DESIGN AND ANALYSIS OF ELECTRO HYDRAULIC THRUSTER BRAKE FOR LIFTING MACHINE

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ABSTRACT

Brakes are very important part of most important part of the crane. Failure of brakes is often associated with the sudden and massive failure. In the recent era disc brakes for a crane has become very important. And incorporating disc often asks greater efficiency and exact position stop when we apply disc brake. The power of disc brake is very higher than of conventional drum brakes. If the liner wear and tear is less and if auto adjustment is provided to disc brakes, it gives an advantage of less maintenance as well greater safety to machine and operator.

KEYWORDS: hydraulic thruster brake, lifting machine,

INTRODUCTION

Electro-hydraulic thruster brakes actuation always offers very smooth brake operation, without giving any jerks or vibration. Production of electric voltage transient on spring return produces stress on electrical components of DC solenoid actuator system. This has many advantages e.g. high maintenance and power reliability issues as compared to electro-hydraulic thruster disc brake. In recent this has become more popular technique, as this is viable, safe and economic to use. Thruster brake is a device type, retardation of speed of moving object and slowly stopping to accurate position is also possible at desired position. In this case brake is applied by pressing a brake shoe which is pre-stressed by usage of compressing spring. The brake shoe is designed in such a way that it applies pressure on rotating drum and slow deceleration occurs and at one point, it will finally come to halt.
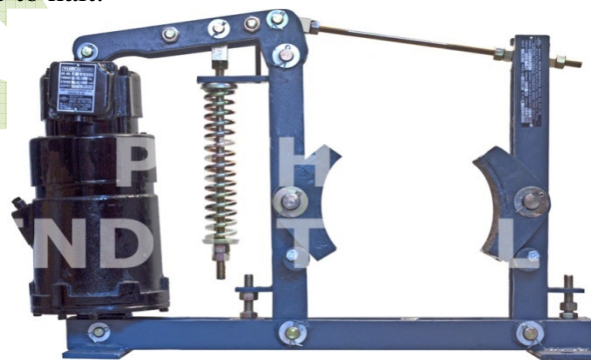

Fig. 1. Hydraulic Thruster Brake

SALIENT FEATURES:
- This is a spring loaded normally ON Failsafe Brake
- Works on 415 V AC, 3 Phase, 50 Hz supply.
- Readily available oil to be filled in thruster cylinder.
- Function is to bring to stop, moving / rotating machinery like motor / gearbox.
- Holds / stops the load in desired place.
- Prevents jerk
- Maintenance free, robust design.
- Torque Spring and Liner riveted to Brake Shoes
- Consists of Electro mechanical Thruster

APPLICATIONS:
- All Material Handling and Lifting Equipment's
- Hoisting
- Conveyors
- Elevators.

Existing system: The conventional thrust brakes employ either an electro mechanical thruster or passive hydraulic thruster. The electromechanical thruster utilizes an electro-mechanical solenoid to apply the braking force whereas the hydraulic thruster brake applies the force via a thruster that is operated by hydraulic force. The value of the hydraulic force is fixed irrespective of the load that the system carries hence this lead to under braking force or over braking force leading to slip of load i.e., improper load positioning or over braking leading to excessive and un-necessary brake wear.
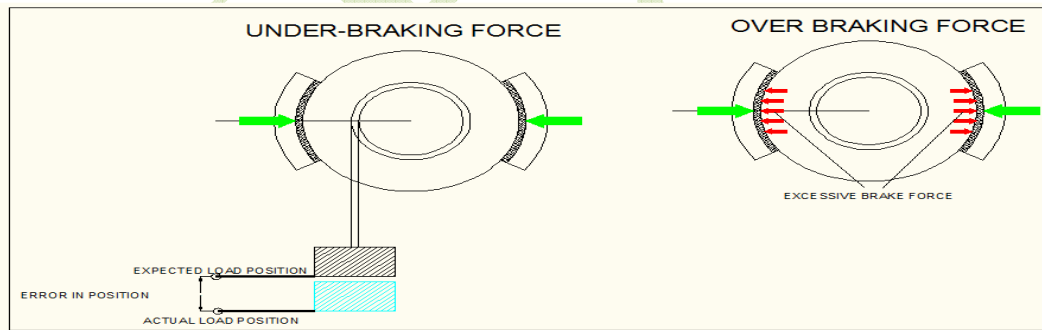

Fig.2. Existing system.

Proposed System:
The solution to the problem is an active electro hydraulic thruster than will apply the load as per set limit dependent upon the braking load. The electro hydraulic thruster will be operated using a positive displacement piston pump operated using a variable speed 12 Volt DC motor .Thus by varying the speed of motor we can vary the amount of fluid entering the piston chamber and thereby the hydraulic force generated by the piston rod. The piston rod will be coupled to the brake lever of the external shoe brake mechanism and thereby he required braking force will be applied to the brake drum.
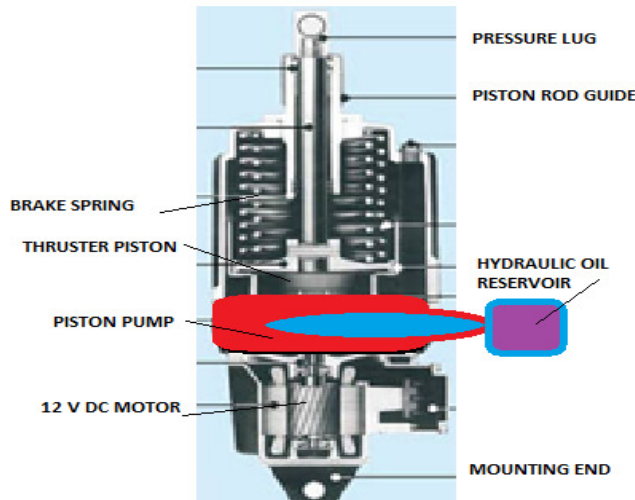
Fig.3. Active Electro Hydraulic Thruster

The active electro - hydraulic thruster will have a construction as shown in fig.3., here the motor used is a 12 volt dc motor with voltage based speed control mechanism in built , made suitably to vary the force for three operating conditions. The pump system is proposed to be piston pump type depending upon the force requirements of the system. The braking spring functions merely to bring the hydraulic piston back to original position once the braking load is released. Pressure lug connects the hydraulic thruster to the brake application lever of the brake caliper whereas the mounting end is used to mount the hydraulic thruster onto the frame.

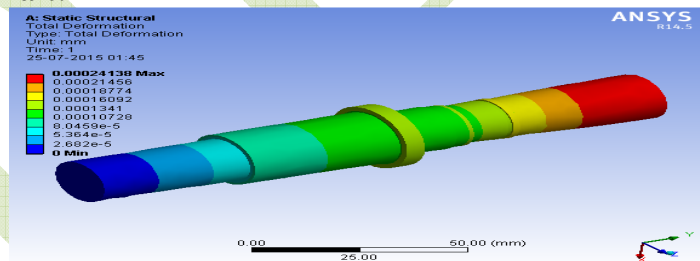## ANALYSIS OF THE SYSTEM USING ANSYS:
Analysis of Input Shaft:

Fig.4. Analysis of input shaft using ANSYS

Table 1. Analysis of input shaft

Part Name	Maximum theoretical stress N/mm^2	Von-mises stress N/mm^2	Maximum deformation mm	Result
RH WORM SHAFT	0.310	0.73	0.00024	Safe

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1. Maximum stress by theoretical method and Von-mises stress are well below the allowable limit; hence the input shaft is safe.
2. Input shaft shows negligible deformation under the action of system of forces.
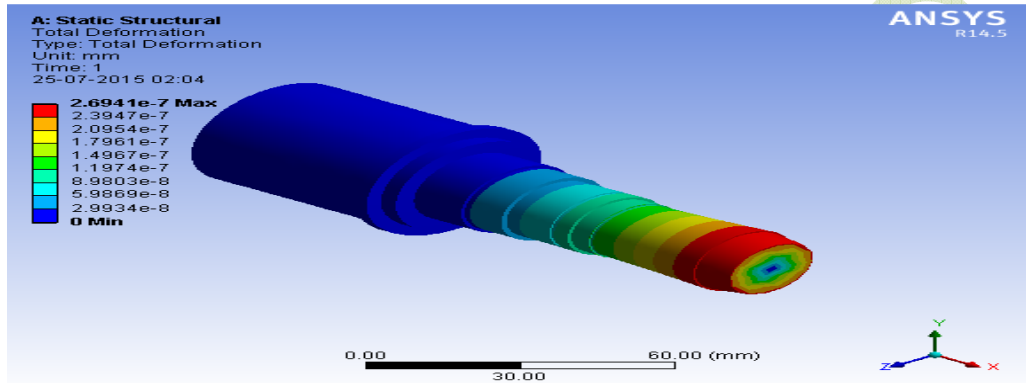
Analysis of drum shaft:

Fig.5. Analysis of drum shaft using ANSYS

Table.2. Analysis of drum shaft.

Part Name	Maximum theoretical stress N/mm^2	Von-mises stress N/mm^2	Maximum deformation mm	Result
DRUM SHAFT	0.69	0.0012	2.69E-7	safe

1. Maximum stress by theoretical method and Von-mises stress are well below the allowable limit; hence the DRUM shaft is safe.
2. DRUM shaft shows negligible deformation under the action of system of forces
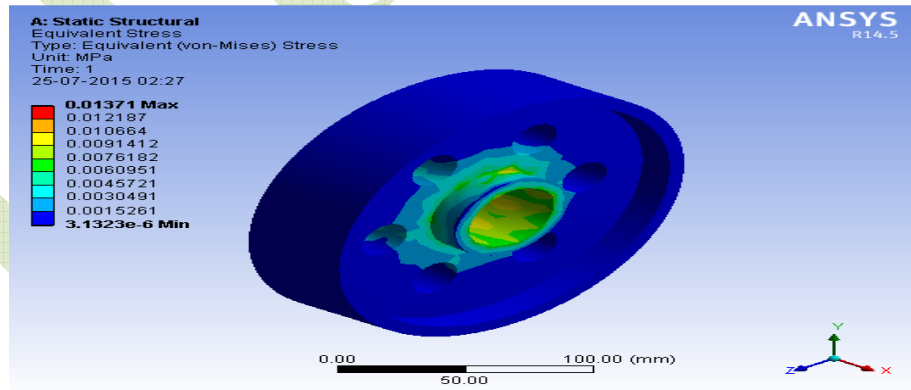
Analysis of Load Drum:

Fig.6. Analysis of load drum using ANSYS

Part Name	Maximum theoretical stress N/mm^2	Von-mises stress N/mm^2	Maximum deformation mm	Result
DRUM	0.027	0.0137	1.81E-6	Safe

Table.3. Analysis of load drum

1. Maximum stress by theoretical method and Von-mises stress are well below the allowable limit, hence the DRUM is safe.
2. DRUM shows negligible deformation under the action of system of forces
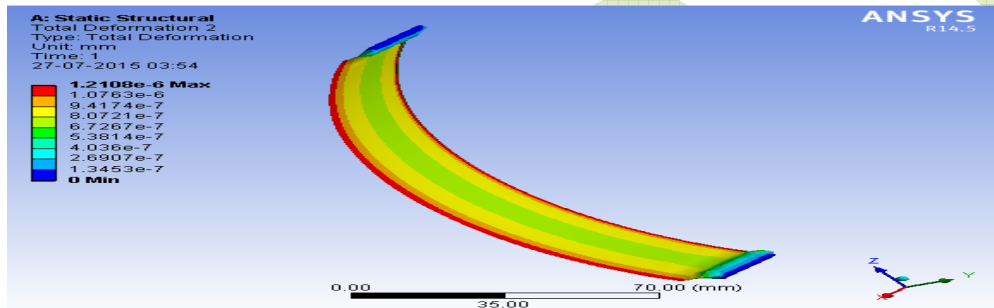
Analysis if brake liner:

Fig.7. Analysis of brake liner using ANSYS

Table.4. Analysis of brake liner.

Part Name	Maximum theoretical stress N/mm^2	Von-mises stress N/mm^2	Maximum deformation mm	Result
BRAKE LINER	0.0345	0.04132	1.2E-6	Safe

1. Maximum stress by theoretical method and Von-mises stress are well below the allowable limit, hence the LINER is safe.
2. LINER shows negligible deformation under the action of system of forces.
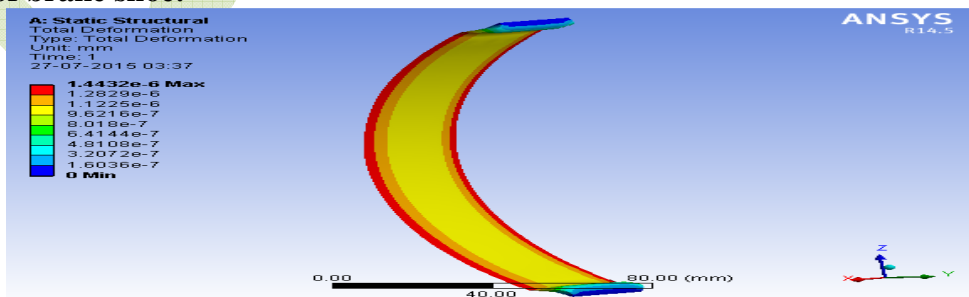
Analysis of brake shoe:

Fig.8. Analysis of brake shoe using ANSYS

Table .5. Analysis of brake shoe.

Part Name	Maximum theoretical stress N/mm^2	Von-mises stress N/mm^2	Maximum deformation mm	Result
BRAKE SHOE	0.0325	0.037	1.44e-6	Safe

1. Maximum stress by theoretical method and Von-mises stress are well below the allowable limit, hence the BRAKE SHOE is safe.
2. BRAKE SHOE shows negligible deformation under the action of system of forces.

Observation table: Table No.6. Gives reading of brake load vs braking distance reading and graph. Taking standard load on dyno brake pulley = 1.5kg

SR. NO.	BRAKE LOAD (KG)	Braking distance(Distance of load travel (mm)
1	0.2	135
2	0.4	121
3	0.6	104
4	0.8	87
5	1	74
6	1.2	61
7	1.4	48
8	1.6	28
9	1.8	11

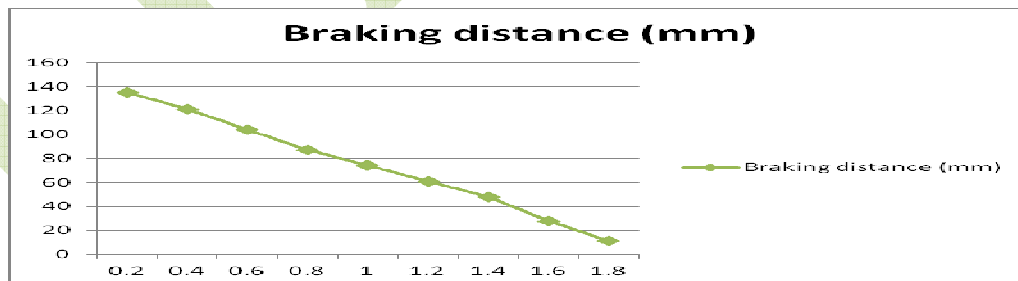**Table.6. Observation Table brake load vs braking distance.**

Fig. 9. Graph of brake load vs braking distance.

The graph indicates that the braking distance reduces with increase in brake load , ie the reaction time of the brake drops with increase in brake load.

CONCLUSION

1. It is observed that the theoretical output speed reduces with the increase in brake force as the power is absorbed in friction.
2. It is observed that the experimental output speed reduces with the increase in brake force as the power is absorbed in friction.
3. It is observed that both the theoretical as well as experimental output speed decreases with the increase in brake load , slight variation is seen in both loads indicating marginal slip in brake
4. It is observed that the %slip increases with the increase in brake load but is limited to below 4%
5. It is observed that   the braking distance reduces with increase in brake load , i.e. the reaction time of the brake drops with increase in brake load.

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