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No. M&C/MIT/I&T/2 **Date:06.08.2019**

Metallurgical Investigation Report No. 49/19

Sub: Metallurgical Investigation of broken traction motor support lug of loco no-30382/WAP7/GZB.

Ref: Sr.DEE/TRS/ECR/Mughalsarai's letter no. no.TRS/MGS/Misc./17, dated: 08.07.2019.

Reference above, four numbers of broken pieces of both LH & RH side (counter to each other) Traction Motor-3 Support lug of loco no-30382/WAP7, ELS/GZB were received for metallurgical investigation. Fracture took place at ECR, DDU-DOS (MGS Yard DN line) on 04.07.2019. The details are as under:

1. **Sample particulars as furnished (in proforma submitted)**

Component/system Identity	**Loco No. 30382/WAP7**
Date of failure	04.07.2019
Place/railway	ECR, DDU-DOS(MGS Yard DN line)
Location in system if part of assembly	Part of pivot transom of bogie
Drawing No./Specification No.	1209-01-112-121/IS 8500, Fe540B
Function of component in brief	To Support TM on pivot transom side
Manufacturer	M/s Ved Sassomechanica, Kanpur
Identification mark on the component	Bogie frame No. VS 31
Date of manufacture	NA
Date of fitment	18.01.2019
Failed in service/assembly/maintenance	Service
Caused derailment/accident	TM3 pivot support frame broken in Two pieces
Train no. in case of Accident	Tr. No.- 22824
Nature of stresses /loading	Damping type of load
Working environment(temp/humidity)	Normal
History of repair/maintenance	IOH-18.01.2019, IA-27.04.2019
Last NDT testing/result if applicable	RDPT during IA
Expected service life	35 Years

2. Lab. Identification No.& Marking

Lab. Identification no.	White Paint marking	White paper tag
49/19/1	---	LHS (counter to each other)
49/19/2	L/S	
49/19/3	---	RHS (counter to each other)
49/19/4	R/S	

3. Visual examination

Both the fractured LH & RH side traction motor-3 support lugs pieces were reconstructed as shown in **fig.1**.

Fig.1: Photograph showing fractured LH & RH side traction motor-3 support lug pieces in as received condition.

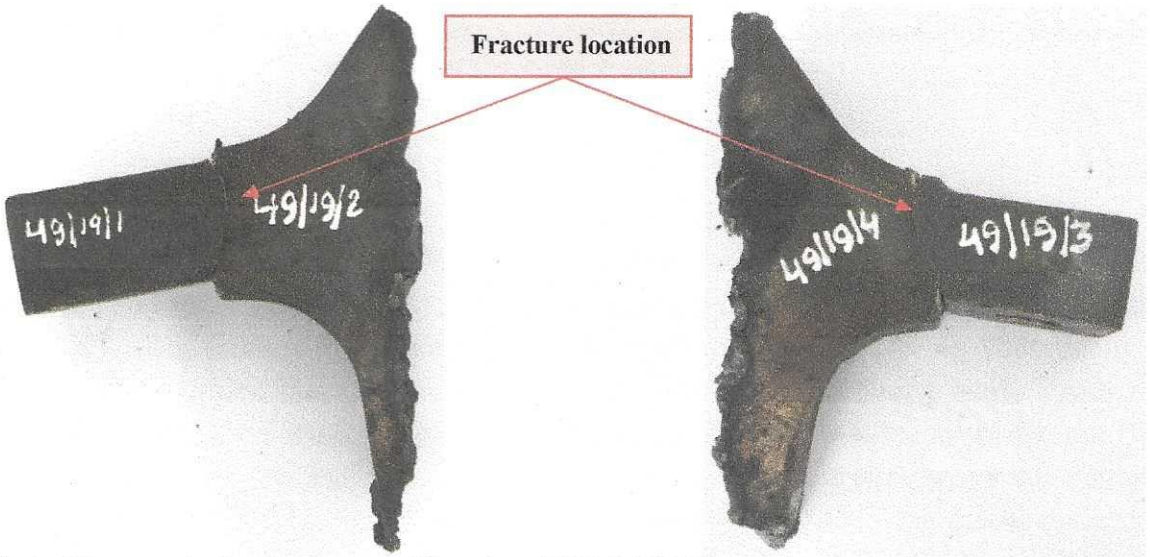


Fig.2: Photograph showing fractured location of LH & RH side traction motor-3 support lug pieces.

Piece No. 49/19/1 & 2

Visual examination revealed that LH side traction motor-3 support lug, having gas cut at one end, had broken near bolt hole position in fatigue manner from inner side of transition area (**fig. 3**). The fracture had taken place in transverse manner (**fig. 2 & 3**). Topography of fracture face revealed that fracture had initiated from rough machining marks present at inner side of transition zone. The other end of fracture face is crystalline in appearance (**fig. 3**). Smooth fracture face indicates that the fracture had initiated in slow progressive fatigue manner. About 35% of fracture face is crystalline in nature (**fig.3**). Shear crack is noticed in the smooth zone which appears to be connected with fatigue initiation point towards surface (**fig.3**).

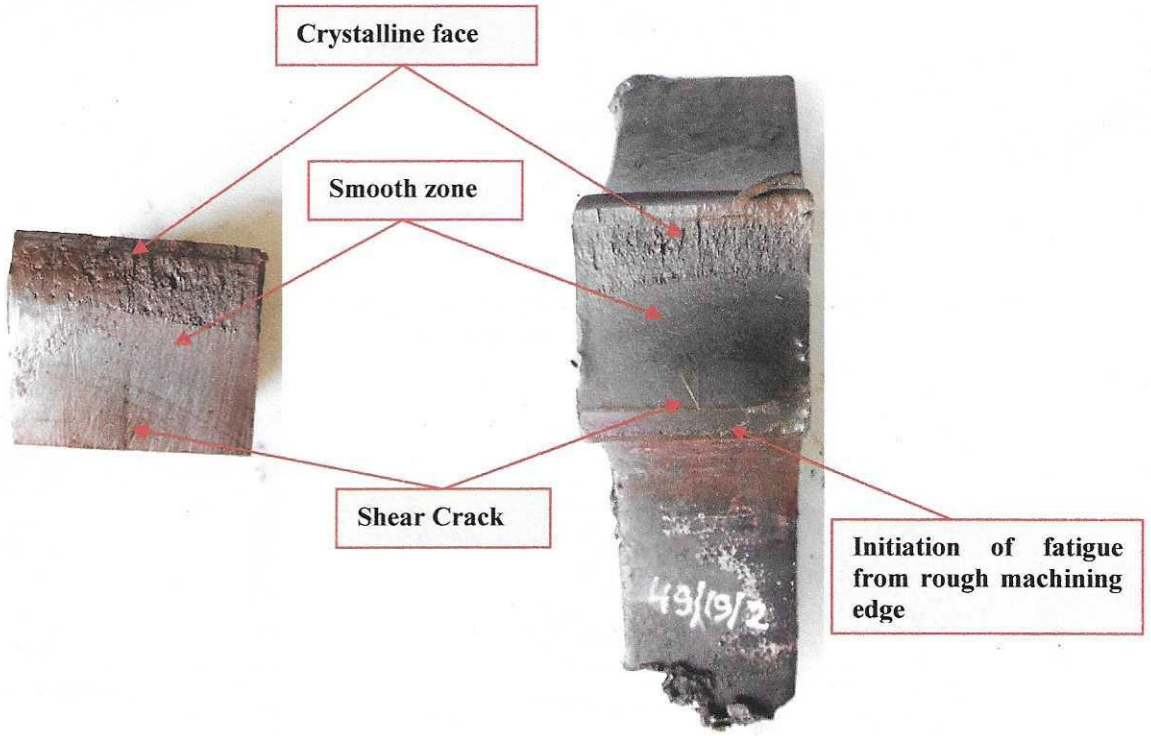


Fig.3: Photograph showing fractured initiation in fatigue manner from rough machining edge of inner LH side traction motor-3 support lug piece.

Piece No. 49/19/3 & 4

Visual examination revealed that RH side traction motor-3 support lug, having gas cut at one end, had broken near bolt hole position in fatigue manner from inner side of transition area (**fig. 4**). The fracture had taken place in transverse manner (**fig. 2 & 4**). Topography of fracture face revealed that fracture had initiated from rough machining marks present at inner side of transition zone. The other end of fracture face is crystalline in appearance (**fig. 4**). Smooth fracture face indicates that the fracture had initiated in slow progressive fatigue manner. About 15% of fracture face is crystalline in nature (**fig.4**). Shear cracks noticed in the smooth zone which appears to be connected with fatigue initiation point towards surface (**fig.4**).

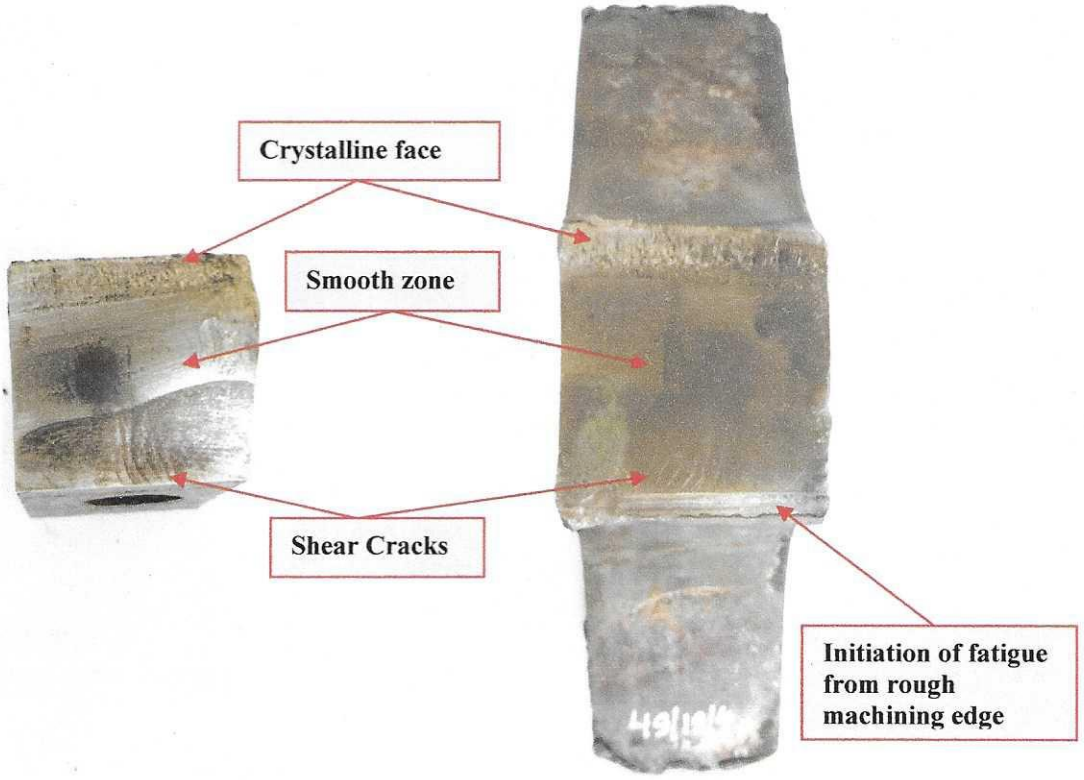


Fig.4: Photograph showing fractured initiation in fatigue manner from rough machining edge of inner RH side traction motor-3 support lug piece.

4. Chemical composition:

Sample No.	%C	%Mn	%Si	%S	%P	CE
49/19/2	0.18	1.03	0.20	0.018	0.036	0.36
49/19/4	0.19	1.01	0.20	0.020	0.036	0.36
Specified as per IS: 8500-1991 Fe540B	0.20 max	1.60 max	0.45 max	0.045 max	0.045 max	0.44 max

5. Hardness:

Sample No.	Observation (3000kg/10mm/15sec)
49/19/2	143, 143, 143
49/19/4	143, 143, 143
Specified as per IS: 8500-1991.	Not specified

6. Tensile Test & Bend Test:

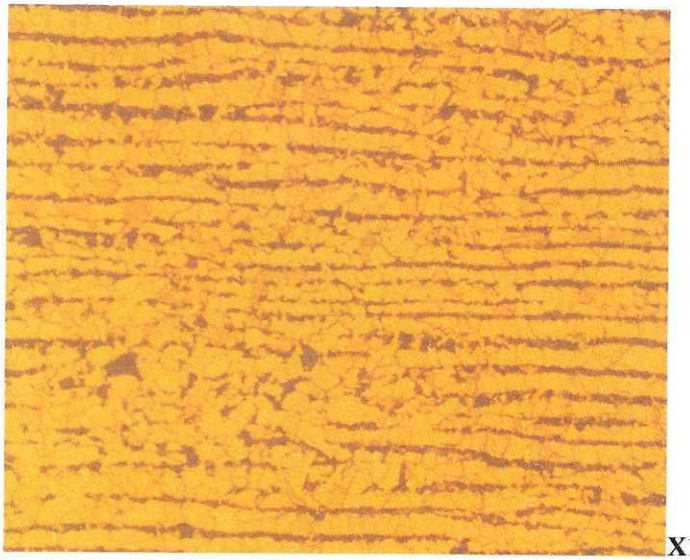
Sample No.	YS, N/mm^2	UTS, N/mm^2	%Elongation (GL = 5.65 $\sqrt{A_o}$)
49/19/2	Could not be conducted due to insufficient sample size		
49/19/4	Could not be conducted due to insufficient sample size		
Specified as per IS: 8500-1991 Fe540B	**380 min. (for 41-63 mm)**	**540 min.**	**20 min**

7. **Impact Test:**

Sample No.	Impact Strength (Joules)
49/19/2	Could not be conducted due to insufficient sample size
49/19/4	Could not be conducted due to insufficient sample size
Specified as per IS: 8500-1991 Fe540B	Average Value: 50 Min. (at room temperature) Average Value: 25 Min. (at - 20^0C)

8. **Micro examination:**

Sample No.	Observation
49/19/2	Revealed ferrite pearlite structure with Average ASTM Grain Size 7 (**fig. 5).**
49/19/4	Revealed ferrite pearlite structure with Average ASTM Grain Size 7 (**fig. 6).**
Specified as per IS: 8500-1991 Fe540B	Not specified



X100

Fig.5: Photomicrograph showing ferrite pearlite structure; Sample no. 49/19/2.

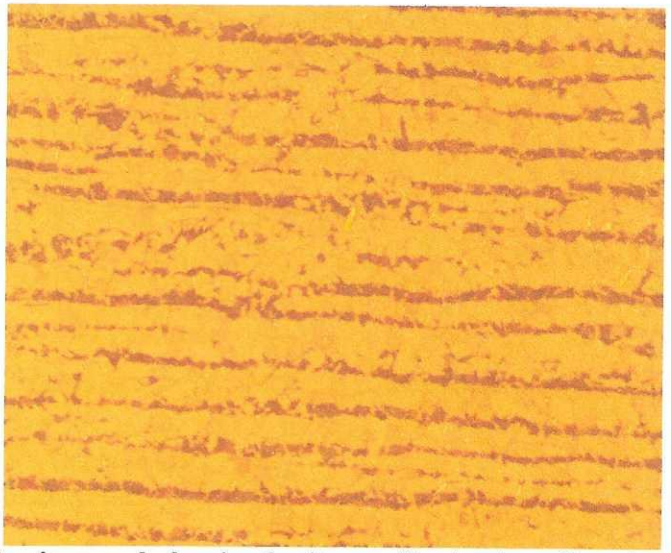


Fig.6: Photomicrograph showing ferrite pearlite structure; Sample no. 49/19/4.

9. **Discussion:**

Visual examination revealed that both LH & RH side traction motor-3 support lugs had broken near bolt hole position in fatigue manner from inner side of transition area. At the inner side of transition area rough machining marks were present and fracture had taken place in transverse manner. Fatigue had initiated from rough machining marks present at inner side of transition zone. Smooth fracture face indicates that the fracture had initiated in slow progressive fatigue manner. Fracture initiated from inner side of transition area and covering about 65% & 85% in fatigue manner and remaining about 35% & 15 % in crystalline manner respectively in LH & RH side traction motor-3 support lugs. Shear cracks noticed in the smooth zone which appears to be connected with fatigue initiation point towards surface

Chemical composition conforms to the relevant specification.

Hardness value is 143 BHN, however hardness is not specified.

Tensile test, Bend test & Impact test could not be conducted due to sample size.

Micro structure is having ferrite-pearlite structure, Microstructure is not specified, however may be considered satisfactory.

It is evident from above that, Traction motor -3 Support lugs have broken near bolt hole position in fatigue manner from inner side of transition area. The fracture had initiated from rough machining area which resulted in progress of fracture in fatigue manner.

10. **Conclusion**

The metallurgical properties of the TM-3 support lugs found satisfactory for the test conducted. TM -3 Support lugs have broken near bolt hole position in fatigue manner from inner side of transition area. The fracture had initiated from rough machining area which resulted in progress of fracture in fatigue manner.

11. **Recommendation:**

1. Rough machining marks shall be avoided which are very prone for generation of fatigue cracks.
2. The Specification No. IS;8500-1991, which is specified in the furnished drawing, does not exist on date. This IS;8500-1991 specification has already been merged with IS;2062-2006. The revised specification shall be incorporated in the relevant drawing no. 1209-01-112-121.

6/8/19

(B. L. Bairwa)
Executive Director/M&C

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