tata Road, Bombay 400 031.

viii) Stearic Acid

Goderej Soaps Pvt. Ltd., Vikroli, Bombay. 400 079.

Contd....46

ix) Paraffin Wax : Aristo Enterprises,
10th Khatwadi, Bombay. 4.

x) China Clay : English India Clays,
Trivandrum.

xi) Suppliers of Machinery

Mixing Mill

1. Richardson & Crudas Ltd.,
Byculla Iron Works, Bombay. 400 008.

2. Kelachandra Iron & Steel Works,
Chingavanam, Kottayam, Kerala.

Hydraulic Process

1. Sohal Engineering Works,
Tulsi Pipe Road, Mahalekshmi,
Bombay. 400 013.

2. Indian Expeller Works,
17A, Saitafalwadi,
Bombay. 400 010

Boiler

Varsha Boilers Private Ltd.,
Green house, Bombay. 400 011.

Suppliers of Laboratory Equipments.

1. Synthetic & Chemicals Ltd.,
7J, Tata Road, Bombay. 1. - Compression set apparatus.

2. Kamal Metal Industries,
Arun Park, Bhaipur,
Khokra, Ahmedabad. - Tensile Tester.

3. P. Dalal & Co.
Kokad Chambers, Worli, Bombay.8 - Hardness Testers.

4. All India Lab-Equipment Corpn.
Cathedral Street,
Bhuleshwar, Bombay. 72. - Chemical Test Eqpt.

5. British Physical Lab,
Commra Centre, Pardeo Market
Bombay. - Electrical testing Equipments.

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