



सत्यमेव जयते

GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

Technical Audit Report

on

Maintenance/Manufacturing Process of Elastic Ring

Report No.: RDSO/2018/EL/TAR/0015 Rev. '0'

Issue Date: 20.02.2018




Approved by	डॉ. म. प्रकाश 20.2.18
Sr. EDSE(Co-Ord)	Signature

Issued by
Electrical Directorate
Research, Designs and Standards Organisation
Manak Nagar, Lucknow-226011

Prepared by	Checked by	Issued by

Status of Revision

SN.	Date of Revision	Page No.	Revision	Reason for Revision
1.		All	0	First Issue

Prepared by	Checked by	Issued by
		

Technical Audit at CLW/CRJ**Date: 09.11.2017****1. INTRODUCTION:**

Elastic rings are used in the traction link of WAP5/WAP7/WAG9 type of three phase electric locomotives to transmit the tractive effort from bogie to body. Traction link provides a permanent connection between the bogies and the locomotive body. The link rod is provided between two pivot points, one on the locomotive body under frame, the other on the end transom of the bogie, permitting lateral movement but restraining longitudinal movement. Recently 5 nos. of failures of Elastic rings of M/s Avadh Rail Infra Limited, Haridwar make was reported by Zonal Railway (Sheds) in newly commissioned locomotives from CLW as below.

SN	Loco No.	Shed	Date of Commissioning	Date of Failure
1	30495	WAT	31.3.2017	24.05.2017
2	31924	WAT	Not Commissioned	16.05.2017
3	31907	WAT	Not Commissioned	11.08.2017
4	31829	BNDM	09.09.2017	07.10.2017
5	31694	TATA	23.03.2016	04.01.2017

In view of above mentioned failure in newly commissioned locomotives it was decided to conduct a technical audit of fitment process of elastic ring at CLW as well as manufacturing process at M/s Avadh Rail Infra Ltd. Haridwar. Points observed during audit are given in this report.

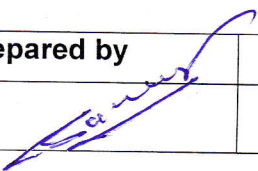

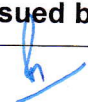
2. Availability of latest guidelines and procedures

- During the visit, it was observed that latest instructions issued by RDSO were available with the concerned SSE's (Section Supervisors).

Recommendation

- All concerned staff should be made aware of latest SMI/MS/TC issued from RDSO. Following guidelines are issued in this regard:

Sl.No.	Guideline no.	Description
1	RDSO/2007/EL/SPEC/0053 Rev '0' with Amendment no.1	Technical specification for Elastic ring used in 3-phase Electric locomotives.
2	RDSO/2009/EL/SMI/0259 dated 09/12/2009	Maintenance Practices and use/replacement of spares/materials for Traction link and housing for 3-phase electric locomotives.
3	RDSO/2017/EL/SMI/0316 dated 09/10/2017	Fitment procedure/Replacement schedule of Elastic ring in 3-phase Electric locomotives

Prepared by	Checked by	Issued by
		

3. Procurement and storage of Elastic ring.

- Elastic ring was being purchased as per latest specification from the approved sources.
- Elastic ring was being stacked in non-air conditioned atmosphere.



Fig.1: Storage of Elastic ring in main store at CLW (not recommended)



Fig.2: Storage of Elastic ring in shop at CLW (not recommended)

Recommendation:

- Elastic ring should be stored in air conditioned room as it is a rubber item. Also in the store depot, system should be there to ensure first in first out to avoid storage for a long time and use of material before expiry of shelf life.

Prepared by	Checked by	Issued by

4. Maintenance Practices

- Anti-rust solution was not being removed from inner surface of pivot housing before fitment of Elastic ring in the housing.

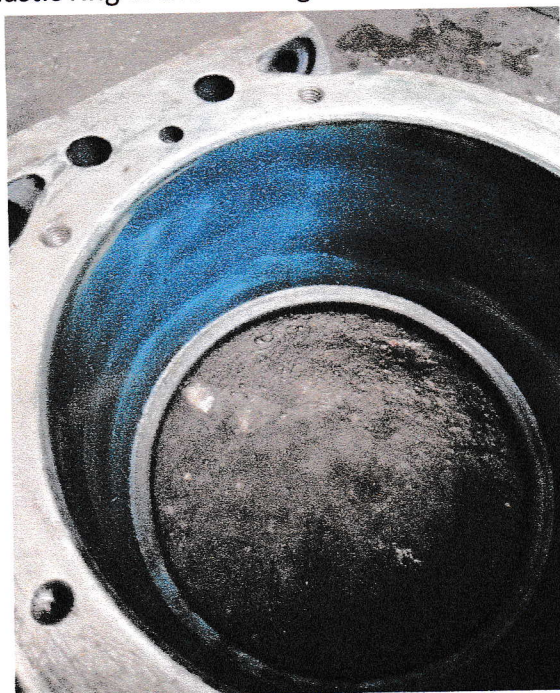


Fig.3: Anti-rust solution was not removed before fitment

- It was found that pivot head was not smoothened properly and Elastic ring was being fitted. Only after asking for the smoothness of pivot head it was smoothened properly by the staff.

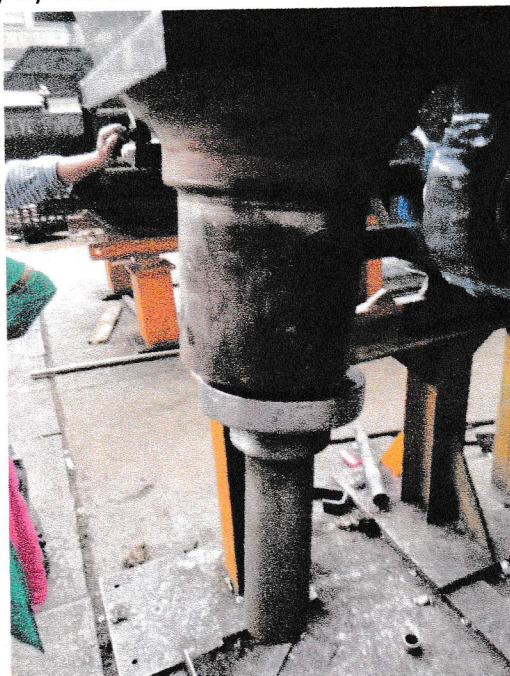


Fig.4: Pivot head was not smoothened properly before fitment of Elastic ring

Prepared by	Checked by	Issued by
<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>

- There were two hydraulic press machines in the shop. Out of two, pressure gauge was available in only one of the hydraulic press which was not in working condition during the visit. Other hydraulic press without pressure gauge was being used.



Fig.5: Hydraulic press without pressure gauge being used for fitment of Elastic ring at CLW

- Gap between Retaining plate and Elastic ring as per the latest SMI no. RDSO/2017/EL/SMI/0316 Rev '0' was not being ensured.
- Manufacturing date was not being punched on the Elastic rings of M/s Acla werke make and M/s Avadh Rail Infra Ltd.

Recommendation:

- Removing of anti-rust solution and cleaning of pivot housing is essential in all cases. It should be ensured that the pivot head is free from all burrs and have a smooth surface.
- Spare hydraulic press with working pressure gauge should be provided in the section and pressure during pressing of Elastic ring on the pivot head should be maintained as per SMI no. RDSO/2017/EL/SMI/0316 Rev '0'.
- As per SMI no. RDSO/2017/EL/SMI/0316 Rev '0' it should be ensured that there is a small gap between retaining plate and Elastic ring. This can be ensured with the help of Feeler gauge.
- Manufacturing date should be punched in all makes of elastic ring. CLW/Zonal Railways may ensure this during inspection of material against purchase order.

Prepared by	Checked by	Issued by

5. Problem noticed in M/s Avadh rail infra Ltd make Elastic rings

- One no. of Elastic ring of M/s Avadh rail infra Ltd make failed during fitment was shown during the visit.

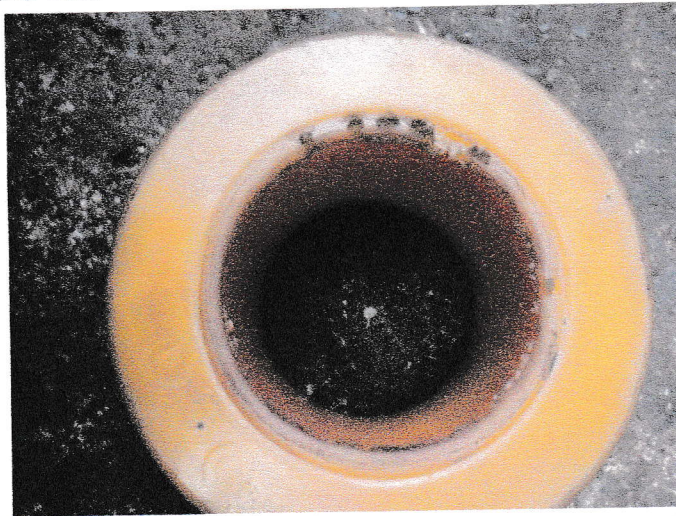


Fig.6: M/s Avadh rubber make Elastic ring failed at CLW during fitment

It got bulged during the fitment itself. It seems that there is some problem in Elastic ring.

- New elastic rings of all the three make were compared.

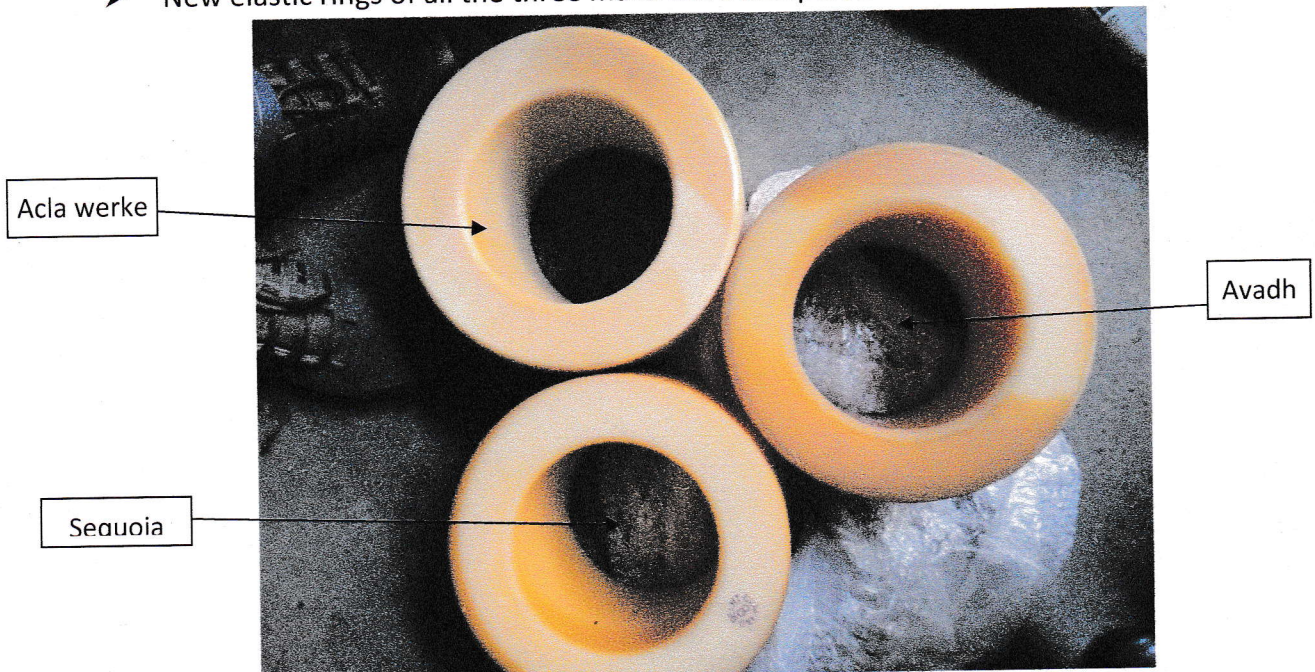


Fig.7: New elastic rings of all the three make supplied to CLW

It was found that surface finish of Elastic ring were at variance with each other.

Prepared by	Checked by	Issued by
<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>

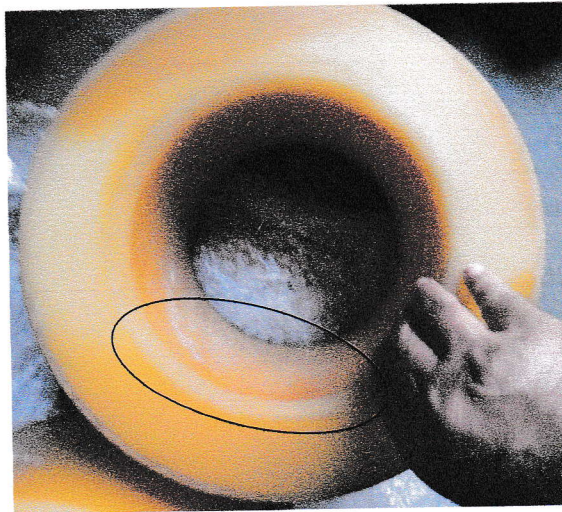
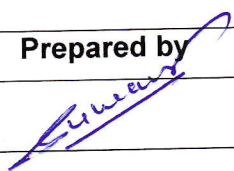
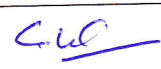
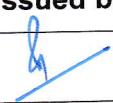


Fig.8: Improper surface finish of Elastic ring found during Inspection at CLW

- CLW was advised to ensure proper inspection of Elastic rings. Any visible defects should be pointed out at the time of inspection and material with defect should not be accepted.
- In view of the failures reported, a comprehensive quality audit was carried out at manufacture's works. The brief of report is enclosed at **Annexure-A**.

Prepared by	Checked by	Issued by
		

Annexure-A**QUALITY AUDIT REPORT ON PREMATURE FAILURES OF ELASTIC RING OF
M/s. AVADH RAIL INFRA LIMITED, HARIDWAR****1.0 Introduction:**

1.1 Recently 5 nos. of failures of Elastic rings of M/s Avadh Rail Infra Limited, Haridwar make was reported by Zonal Railway (Sheds) in newly commissioned locomotives from CLW as below.

SN	Loco No.	Shed	Date of Commissioning	Date of Failure
1	30495	WAT	31.3.2017	24.05.2017
2	31924	WAT	Not Commissioned	16.05.2017
3	31907	WAT	Not Commissioned	11.08.2017
4	31829	BNDM	09.09.2017	07.10.2017
5	31694	TATA	23.03.2016	04.01.2017

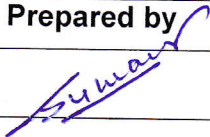


1.2 A meeting was conducted at RDSO on 25.09.2017 to discuss the premature failures of elastic ring supplied by M/s. Avadh. It was decided to conduct quality audit of the firm. Observations are as under:

2.0 Quality Raw material:

Drum of raw material Desmodur and Butanedoil for cast polyurethane elastomer is obtained from Covestro/Germany (earlier Bayer). Incoming material is being verified by supplier test report. Firm is having adequate covered area for storage of raw material as well as finished. Raw material is being used on First in first out basis.

As per the specification no. RDSO/2007/EL/SPEC/0053 (Rev-0) of elastic ring vendor shall obtain raw material for cast polyurethane and manufacturing technology/process from one of the following reputed cast polyurethane manufacturers: Bayer, BASF, Huntsman, Mitushibishi, Uniroyal- Crompton, Dow Chemical, Dupont or Baule.

Firm is obtaining raw material and technology for reputed source i.e. Covestro/Germany Spin off of Bayer/Germany. Raw material drum are shown in Figure 1 & 2 for ready reference. Therefore, it is concluded that raw material used is of proper quality.

Prepared by	Checked by	Issued by
		

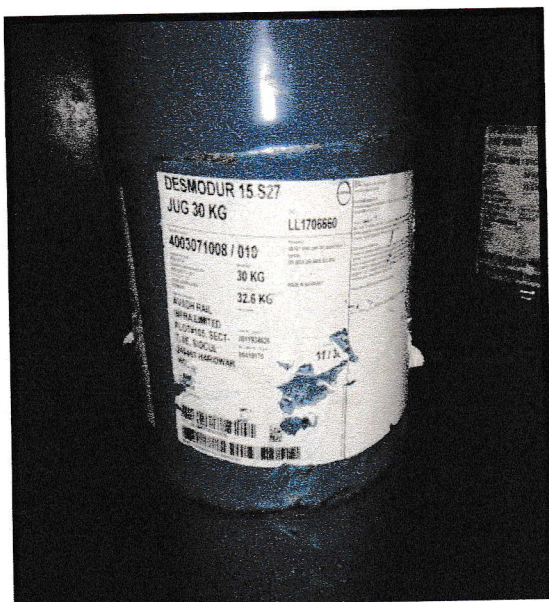


Fig.1- RAW MATERIAL(DESMODUR)

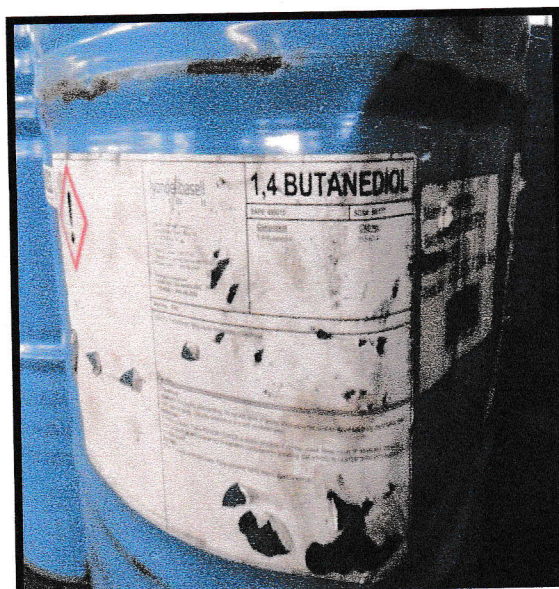
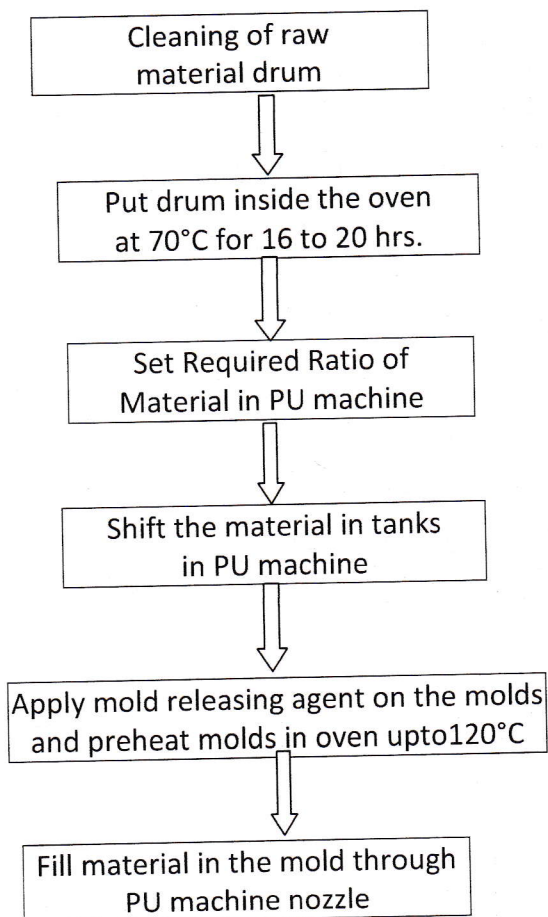


Fig.2- RAW MATERIAL(BUTANEDOIL)

3.0 Manufacturing Process:

Manufacturing process of the firm was found as per flow chart as given below-

3.1 Moulding Process:



Prepared by	Checked by	Issued by
<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>

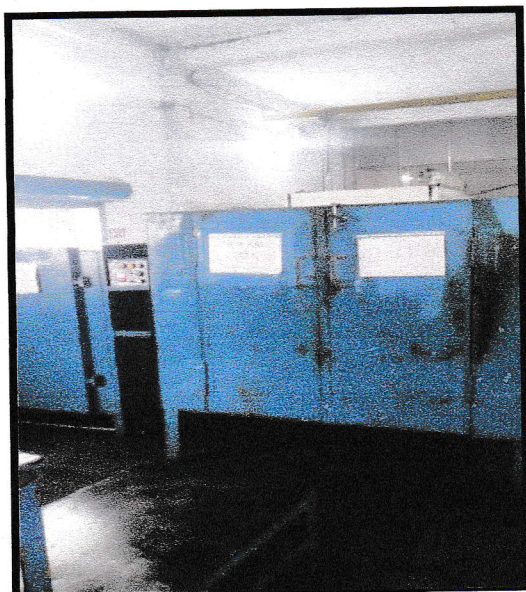


Fig.3-HOT AIR OVEN
Range: 0 to 250°C
Make: Prolific

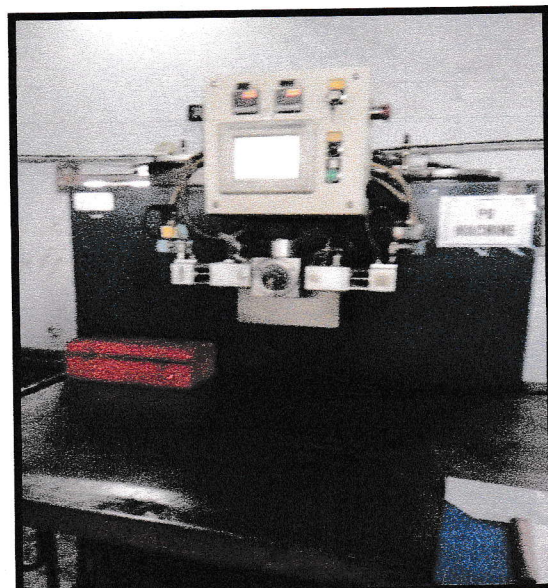


Fig.4- PU(POURING) MACHINE



Fig.5-RING MOLD

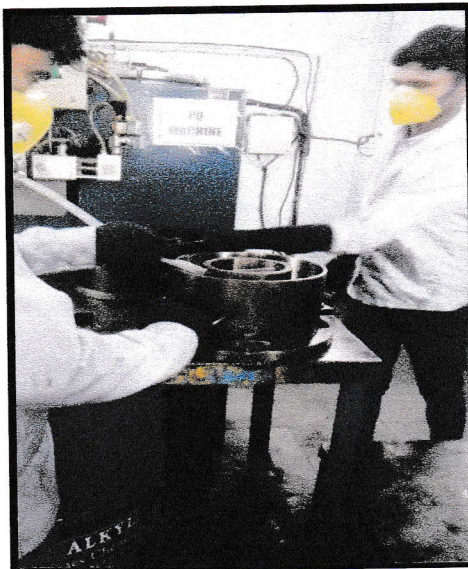


Fig.6-FILLING PROCESS

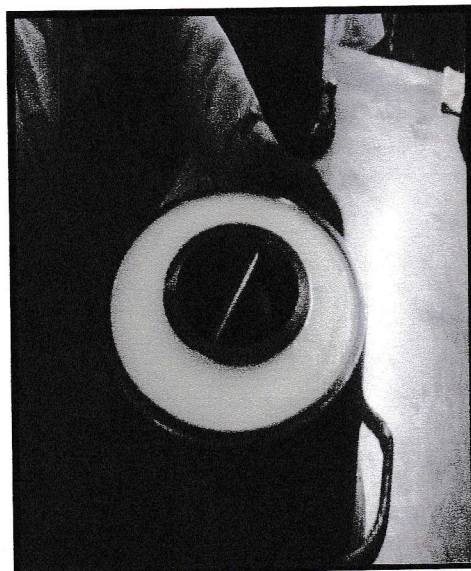


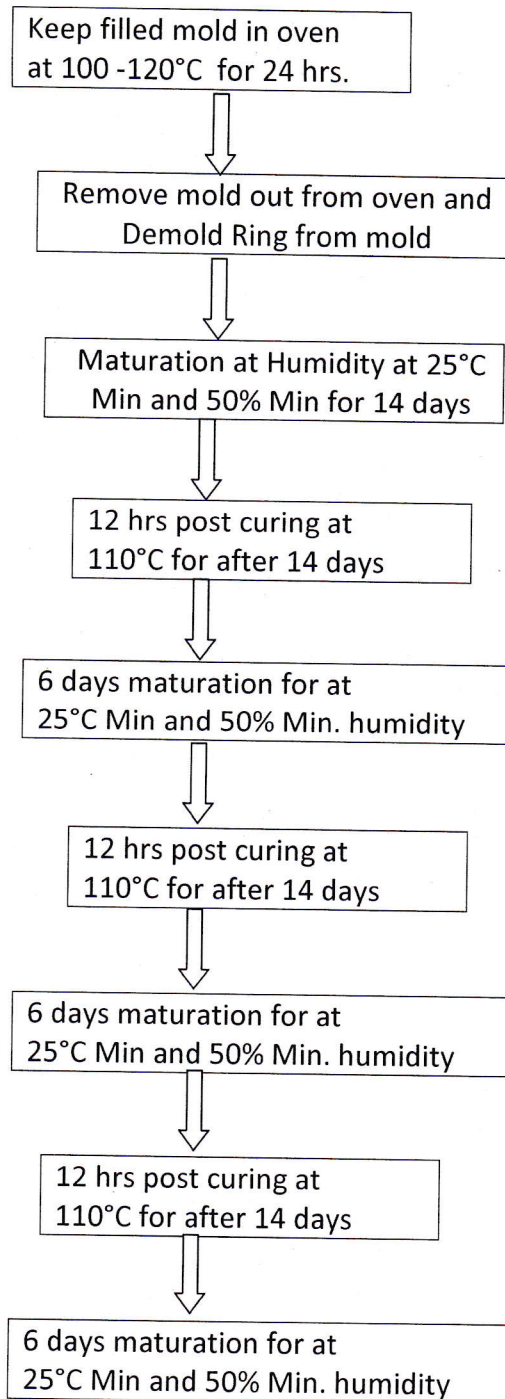
Fig.7-FILLED MOLD

Various manufacturing processes as described in flow chart are indicated in figure-3 to figure-7 for ready reference. From the above it is found that manufacturing process is in order.

Prepared by	Checked by	Issued by
<i>Simran</i>	<i>C.R.</i>	<i>[Signature]</i>

3.2 Curing Process:

Curing process of Elastic ring is very important. During the inspection its process was found as under:-



Earlier M/s Avadh was keeping ring for maturation only for 7 days only. M/s Avadh has sent failed sample and their manufacturing process to M/s Covestro/Germany for failure investigation and suggestion for improvement of quality. M/s Covestro/Germany has reported that failure occurred due to hydrolysis or/and dynamic effects (melting due to inner heat buildup). M/s Covestro/Germany has recommended that maturation process must be

Prepared by	Checked by	Issued by
<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>

made in minimum 6 post curing steps in an air circulating oven (one week for each 5mm thickness) the part must go through cure process, each 6-7 days.

As per the guidelines of the M/s Covestro (attached as attachment-1), now complete curing and maturation is being done in 35 days. Maturation of ring is being ensured by the filled format attached at attachment-2. RDSO has suggested some changes in the format. Suggested format is attached as attachment-3.

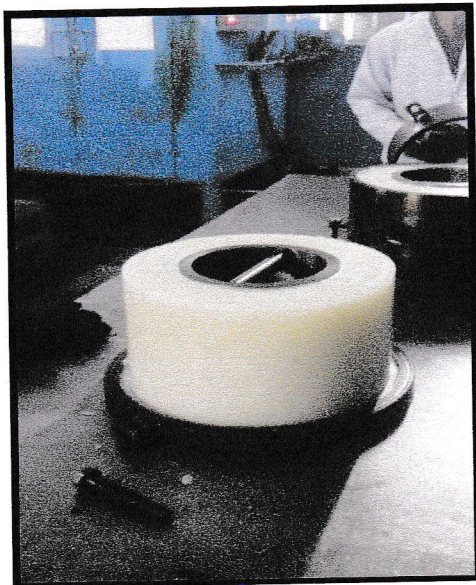


Fig.8- DE-MOLDING OF RING



Fig.9-HUMIDITY CHAMBER FOR MATURATION

From the above, it is observed that the firm has corrected its curing process as per the requirement.

4.0 Inspection and Testing:

Found proper lighting and cleanliness in the works premises. Following routine tests on one fresh sample developed by the firm was conducted. The details are given below:-

- (a) Visual Inspection
- (b) Dimension Check
- (c) Physical properties of material such as hardness, tensile strength, stress & elongation etc.
- (d) Compression set after 24 hrs at $70 \pm 1^\circ\text{C}$
- (e) Tear Propagation Resistance
- (f) Density
- (g) Specific gravity
- (h) Load Deflection



Fig.10-LOAD DEFLECTION TEST
Range: 0-1000kN

Prepared by	Checked by	Issued by
<i>[Signature]</i>	<i>C. G. G.</i>	<i>[Signature]</i>

5.0 Marking of the Elastic ring:

5.1 It was observed that batch number i.e. manufacturing month/year was not punched on the Elastic rings. Only name of firm & Specification were mentioned as shown in figure-11 below. Firm was advised to punch batch number, manufacturing month/year on the rings. Firm has started punching lot number/ batch on the rings as shown in figure-12. As per punched lot/batch on the ring, manufacturing month/year can be traced in internal record of the firm.

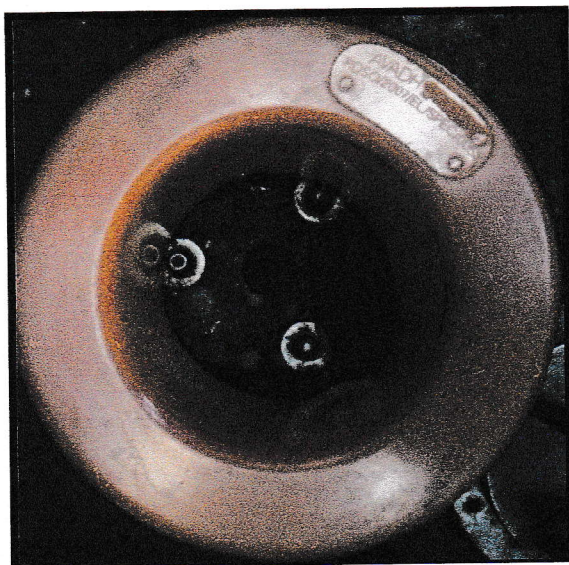


Fig.11 No marking of batch number
AVADH
RDSO/2007/EL/SPEC/0053

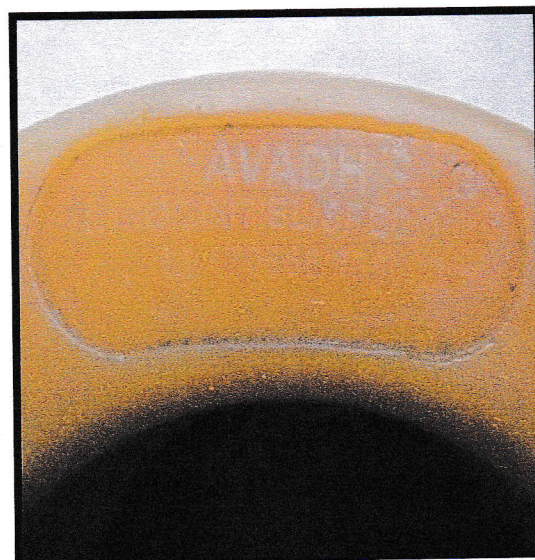


Fig.12 Batch number marked
AVADH
RDSO/2007/EL/SPEC/0053
LL170666/5650

5.2 Mechanical finishing (machining) of elastic rings was not found equal around the elastic ring diameter. As per the Covestro/Germany guidelines mechanical finishing (machining) should be done after 1st week of maturation period because the material matures from outside to the inside. M/s Avadh Rubber were advised to follow the Covestro/Germany guidelines. It is also recommended that Mechanical finishing (machining) of elastic rings shall be done with using proper radius gauge for equal surface finish around the elastic ring diameter.

5.3 As the firm has taken action to improve their process, a continuous watch on the performance to be kept and performance feedback from Zonal Railways to be taken to evaluate the performance for needful.

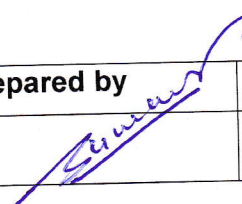
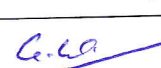

.....XXXXXXXXXX.....

Prepared by	Checked by	Issued by
<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>

Attachment-2

Avadh Rail Infra Ltd.		Elastic Ring Process Dat Sheet		Doc. No.- PCS-07- P-001/03/00 Rev-00.0	
Process Name - Material Pre- Heating					
Material Name -	Desmodore			BCD	
Hot Air Oven	Temperature: 70 ^o C				
Drum In	Time- 3:00 pm			Date - 10/11/17	
Drum Out	Time- 10:00 Am			Date - 11/11/17	
Process - Calibration - Check Calibration Sheet					
A: OK		B: OK			
Process Name - Pouring (Moulding)					
Mould Temperature-	120 ^o C	120 ^o C	120 ^o C		
Material Temperature-	100	100	100		
Ring Curing In Time -	8:10 pm	5:00 pm	7:40 pm		
Ring Curing out Time -	9:55 pm	5:45 pm	8:25 pm		
Process Name- Post Curing for 16 to 20 hrs. at 110-120°C					
Ring In Time & Date- 11/11/17	4:10 pm	6:00 pm	8:40 pm		
Ring Out Time & Date - 12/11/17	11:00 Am	12:00 pm	4:00 pm		
Process Name - Maturation at Temp. 25°C Min and Humidity 50 % Min For 14 days					
Elastic Ring Room In Time & Date - 12/11/17	11:00 Am	12:00 pm	4:00 pm		
Elastic Ring Room Out Time & Date - 26/11/17	8:00 pm	8:00 pm	8:00 pm		
12 hrs. Post curing At 110°C for after 14 days					
IN	Date	Time	out	Date	
	26/11/17	8:00 pm		27/11/17	8:00 Am
6 days maturation for at 25°C min. and 50% min humidity					
IN	Date	Time	out	Date	
	27/11/17	8:00 Am		03/12/17	7:00 pm
12 hrs. Post curing At 110°C					
IN	Date	Time	out	Date	
	03/12/17	7:00 pm		04/12/17	7:00 Am
6 days maturation for at 25°C min. and 50% min humidity					
IN	Date	Time	out	Date	
	04/12/17	7:00 Am		10/12/17	9:00 pm
12 hrs. Post curing At 110°C					
IN	Date	Time	out	Date	
	10/12/17	9:00 pm		11/12/17	9:00 Am
6 days maturation for at 25°C min. and 50% min humidity					
IN	Date	Time	out	Date	
	11/12/17	9:00 Am		17/12/17	

Prepared by -
Designation -Ashutosh Kumar
(Sr. Operator)Final checked by -
S.P. Tiwari
(Prod. manager)Checked by -
Designation -Sachin Kumar
(Shift Eng.)

Prepared by	Checked by	Issued by
		

Attachment-1



Thermal post-treatment/maturing

To obtain the high-grade material properties, all the cast parts must be thermally post-treated (conditioned) for 24 hours at 110 °C. They should then be stored at temperatures of 25 °C to 30 °C at a relative humidity of about 50 %. For articles up to a thickness of 6 mm, a storage period of 2 weeks is adequate. For thicker parts or parts that are cast over a large area on to another material, it is necessary to perform additional conditioning cycles. The following diagram shows the conditioning data for different article thicknesses.

parts < 6 mm	24h; 110°C	14 days at min. 25°C; min. 50% r.h.					
parts 6-12 mm	24h; 110°C	14 days at min. 25°C; min. 50% r.h.	12h; 110°C	6 days at min. 25°C; min. 50% r.h.			
parts 12-20 mm	24h; 110°C	14 days at min. 25°C; min. 50% r.h.	12h; 110°C	6 days at min. 25°C; min. 50% r.h.	12h; 110°C	6 days at min. 25°C; min. 50% r.h.	
parts > 20 mm	24h; 110°C	14 days at min. 25°C; min. 50% r.h.	12h; 110°C	6 days at min. 25°C; min. 50% r.h.	12h; 110°C	6 days at min. 25°C; min. 50% r.h.	12h; 110°C
		1st + 2nd week	3rd week	4th week	5th week		

Note: Should mechanical finishing (machining) be planned, this should be carried out at the end of the first week because the material matures from the outside to the inside.

Very long maturing times can be avoided if an adjustable climatic cabinet is available. For articles with a thickness of up to 40mm, for example:

- Post-conditioning after demolding (24 hours at 110 °C)
- Placing in the conditioning cabinet (without cooling)
- Storage for 3 days at 60 °C and 90 % relative humidity (maturing)
- Storage for 3 days at 60 °C and 0 % relative humidity (drying)
- Removal and, if necessary, machining

During the entire post-treatment, ample contact of the cast parts with fresh air is required. They should not be stacked on top of one another or tightly packed together.

Prepared by	Checked by	Issued by

Attachment-3

FORMAT FOR QUALITY CONTROL OF ELASTIC RING						
Firm:		M/s Avadh Rail Infra Ltd.				
Lot /Batch No.				Quantity		
MATERIAL PRE HEATING PROCESS:						
Material:		DESMODUR		BDO(BUTANEDOIL)		
Temperature of Hot Air Oven		70°C				
Drum in	Time			Date		
Drum Out	Time			Date		
CALIBRATION PROCESS:(Check Calibration Sheet)						
Calibration for A:						
Calibration for B:						
POURING(MOULDING) PROCESS:						
Mould Temp.						
Material Temp.						
Ring Pouring Time						
Filled mold curing time after pouring						
Mold open Time						
POST CURING PROCESS:						
Post Curing for 24 hrs at 110-120°C						
Ring Curing in Time & Date						
Ring Curing out Time & Date						
MATURATION PROCESS:						
Maturation at Temp. 25°C Min and Humidity 50% Min for 14 days						
Ring Room in Time & Date						
Ring Room out Time & Date						
12 hrs Post Curing at 110°C for after 14 days						
1	IN	Date	Time	Out	Date	Time
	6 days maturation for at 25°C min. and 50% min. humidity					
	IN	Date	Time	Out	Date	Time
12 hrs Post Curing at 110°C						
2	IN	Date	Time	Out	Date	Time
	6 days maturation for at 25°C min. and 50% min. humidity					
	IN	Date	Time	Out	Date	Time
12 hrs Post Curing at 110°C						
3	IN	Date	Time	Out	Date	Time
	6 days maturation for at 25°C min. and 50% min. humidity					
	IN	Date	Time	Out	Date	Time

Prepared by

Checked by

Final Checked by

Prepared by	Checked by	Issued by
