INDIAN RAILWAYS

FUNCTIONAL REQUIREMENT (FR) SPECIFICATION

FOR

BRAKE GEAR BUSHES FOR ICF DESIGN B.G. MAINLINE COACHES

DRAFT

Issued by

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FUNCTIONAL REQUIREMENT SPECIFICATION FOR BRAKE GEAR BUSHES FOR ICF DESIGN B.G.MAINLINE COACHES

1.0 SCOPE

1.1 This FR Specification covers the technical requirements/provisions relating to material, tests and quality control facilities and does not include the necessary provisions of the contracts.

1.1 The brake gear bushes are to be used in ICF design BG Mainline Coaches.

1.2 For the purpose of deciding whether a particular requirement of the FR Specification is complied with, the final value observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS:2-1960. The number of significant places retained in the rounded off value shall be the same as that of the specified the values in this FR Specification.

1.4 While preparing this specification, due consideration has been given to the latest developments in the field of polymeric materials and process technologies, service requirements of the Indian Railways and practices followed in advanced countries

2 REQUIREMENTS

2.1 Material

2.1.1 The Brake Gear Bushes shall be made of virgin raw material. Use of regenerated/ reconstituted raw material from plastic scrap is not permitted. A guarantee shall be given by the manufacturer that no reconstituted and recovered material has been used for the manufacture of Brake Gear Bushes.

2.1.2 The Brake gear bushes shall be supplied in natural colour of resin and use of any external colouring agents is not permitted. The firm shall specify colour of resin at the time of registration.

2.1.3 The raw material shall be resistant to oil/ grease contamination. A certificate from the primary manufacturer of raw material will be required for compliance of this requirement.

2.1.4 The manufacturer shall have a valid tie-up in the form of a written Memorandum of Understanding (MOU)/contract with primary raw material supplier for manufacture of Brake Gear Bushes, covering raw material supplies and technical support including quality control at least for 10 years mentioning raw material details including grade.

2.1.5 The manufacturer shall produce to the inspection authority the record of raw material received from primary raw material supplier and details of supplies made to Railways/Production Units.

3 DIMENSIONS AND TOLERANCES

The Brake gear bushes shall be strictly manufactured as per the RDSO drawing number SKETCH-81039 with latest alteration.

4 CONSTRUCTION, WORKMANSHIP AND FINISH

The surface of the Brake gear bushes shall be smooth, free from moulding defects such as bubbles, surface streaks, splash marks, voids, surface sinking, crazing, cracks blistering of the surface. All edges shall be neatly finished and free from flash.

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5 PERFORMANCE REQUIREMENTS

5.1 The manufacture will have to assess the actual working conditions of Indian Railways and material offered for brake gear bush should perform satisfactory in existing working conditions.

5.2 The manufacture shall specify following basic property along with standard test method in their QAP for proper identification of raw material used in manufacture of Brake Gear Bush. A test certificate shall be submitted by primary raw material supplier in this regard. These tests shall be performed on standard test specimen prepared from raw material:

i. Melting point
ii. Density /Specific Gravity
iii. Water Absorption
iv. Ash content
v. Compressive Strength
vi. Tensile Strength
vii. Hardness
viii. Izod impact (Notched)
ix. Any other tests/properties relevant for identification of a particular raw material

5.3 The finished Brake gear bushes shall conform to the requirement given in the Table-2

Table – 2(A)
(To be measured on finished Brake Gear Bush)

Sr. No.	Property	Value	Unit	Test Method
1	Melting Point	Test Method & value to be specified by the manufacturer in their QAP		
2	Density/Specific Gravity			
3	Ash Content (Max.)			
4	Hardness	To be specified by the manufacturer in their QAP		As per Appendix D
5.	Water Absorption	To be specified by the manufacturer in their QAP		As per Appendix A

Table - 2(B)
(To be measured on finished Brake Gear Bush)

Sr. No.	Property	Value	Unit	Test Method
1	Drop Impact Strength Test (min)	To be specified by the manufacturer in their QAP	Kg-m	As per Appendix B
2	Wear Test – Mass Loss For 2 Hrs	Less than 0.60	%	As per Appendix C
3	Wear Test – Mass Loss For 24 Hrs or 50400 cycles.	Less than 1.2	%	As per Appendix C
4	Crush Strength Test (min)	As per Appendix E	tonne	As per Appendix E
5	Compressive Load Test Circumferential	As per Appendix F	tonne	As per Appendix F

5.4 Unless otherwise specified, all tests shall be carried out at a temperature of $27\pm2\ ^{0}C$ and relative humidity $50\pm5\%$.

6 TESTS AND SAMPLING CRITERIA FOR CONFORMITY

6.1 Tests

6.1.1 The tests for all the requirements laid down in this FR Specification are mandatory for product approval.

6.1.2 All the tests specified under clause 5.1 and Wear Test-Mass Loss (24 Hrs) specified in Table-2(B), shall constitute "Type Test" and shall be carried out at the time of approval of the firm and at an interval of one year or as decided by RDSO, Lucknow. Wear Test-Mass Loss (24 Hrs) shall be carried out on any one bush randomly selected.

6.1.3 The tests specified in Table-2(A) & 2(B) except, Wear Test-Mass Loss (24 Hrs) are "Acceptance Tests" and shall be carried out on each lot/ batch.

6.1.4 "Wear Test – Mass Loss for 2 Hrs/24 Hrs" as specified in Table 2(B) shall not be conducted on Item No. 11 of RDSO Drg. No. SK-81039 (latest alt.).

6.1.5 In case, nominal dimension of ordered bushes are not matching the nominal dimension given in the RDSO drawing No. SK-81039 (latest alteration), the tests specified under Table 2(A) shall only be carried out on each lot/batch.

6.2 Sampling criteria for conformity

6.3.1 The Acceptance Test shall consist of the following:

i. Visual Inspection
ii. Dimensional Check
iii. Melting Point (as per Table 2A)
iv. Density/Specific gravity (as per Table 2A)
v. Ash Content (as per Table 2A)
vi. Hardness (as per Table 2A)
vii. Water Absorption - 2 Hrs (as per Table 2A)
viii. Drop Impact Strength Test (as per Table 2B)
ix. Wear Test – Mass Loss For 2 Hrs. (as per Table 2B)
x. Crush strength test (as per Table 2B)
xi. Compressive Load Test Circumferential (as per Table 2B)

6.3.2 The inspection lot shall consist of 5000 Nos of bushes or part thereof.

6.3.3 The numbers of Brake gear bushes to be selected from the lot for Acceptance Test shall be as under:-

a	Visual Inspection	Minimum 20 Nos shall be drawn at random from each lot.
b	Dimensional Check	
c	Melting Point	Minimum 20 Nos shall be drawn at random from each lot and 1 bush shall be tested for c, d, e, f & g.
d	Density/Specific Gravity	
e	Ash Content	
f	Hardness	
g	Water Absorption- 2 Hrs	
h	Drop Impact Strength Test	Minimum 20 Nos shall be drawn at random from each lot and 1 bush each shall be tested for h, i, & j.
i	Crush Strength Test	
j	Compressive Load Test Circumferential	
k	Wear Test-Mass Loss- 2 Hrs	Minimum 20 Nos shall be drawn at random from each lot (consisting of all types of bushes) and 1 bush (except for item No. 11) shall be tested.

6.3.4 Sample selected for Acceptance Test shall conform to the requirements as laid down under Clause 6.1.3 & 6.1.5 of this FR Specification. Should any one of the test samples fail to meet

the requirements of Acceptance Test, double the number of samples from the same lot shall be drawn for re-testing. Should any of these samples fail, the entire lot shall be rejected.

6.3.5 In case of non-compliance in regard to dimensional check, the manufacturer may be given one chance to segregate the lot for dimensional conformity.

6.3.6 In the event of rejection of the lot, all the Brake Gear Bushes constituting the lot shall be made un-usable in the presence of the Inspecting Authority.

6.3.7 During inspection, Purchasing/ Inspecting Authority, at their discretion may conduct Type Test and the samples shall conform to the requirements as laid down under clause 6.1.2 of this FR Specification.

6.3.8 In case of any dispute at the Consignee's end regarding testing, the opinion of RDSO, Lucknow will be final.

6.3.9 RDSO may draw the samples for quality checks at its discretion and conduct tests at manufacturer's premises or at RDSO. If need arises, sample shall be sent to a reputed outside laboratory as decided between RDSO and manufacturer and testing charges shall be borne by the manufacturer.

7 APPROVAL OF FIRMS

7.1 Brake Gear Bushes shall be procured from RDSO approved firms only.

7.3 During bulk production, the supplier shall not alter any material or process after having successfully undergone the approval process.

7.4 The firm shall have all the testing and manufacturing facilities to be mentioned in QAP..

7.5 A request for the registration for the Brake Gear Bushes shall be made in the prescribed form to RDSO. The request for registration shall be accompanied with in-house test results and a valid copy of MOU as specified under clause 2.1.5 of this FR Specification.

7.6 The firm will be assessed by RDSO for compliance of FR specification & QAP in accordance with extant procedure. All tests mentioned in the FR Specification are mandatory for product approval.

7.7 Based on satisfactory assessment, verification of infrastructure facilities and type test, firm shall supply a minimum of 100 coach sets of Brake Gear Bushes for extensive field trial for a period of 18 months. Final approval of the firm will be granted in part-II after satisfactory performance of the field trials. The trial shall be carried out on 50 new coaches and 50 old coaches as per RDSO trial Performa. For the purpose of field trial, RDSO will nominate 2 to 3 Railways and Production units where trials will be carried out. In case manufacturer is procuring and using the same raw material and technology support from the primary raw material supplier with whose material and technical support the other manufacturer has already manufactured brake gear bushes and which have been cleared for regular used after successful field trials, the field trials will not be necessary before approval in part-II.

8 MARKING

Each Brake Gear Bush shall be suitably marked on the upper face with the following legend as per size and location indicated in the drawing by screen printing in such a way that it remain legible throughout service life of bush.

i. Manufacturer's name/ initial/ trade mark
ii. Month and year of manufacture
iii. Drawing Number/Part Number.

The markings should be clearly visible and readable.

9 PACKING

The bushes shall be securely packed in plastic bags as to permit convenient handling and to protect against loss or damage during transit and storage.

10 STORAGE

10.3 The bushes shall be stored in a cool and dry place, free from constraints, in the original packing.

10.4 Bushes shall be kept covered and free from exposure to bright light, particularly sunlight.

10.5 Bushes shall be stocked and arranged in such order as to ensure use of old stock first.

11 WARRANTY

The bushes supplied against an order shall bear a warranty of the contractor against defective material/workmanship and performance (worn out) for a minimum period of 24 months from the date of supply or 18 months from the date of fitment whichever is earlier. In case, any bush cracks/breaks or prematurely worn out within 18 months of service, it shall be replaced by new one free of cost within one month of receipt of information.

12. QUALITY CONTROL REQUIREMENTS

12.1 The firm should have acquired ISO: 9001-2008 certificate from certifying agency accredited to NABCB and the product for which the approval is sought should be broadly covered in the scope of the certification for manufacture and supply.

12.2 The Quality manual of the firm for ISO 9001-2008 should clearly indicate at any stage the control over the manufacturing and testing of the said railway product.

12.3 There should be a system to ensure the traceability of the product from raw material stage to finished product stage. The system should also facilitate to identify the raw material composition from the finish product stage.

12.4 It should be ensured that there is a Quality Assurance Plan for the product detailing the following various aspects.

- Organisation chart
- Process flow chart
- Stage inspection details from raw material stage to finished product stage.
- Parameters to be checked and level of acceptance of such parameters indicated and method to ensure control over them.
- Disposal system of rejected raw material and components

12.5 There should be at least one full time technologist having a minimum bachelor's degree in relevant field with experience of at least 5 years or a person with diploma in relevant field with 12 years experience. He should be free from day to day production, testing and quality control responsibilities. He should be mainly responsible for development of a product, analysis of products, control over raw material, and corrective action in case of difficulties in achieving the parameters.

12.6 Ensure that the in-charge of the Quality Control Section is having a qualification of minimum bachelor's degree in the relevant field and has a minimum of 5 years experience. Alternatively he should be a diploma holder with minimum of 12 years experience. He should be actively involved in day- to-day activities of quality control stage inspection compliance of QAP etc.

12.7 The firm must ensure that proper analysis is being done on monthly basis to study the rejections at various internal stages and it is documented.

12.8 The firm should ensure that latest version all the relevant specifications, IS Standards are available with the firm.

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13. DOCUMENTATION

Firm shall maintain the following documents/ records

13.1 A well documented Quality Plan.

13.2 Incoming raw material register with Test Certificates references of suppliers and internal test results.

13.3 Stage inspection results including finished products results.

13.4 Records of internal rejection and its analysis vis-à-vis action plan.

13.5 Records of final products inspection by external agencies (like RDSO), Non-Conformity Reports and case analysis as well as action taken thereof.

13.6 Records for maintenance of dies/moulds.

13.7 Ensure that proper systems are available for dealing with customer complaints.

13.8 Records of raw material received and supplies made to Railways against the raw material.

14. TRAINING

Training needs should be identified for all concerned officials and regular training shall be organized and imparted on maintenance of machines, quality assurance, safety parameters etc.

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APPENDIX- A

WATER ABSORPTION TEST- 2 Hrs

1. Mark and weigh two bushes of each type and record the weight.
2. In a tank of suitable size, heat water to $100^0C \pm 5^0C$.
3. Fully immerse the pre-weighed bushes in the water tank.
4. Turn off the tank heater and close the water tank with a lid.
5. Leave the bushes in the water tank for 2 hours.
6. After 2 hours, remove the bushes and wipe dry.
7. Weigh the bushes again.
8. Water Absorption should not be more than 0.75%.
9. Water Absorption % should be calculated as follows:

$$WA\% = \left\{ \frac{WBAI - WBBI}{WBBI} \right\} X\ 100$$

WA= Water Absorption

WBAI= Weight of Bush after Immersion

WBBI= Weight of Bush before Immersion

APPENDIX- B

DROP IMPACT STRENGTH TEST

The test shall be conducted on bushes of all types randomly selected. The Bush shall be placed in a fixture as shown in Fig.1. For all bushes, except Bush No. 11, a striker of 10 kg. weight shall be allowed to fall freely on the bush from a height of 1.50 meters. This should be repeated thrice. The bush should not show any crack when inspected immediately after the third fall.

For Bush No.11 of RDSO Drg. No. Sk-81039, a striker of 5 kg. weight shall be allowed to fall freely on the bush from a height of 1 meter.

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APPENDIX- C

WEAR TEST - MASS LOSS

Objective: To determine the moss loss of bush due to wear.

Test specimen: Finished bush

Apparatus: A schematic diagram of the Test Rig is shown in Fig.2. The features of test rig are given below: -

1. Power Source: - Electrical Motor of capacity min. 3HP
2. Speed Reduction Gear Box: - Capable to reduce the electrical motor speed to minimum 35 RPM.
3. Linkage: - To covert rotary motion to oscillatory motion. Linkage should be such that mandrel can oscillate minimum 35 cycles/ minute at an angle of minimum 30^0 from the mean position.
4. The diameter of mandrel to be kept equivalent to pin diameter to be used for the bush. The surface finish of the mandrel to be kept N5 and electroplated to 25 micron to service grade No. 3 of IS:1068.
5. Arrangement for applying the load of 20KN on the bush and maintained throughout the test.
6. The weighing device of measuring accuracy to 1mg.
7. Five digit counter attached to test rig to count oscillation cycles.

Procedure:

Bush shall be weighed and subsequently mounted on mandrel of Wear Test Rig and subjected to a compressive load of 20 KN. The test Rig shall than be switched on for specified period of time. The operating speed to be kept minimum 35 cycles/minute. After the test duration (2hrs/24hrs), the bush shall be removed, and weighed. The mass loss in percent due to wear after test shall be calculated as under:

$$\text{Moss loss in \%} = \left\{ \frac{\text{Initial Weight of Bush - Final Weight of Bush}}{\text{Initial Weight of Bush}} \right\} \text{X } 100$$

For Bush of No 7 of RDSO Drg. No. Sk-81039, the collar should be removed and then tested.

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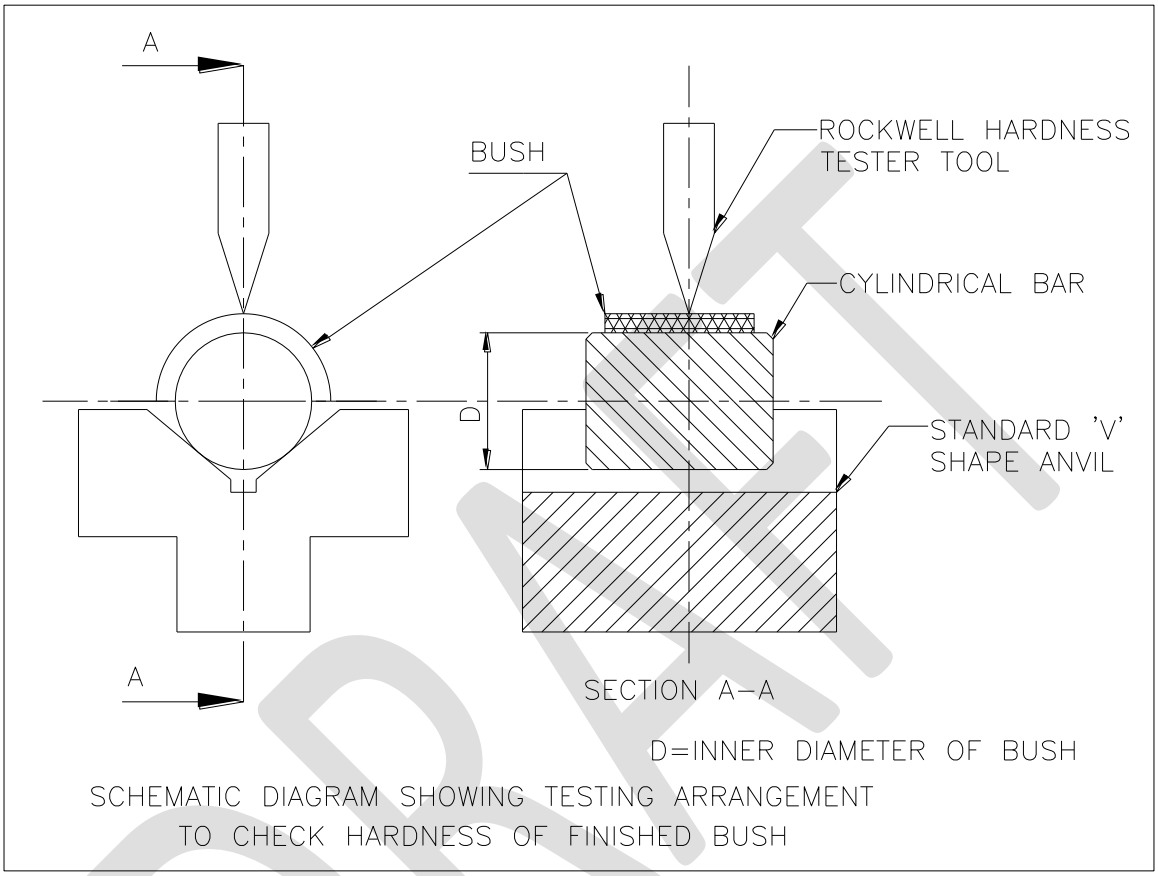
APPENDIX- D

HARDNESS TEST FOR FINISHED BUSH

Test Specimen: Longitudinally half cut pieces from finished bush.

Apparatus: Standard 'V' shape anvil and cylindrical bar with diameter equivalent to inner diameter of bush as per arrangement shown below.

Testing Procedure: As per ASTM D-785



SCHEMATIC DIAGRAM SHOWING TESTING ARRANGEMENT TO CHECK HARDNESS OF FINISHED BUSH

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APPENDIX- E

CRUSH STRENGTH TEST

The test shall be carried out with machine speed of 10 ± 5 mm/minute. Each type of Bush shall be placed in a fixture as shown in Fig-3. The Brake Gear Bushes for Item No. 1 to 10 of RDSO drawing SK-81039 (Latest alteration) shall be subjected to load of 3 t and released immediately. The Brake Gear Bush for Item No. 11 shall be subjected to load of 1 t and released immediately. The outer and inner diameter and length of bushes shall be checked after release of load and the dimensions should be within the tolerances specified in the drawing.

Further, the bush shall be subjected to the relevant load stipulated below and released immediately. Bush should not crack/break even after permanent set or deformation.

Sr. No.	ITEM No. of RDSO Drawing number SKETCH-81039	Minimum Load (tonne) per Bush
1	1	5
2	2	6
3	3	9
4	4	14
5	5	14
6	6	14
7	7	16
8	8	5
9	9	6
10	10	9
11	11	2

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APPENDIX- F

COMPRESSIVE LOAD TEST CIRCUMFERENTIAL

The test shall be carried out at machine speed of 10 ± 5 mm/minute. The bush shall be placed in a fixture as shown in Fig.4 and shall be subjected to respective loads as shown below, and the load shall be released immediately. At maximum load the sample shall not crack/break even after permanent set or deformation.

Sr.No.	Item of RDSO Drg. No. Sketch -81039	Minimum Load (tonne) per Bush
1	1	7
2	2	7
3	3	7
4	4	7
5	5	7
6	6	7
7	7	7
8	8	7
9	9	6
10	10	4
11	11	1

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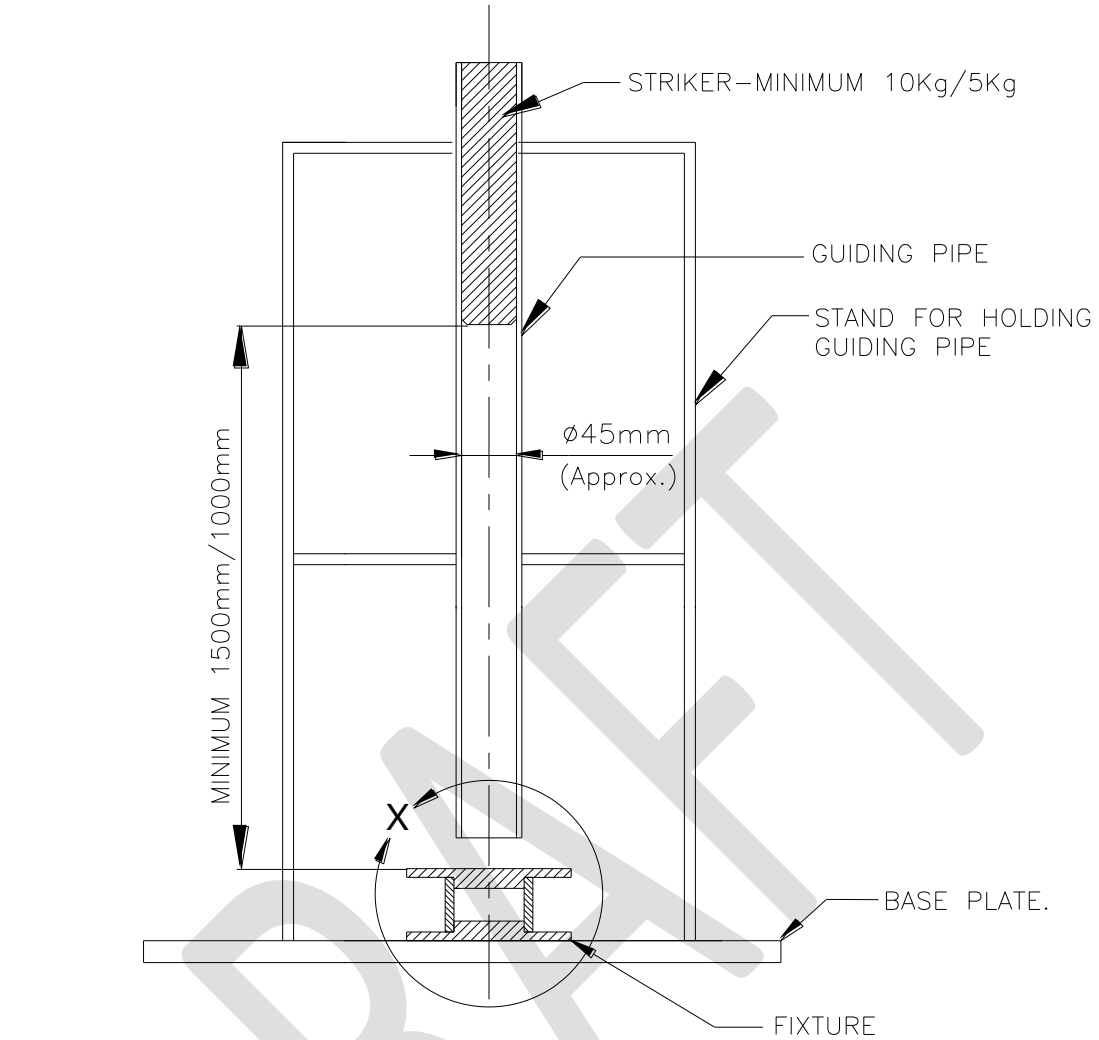

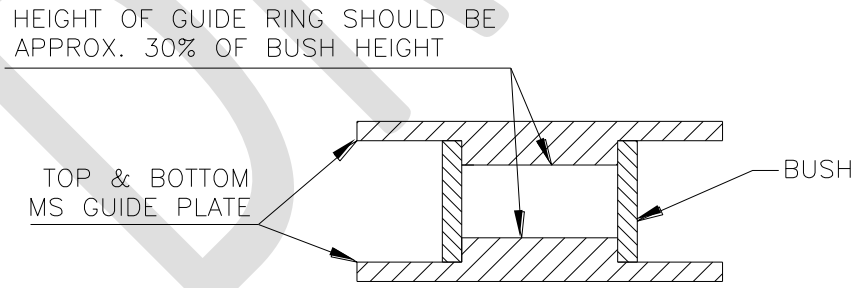

DETAIL AT- 'X'

Fig.1

SCHEMATIC DIAGRAM
FOR
DROP IMPACT STRENGTH TEST

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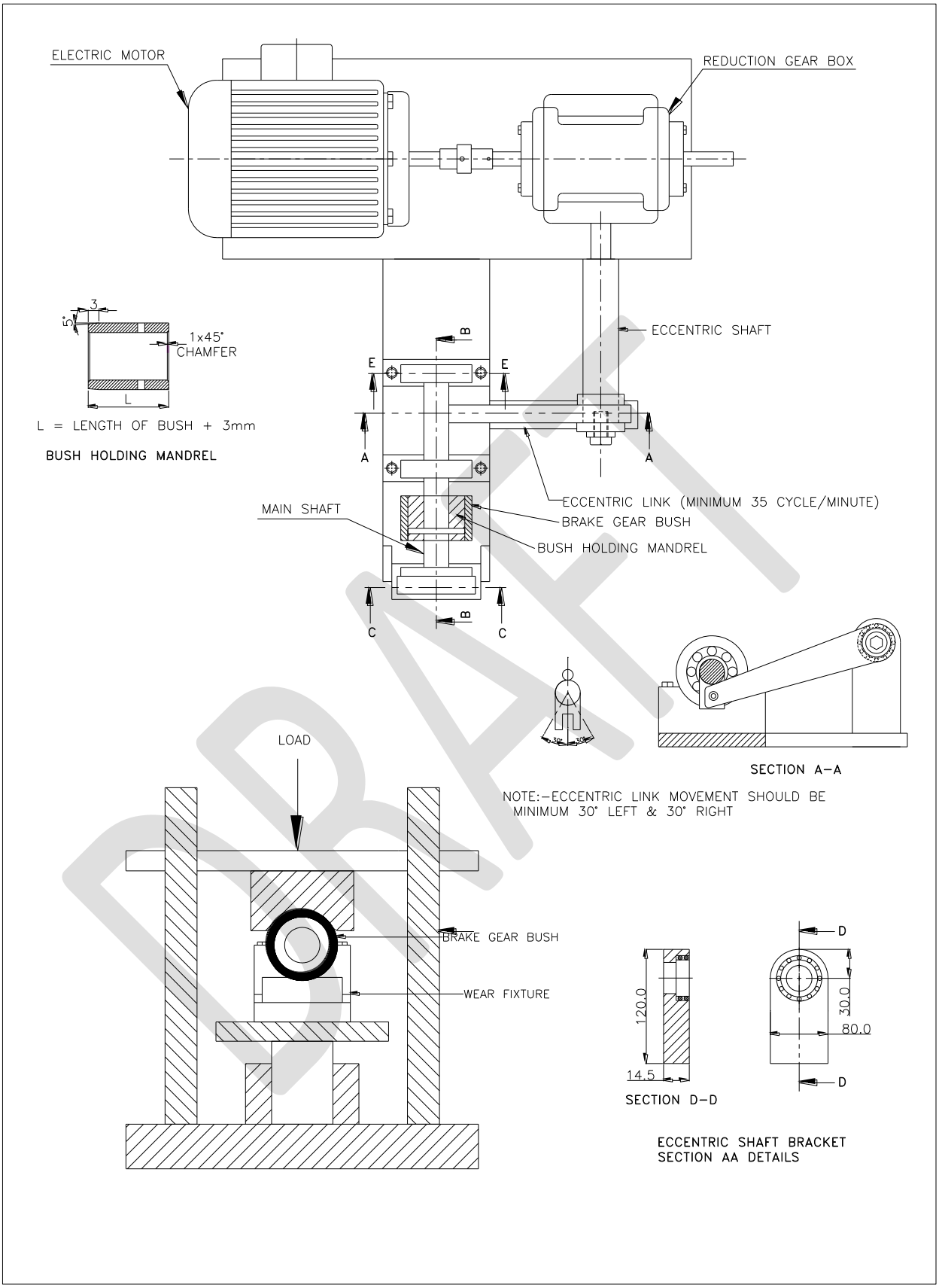
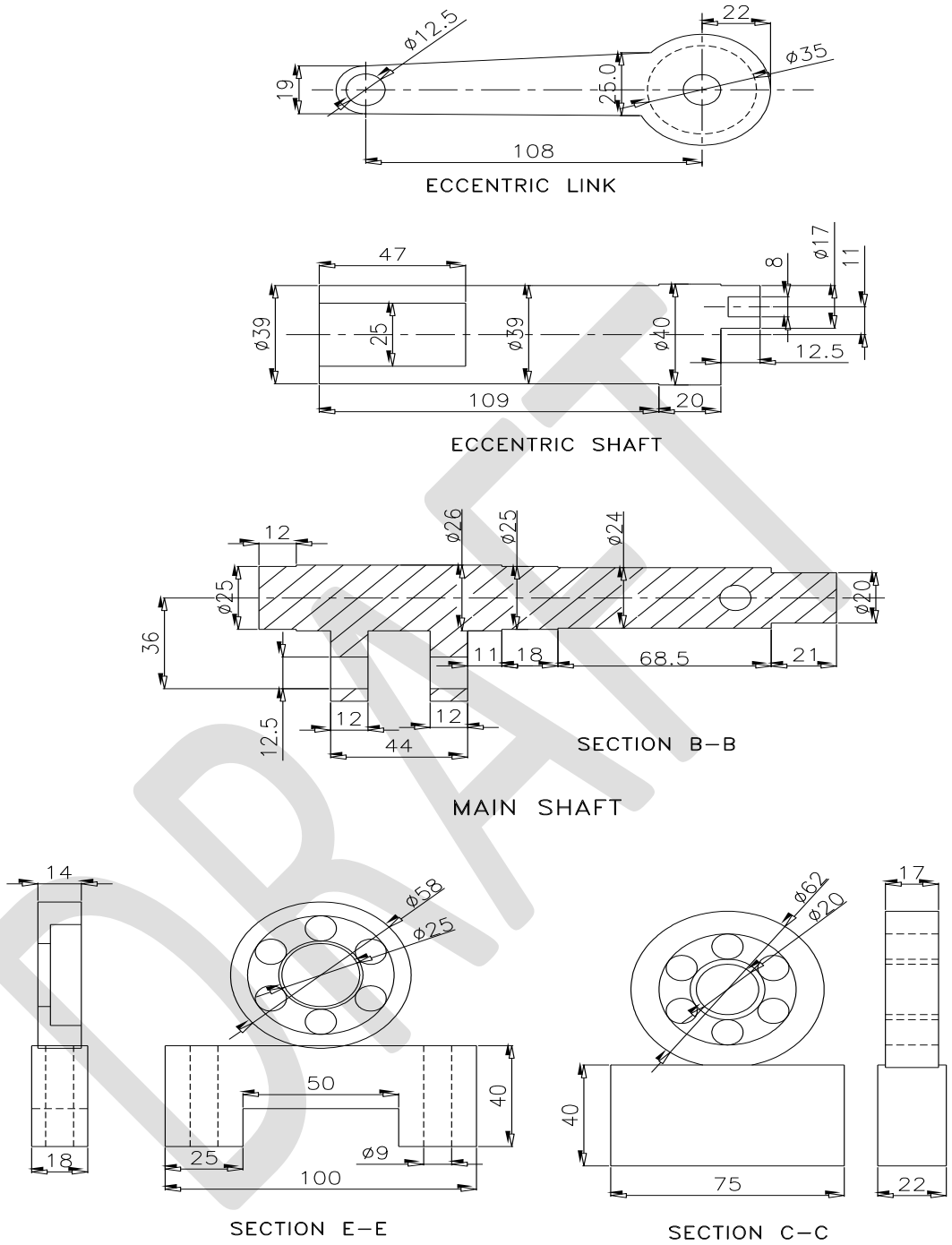


Fig.2

SCHEMATIC DIAGRAM FOR WEAR TEST RIG – SHEET-1 OF 2



NOTE:–DIMENSIONS GIVEN FOR GUIDANCE PURPOSE

Fig.2

SCHEMATIC DIAGRAM
FOR
WEAR TEST RIG – SHEET-2 OF 2

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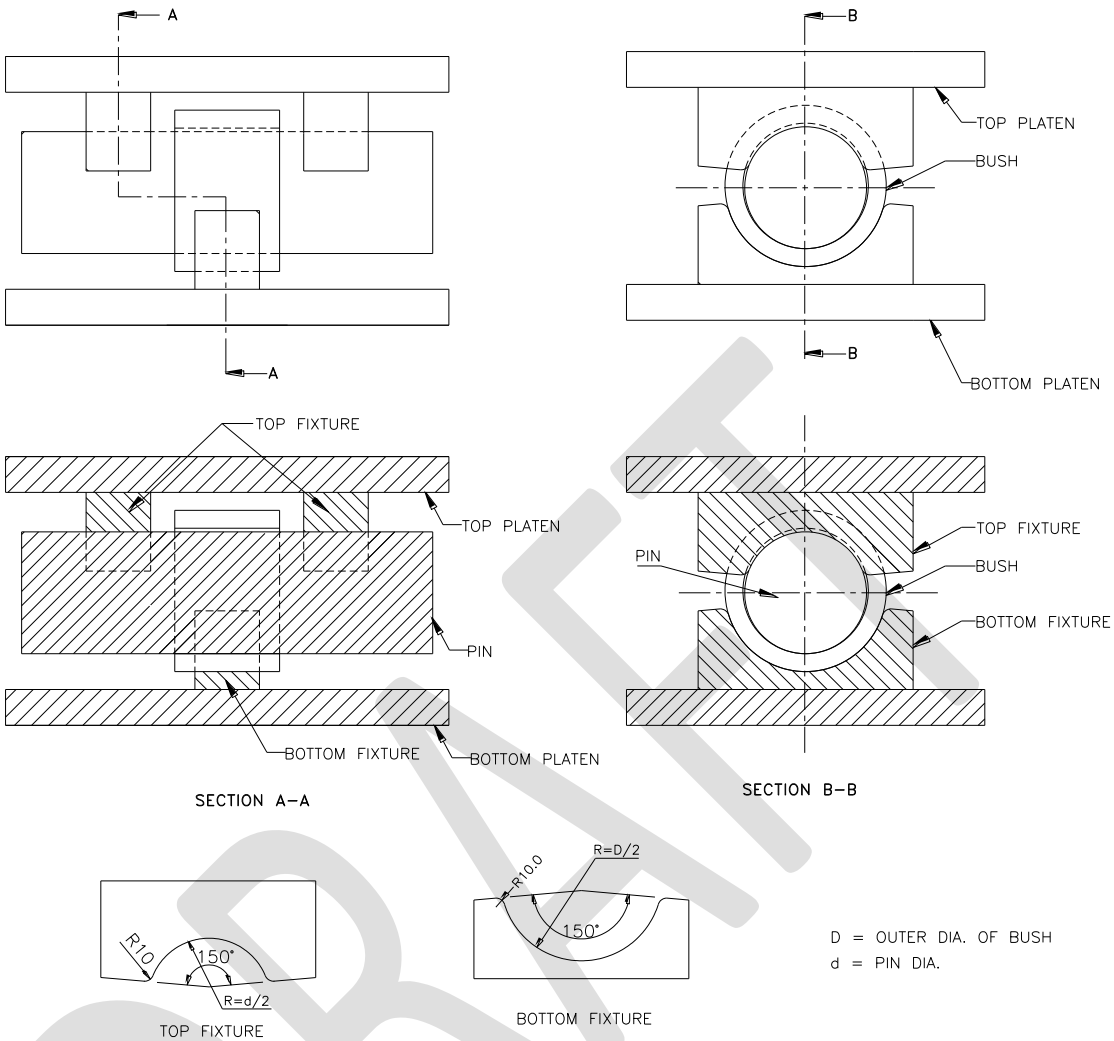

NOTE : 1) PIN TO BE SLIDE FIT IN BUSH
2) PIN SHOULD BE GROUND & HARDCROME PLATED

Fig.3

SCHEMATIC DIAGRAM FOR CRUSH STRENGTH TEST

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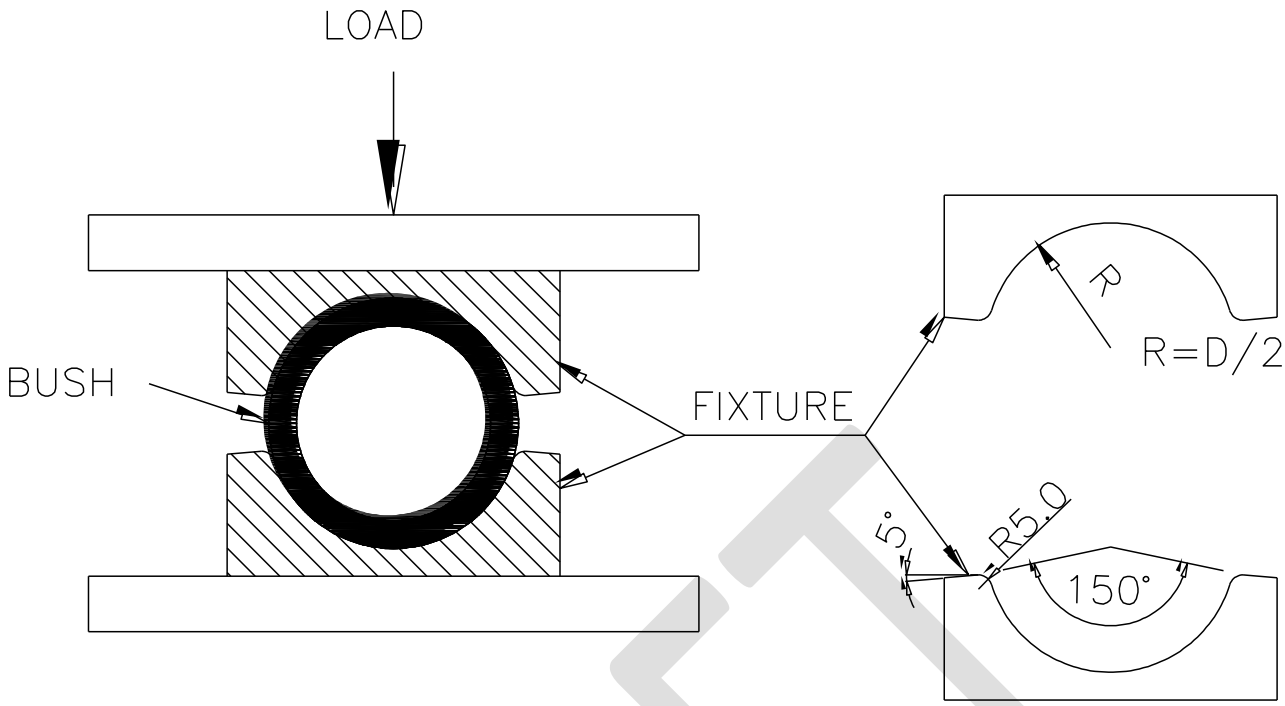

NOTE :
1. ALL SHARP CORNERS TO BE ROUNDED R2.0
2. D=OUTER DIAMETER OF BUSH

Fig.4

SCHEMATIC DIAGRAM
FOR
COMRESSIVE LOAD TEST CIRCUMFERENTIAL

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