

# Failure analysis in locomotive Bogie Brake-Hanger

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## Abstract

Breakage of brake riggings in WAP7 locomotives has been a matter of concern since 2004, almost after its commencement of manufacturing, which is having same bogie design as that in WAG9 locomotives. Both of these bogies are having TBU/PBU assembly for brakes, but breakage of brake hangers in WAG9 locomotives are unheard off. Both the inner as well as outer hangers are breaking. However, the cases of breakage of inner hangers towards bogie frame are much more with 80% of the total failures. This paper deliberates to understand the various failures in locomotive Bogie Brake-Hanger and on root cause analysis for the failure of Brake hanger. In this paper we analyze the characteristics of brake hanger using FEA software.

The goal of the project is to develop a high-speed train system capable of reaching the maximum speed and to secure its key technologies, one of which is the braking technology.

**Keywords:** Failure, WAG, WAP, PBU, TBU.

## 1. Introduction

Regardless of the remarkable increase in the train speed, trains need to be stopped safely within a limited braking distance without causing any discomfort to the passengers.

Currently, most trains are run by electrical power and have a combined electrical and mechanical (friction) braking system. Breakage of brake riggings in WAP7 locomotives has been a matter of concern since 2004, almost after its commencement of manufacturing, which is having same bogie design as that in WAG9 locomotives. Both of these bogies are having TBU/PBU assembly for brakes, but breakage of brake hangers in WAG9 locomotives are unheard off. Both the inner as well as outer hangers are breaking. However, the cases of breakage of inner hangers towards bogie frame are much more which 80% of the total failures.

### 1.1. WAG-7 Type Electric Locomotives

WAG-7 is an electric locomotive engine of Indian railways used to haul specially goods train and is maintained by Ajani Loco shed, Nagpur India. The Loco has six axles in two sets of three frontal and rear wheels. WAG-7 is the name of a type of electric locomotive shown in figure 1 used in India. Homed mainly At Gomoh, Ajni, Lallaguda, Tughlakabad and Bhilai. It is very similar to the class WAP-9; the only difference being the gear ratio which makes it suitable for heavy weight Operations. The technical specifications of WAP-9 type electric locomotive are mentioned in table 1.



Figure 1: WAG-7 type Electric Locomotive

Table 1: Technical Specifications of Electric WAP-9

<b>Manufacturers</b>	<b>ABB, CLW</b>
Traction Motors	ABB's 6FRA 6068 (850kW, 2180V, 1283 rpm, 270/310A. Weight 2100kg) Axle-hung, nose-suspended.
Gear Ratio	77:15
Transformer	ABB's LOT 6500, 4x1450kVA.
Hauling capacity	4250t
Wheel base	15700mm

**1.2. Brake Hanger of Electric Locomotive WAG-7 and WAG-9**

During a brake application, the brake beam on either side of a wheel set are moved by the brake cylinder through the brake rigging so that the brake block holders are pulled towards the wheel treads. The brake beam however only controls the movement of brake blocks in horizontal plane and provides no vertical restraint. The upper part of the brake hangers are connected brackets on bogie frame by the upper brake hanger-pins.



Figure 2: Brake hanger assembly

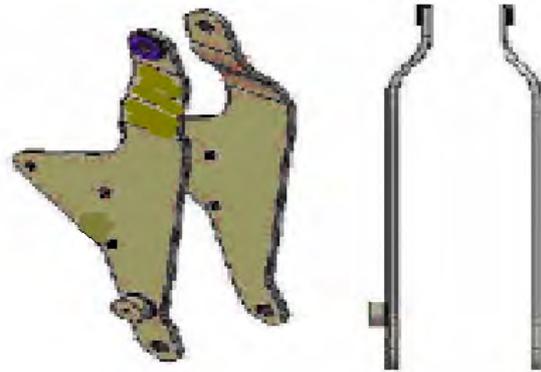


Figure 3: Brake hanger

Table 2: Technical specifications of Brake hanger

PART NAME	QTY/LOCO	MATERIAL
BRAKE LEVER	6	STEEL Fe 540B, I S : 8500
PLATE	6	STEEL Fe 540B, I S : 8500
BUSH(PRESS FIT)	6	STEEL Cr 45C8, I S : 5517
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**2. Observations**

The problem identified in the assembly of brake-hanger of WAG-7 railway engine is that the brake-hanger fails under fatigue. Following are the observations on failed brake-hanger.

1. The brake-hanger usually fails during running condition after certain period.
2. 100% breakage at the top of the hanger plate
3. The initiation of crack begins near the bush welding which progresses and breaks the hanger plate into two pieces.
4. Both the inner and outer hangers are breaking but the breakage of inner hanger towards bogie frame is much more with 80% of total failure.
5. Failures in PBU (weight of 150 kg) are more compared to TBU (weight of 130 kg).  
(It should be noted that, the material report confirms the brake-hanger material as per requirements.)

Table 2: Technical specifications of Brake hanger

YEAR	SHED		TOTAL FAILURES
	GZW	GMO	
06-07	06	15	21
07-08	26	15	41
08-09	64	16	80
09-10	26	07	33



Figure 4: Various types of failures in Brake hanger



Figure 5: Present failure in Brake hanger

**3. Analysis Using -ANSYS 12.0**

The above observed failure in brake hanger could be analysed by using ANSYS. The following are the outcomes for existing model. It shows the Equivalent (Von-Mises) stress and Maximum Shear stress.

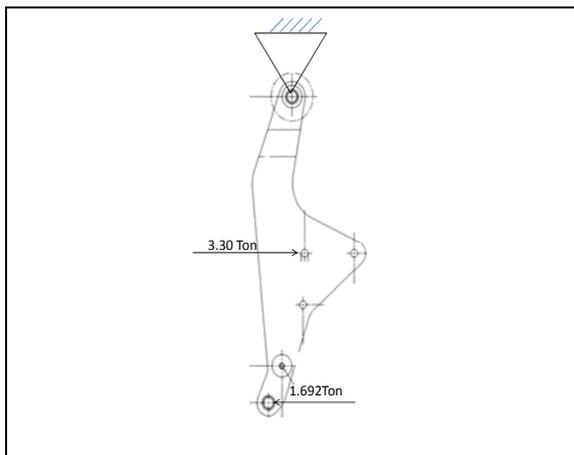


Figure 6: F.B.D. of Brake Hanger (for WAG-7)

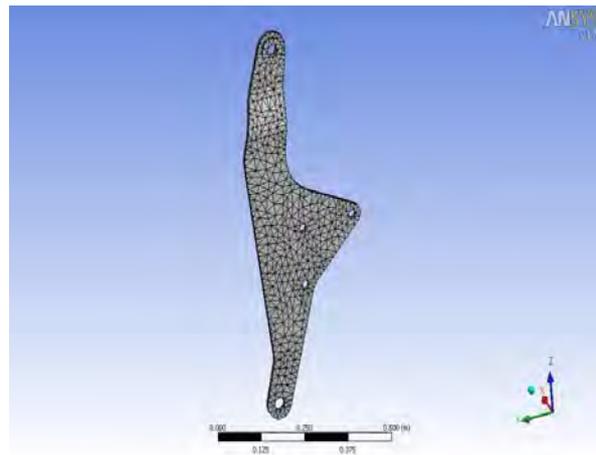


Figure 6: Meshed Model of Brake hanger

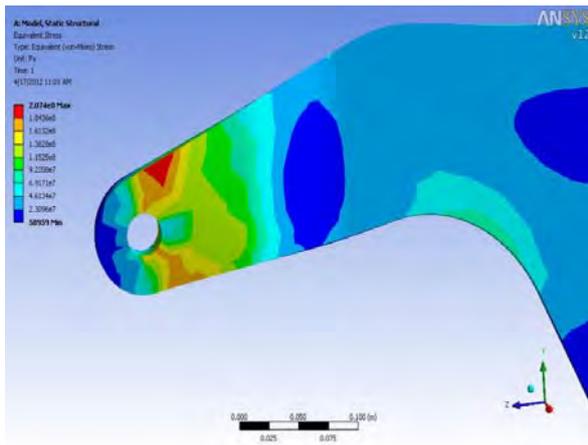


Figure 6: Von-Mises(Inner side) Stress in Brake hanger

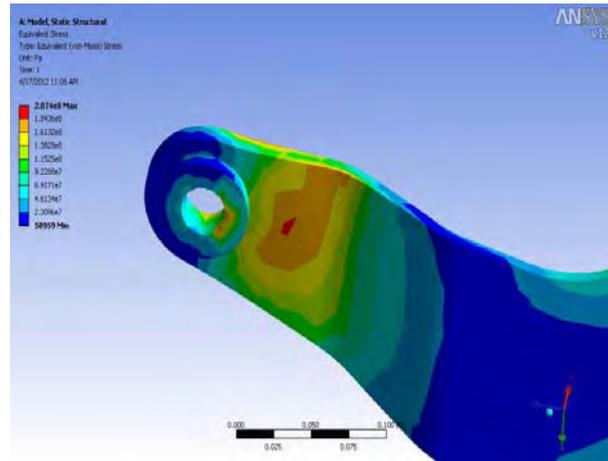


Figure 7: Von-Mises(Outer side) Stress in Brake hanger

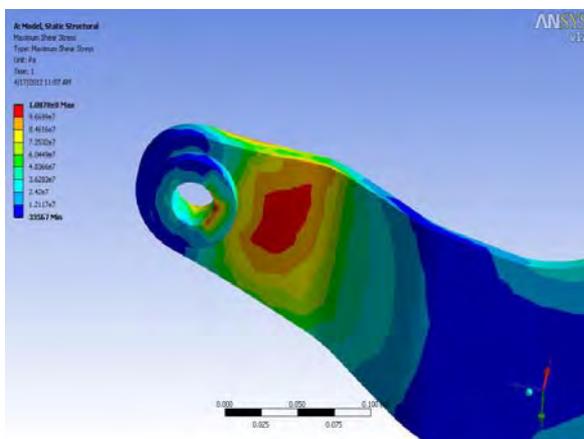


Figure 8: Max. Shear stress (Outer side)

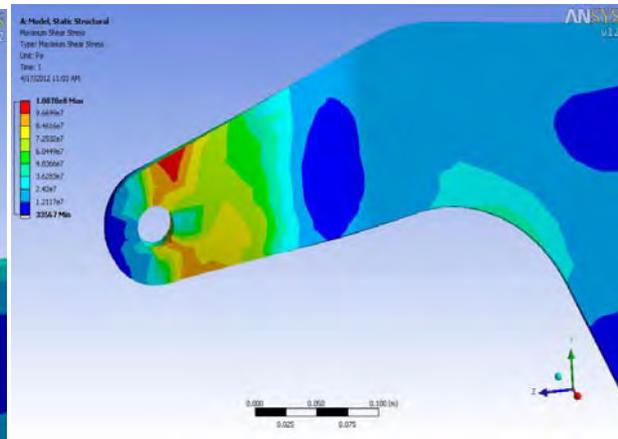


Figure 9: Max. Shear stress (Inner side)

**Conclusion**

Since with the analysis of present brake hanger using ANSYS 12.0, the critical points were observed where high stress concentration is present, and the values of respective stresses are calculated. From these locations of critical zones only the fracture may start and it confirms to the present failure occurring in the brake hanger.

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