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To study the Railway Air brake System & Design and Analysis of Brake Block

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ABSTRACT: Braking System is essential feature to retard and stop the railway in minimum time and distance. This paper presents a discussion on braking system used in Indian railways, the component of air braking system, comparison between air brake system and vacuum brake system, types of air brake system, schematic diagram of single pipe and twin pipe system, working of distributor valve and cocks , brake shoe material , working of air brake system, working of brake cylinder, component of brake cylinder and increase the Efficiency and life of Brake Block of railway by designing and analysing the brake block by changing brake block material.

Keywords: Air brake system, components, Design and analysis of Brake Block

1. INTRODUCTION:

The brakes are used on the coaches of railway trains to enable deceleration, control acceleration or to keep them standing when parked. While the basic principle is similar from road vehicle, the usage and operational features are more complex because of the lead to control multiple linked carriages and to be effective on vehicles left without a prime mover. In the control of any braking system the important factors that govern braking action in any vehicle are pressure, surface area in contact, amount of heat generation and braking material used. Keeping in view the safety of human life and physical resources. Braking system must have following requirements. The brake must be strong enough to stop the vehicle during an emergency within shortage possible distance.

There should be no skidding during brake application and driver must have proper control over the vehicle during emergency. Brake must keep the vehicle in stationary position even when the driver is not present. Effectiveness of brakes should remain constant even on prolonged application or during descending on a down gradient.

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Classification of compressed air brake system

Compressed air brakes can be further classified into two types:

1. Single pipe graduated release air brake system.
2. Twin pipe graduated release air brake system.

2. OBJECTIVE:

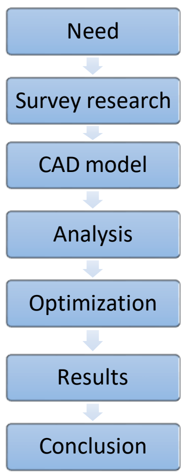
The objective of this paper is to study the air brake system and to optimize the brake block so as to increase its efficiency. Based on literature survey done on air brake system, we studied the air brake system. We designed the brake block with the help of orthographic drawing provided by the railways and constructed its 3-D model using modelling software (CREO 5.0). Then we analyzed the 3-D model of the brake block for static, thermal and fatigue tests. Our main objective is to check whether the efficiency and life span of the brake block improves while changing the material of brake block.

3. LITERATURE REVIEW

A Railway Braking system uses compressed air as a medium to operate the brakes. Modern Railway Braking system are based on the design patented by George Westinghouse. We have modelled and analyzed the brake shoe & brake block for static & thermal stresses. As we found that the shoes were overhauled within the period of 18 months. So as to increase the life and efficiency of the braking system we used another material for brake block named COMPO 04 which is made available by the Hindustan Composite Co. the same company which manufactures the brake shoes which Railways is currently using. The following paper discusses about the comparison between those two composite materials and their results respectively.

4. METHODOLOGY:

During the survey of the Railway workshop, we found that the brake block used currently gets overhauled within the period of 18 months. So we modelled and analyzed the brake block & used other product provided by Hindustan Composite (same company which provides brake blocks to Railways) to verify whether it gives better results than the one Railway is currently using.



4.1 Twin pipe graduated release air brake system

In twin pipe graduated release air brake system the brake pipe is charged to 5kg/sq cm2 by the driver's brake valve. The auxiliary reservoir is charged by the feed pipe at 6kg/sq cm2 through check valve and choke. The brake cylinder is connected to the atmosphere through a hole in the DV. When brakes are under fully released condition. To apply brakes, the driver moves automatic brake valve handle either in steps for a graduated application or in one stroke to the extreme position for emergency application. By this movement the brake pipe pressure is reduced and the pressure differenced is sensed by the DV against the reference pressure locked in the control reservoir. Air from auxiliary reservoir enters the brake cylinder and the brakes are applied. At the time of release the air in the brake cylinder is vented progressively depending upon the increase in the brake pipe pressure. When the brake pipe pressure reaches 4.8kg/sq cm2 the brake cylinder is completely exhausted and brakes are fully released.

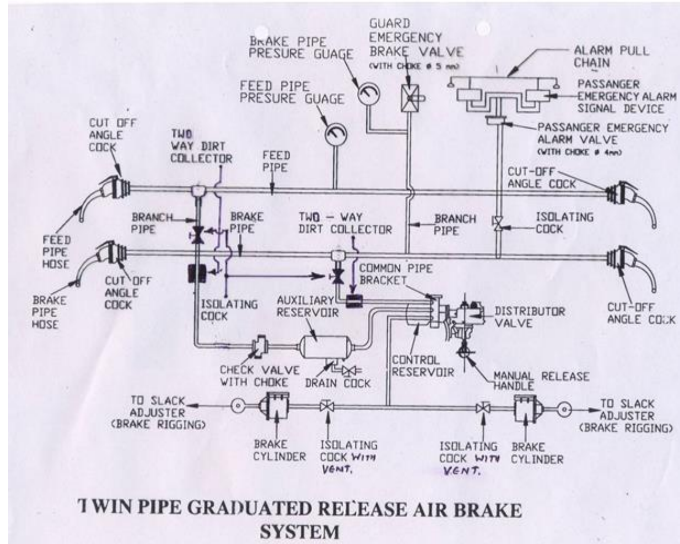


Fig 4.1

4.2 Components of air brake system.

Various components used in the braking system are as follows.

1. Compressor
2. Main Reservoir
3. Drivers Brake Valve
4. Feed Valve
5. Equalizing Reservoir
6. Brake pipe
7. Angle Cocks
8. Couple Hoses
9. Brake Cylinder
10. Auxiliary Reservoir
11. Brake Block
12. Brake Rigging
13. Distributor valve
14. Non-returning valve
15. Dirt Collector

4.3 Orthographic drawing of Brake Shoe

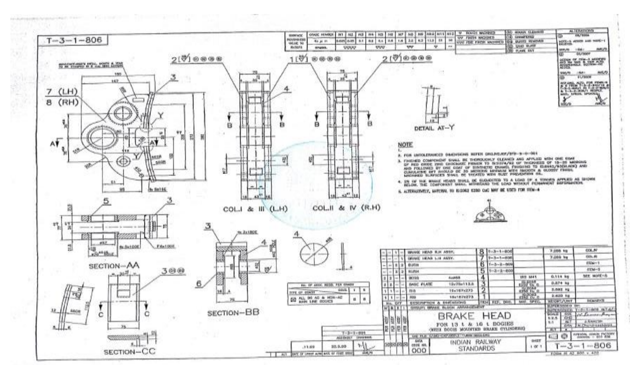


Fig 4.2

4.4 3-D Model of Brake Shoe

Fig 4.3

Fig 4.4

4.5 3-D Model of Brake Block

Fig 4.5

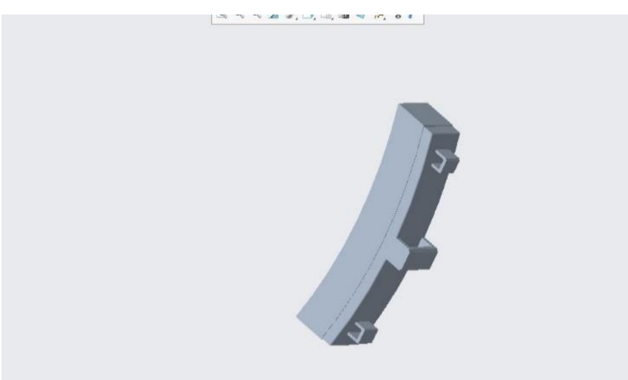


Fig 4.6

4.6 Final Assembly of Brake block and Brake Shoe

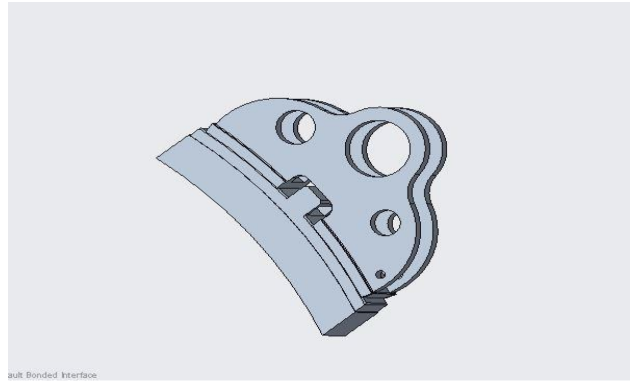


Fig 4.7

4.7 Failure stages of Brake block

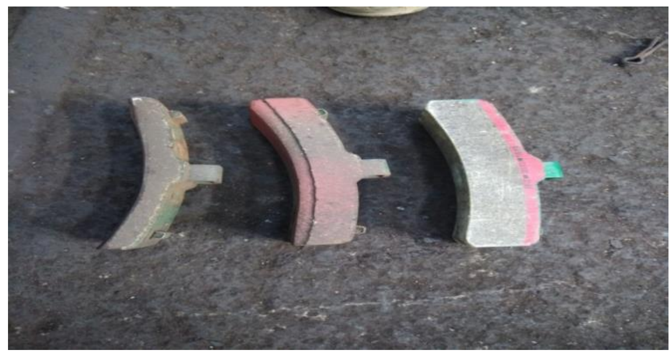


Fig 4.8

4.8 Material Physical Properties

For analyzing purposes the following materials were used with given physical properties.

Table 4.1

4.9 Analysis by using Compo HC/03 material

4.9.1 Total deformation

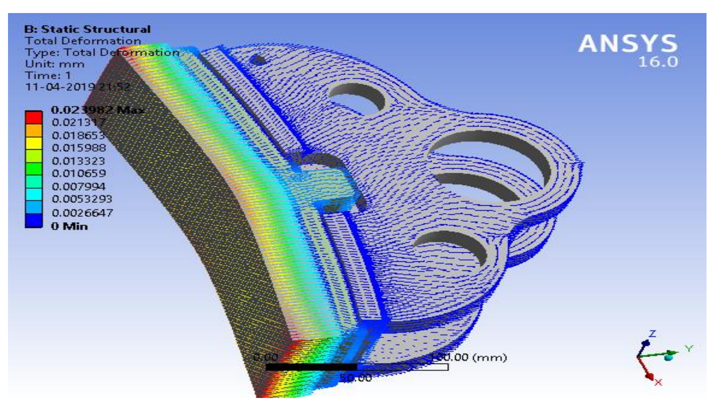


Fig 4.9

Total deformation is 2.3982e-2mm.

	Mild Steel	Compo HC/03	Compo HC/04
Density kg mm^-3	7.85e-006	1.9e-006	2.1e-006
Thermal Conductivity mm^-1 C^-1	46	**54**	49.59
Young's Modulus MPa	2.1e+005	**2835**	**3240**
Poisson's Ratio	0.303	**0.23**	**0.23**
Bulk Modulus MPa	1.7766e+005	**1750**	**2000**
Shear Modulus MPa	80583	**1152.4**	**1317**
Compressive Yield Strength MPa	250	**25**	**30**

4.9.2 Equivalent elastic strain

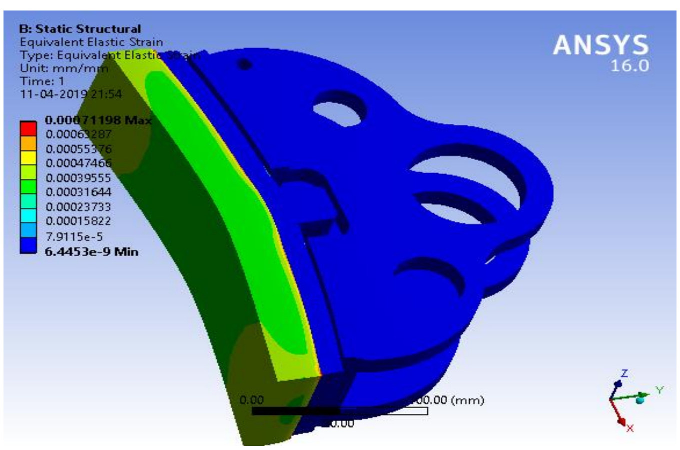


Fig 4.10

Maximum equivalent elastic strain is 7.1198e-4 mm/mm.

4.9.3 Shear stress

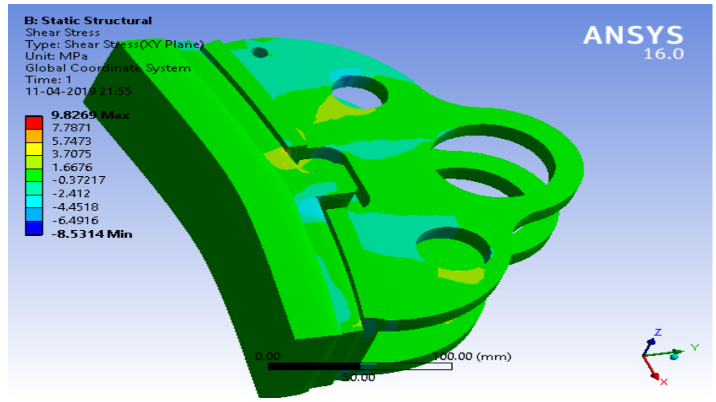


Fig 4.11

Maximum shear stress is 9.8269 MPa.

4.9.4 Equivalent stress

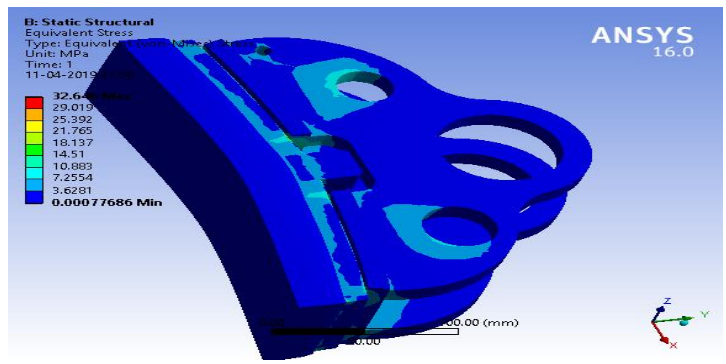


Fig 4.12

Maximum equivalent stress is 32.64 MPa.

4.9.5 Total heat flux

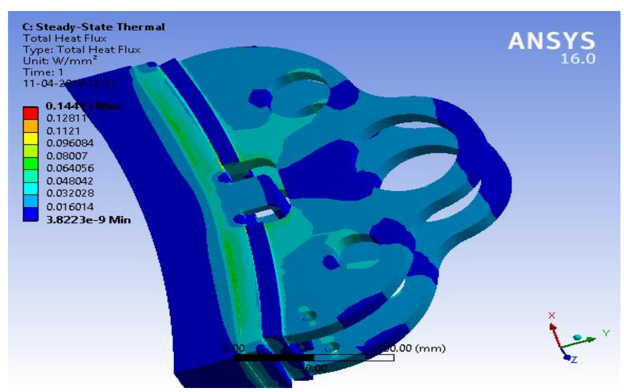


Fig 4.13

Total heat flux is 0.14413 W/mm².

4.10 Analysis by using compo HC/04 material

4.10.1 Total deformation

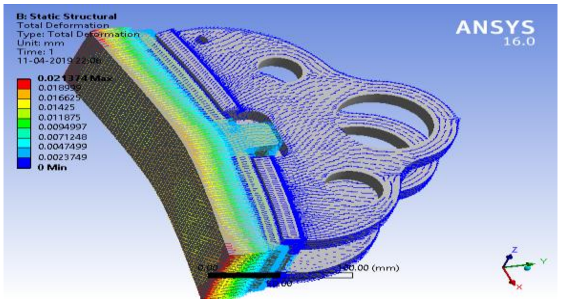


Fig 4.14

Total deformation is 2.137e-2 mm.

4.10.2 Equivalent elastic strain

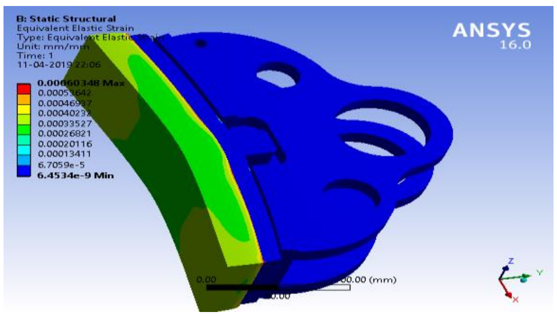


Fig 4.15

Maximum equivalent elastic strain is 6.0348e-4 mm/mm.

4.10.3 Shear stress

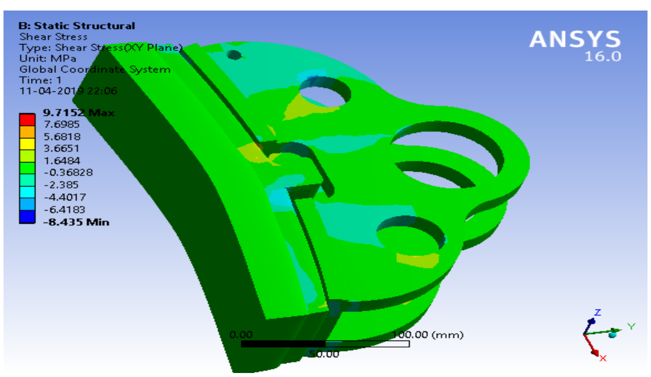


Fig 4.16

Maximum shear stress value is 9.7152 MPa

4.10.4.Equivalent stress

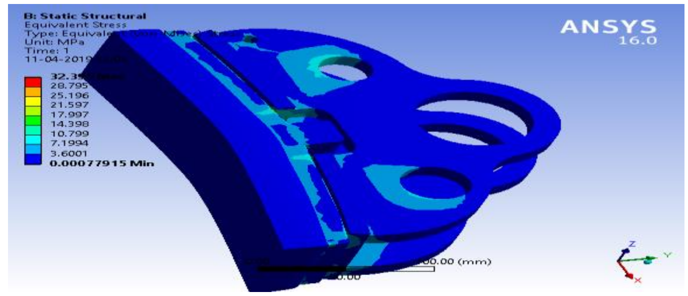


Fig 4.17

Maximum equivalent stress is 32.395 MPa.

4.10.5 Total heat flux

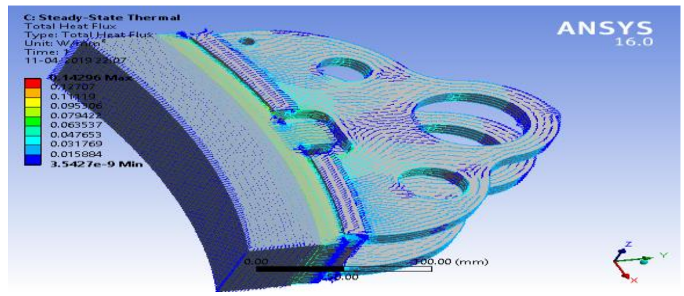


Fig 4.18

Maximum total heat flux is 0.14296 W/mm².

5 RESULTS & DISCUSSION

Hence after the analysis of both the brake shoes, we found out that the composite material COMPO 04 gave better and efficient results than the material COMPO 03 which is currently used by the Railways. Hence our suggestion based on overall results is to use material COMPO 04 instead of material COMPO 03.

MATERIAL	Total Deformation[mm]	Equivalent strain [mm/mm]
COMPO 03	0.0239	0.00071
COMPO 04	0.02137	0.00060

Table 5.1

Material	EQUIVALENT STRESS[MPa]	SHEAR STRESS [MPa]	TOTAL HEAT FLUX [W/mm²]
Compo 03	32.64	9.8269	0.1441
Compo 04	32.39	9.71	0.1420

Table 5.2

6 CONCLUSION

From the above analysis results we can conclude that the material COMPO 04 is better material than the existing material COMPO 03 in all the aspects which are considered in a good braking system. Hence if it is used instead of existing one, we can get better results.

7 REFERENCES

1. Sharma, R. C., Dhingra, M., & Pathak, R. K. (2015). Braking systems in railway vehicles. International Journal of Engineering Research & Technology, 4(1), 206-211.
2. Vakkalagadda, M. R. K., Srivastava, D. K., Mishra, A., & Racherla, V. (2015). Performance analyses of brake blocks used by Indian Railways. Wear, 328, 64-76.
3. Vakkalagadda, M. R. K., Vineesh, K. P., Mishra, A., & Racherla, V. (2016). Locomotive wheel failure from gauge widening/condemning: Effect of wheel profile, brake block type, and braking conditions. Engineering Failure Analysis, 59, 1-16.
4. Petrenko, V. (2017). Railway rolling stock compressors capacity and main reservoirs volume calculation methods. Procedia Engineering, 187, 672-679.
5. Ajayi, J. A., & Adeleke, O. A. (1997). Failure analysis of railway brake blocks. Engineering Failure Analysis, 4(3), 205-213.