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MEASUREMENT OF INDUSTRIAL DISC BRAKE ON AUTOMATIC CONTROLLED TEST STAND

MĚŘENÍ PRŮMYSLOVÉ KOTOUČOVÉ BRZDY NA AUTOMATICKÉM EXPERIMENTÁLNÍM STANOVIŠTI

Abstract

The entry deals with problems of designing and measuring of industrial disc brake with using strain gauge. In the first stage the brake is tested for stress analysis with using FEM (Finite Element Method) to find out the most appropriate positions for strain gauges installing. Strain gauges measuring calibration went before constructing of experimental stand. Experimental results will be used for design optimization of similar brake types.

Abstrakt

Příspěvek se zabývá problematikou návrhu zkoušek a měření průmyslové kotoučové brzdy s použitím tenzometrů. V první části je provedena analýza napětí v brzdě s použitím MKP (metoda konečných prvků), aby byla nalezena místa s největším namáháním pro instalaci tenzometrů. Před zhotovením zkušebního zařízení je provedena kalibrace tenzometrů. Získané experimentální výsledky budou použity pro optimalizaci konstrukce kotoučových brzd podobného typu.

1 INTRODUCTION

Disc brakes with controlling lam mechanism are used for industrial applications. Hydraulic cylinder or similar actuator pushes the couple of brake plates to the disc.

For information about working parameters and brake loading possibilities there are done working tests. Establishing of made out brake torque size during different working states of the brake, especially depending on temperature of the friction couple and joint sliding velocity, is the main purpose of the working tests. In the next step the brake thermal proportions in dependence on brake performance and brake working intensity are solving. Possibilities of working load of the brake are getting from these working tests. Brake reliability and possibilities of its loading during continual working is verifying by the long-time tests.

2 WORKING TESTS

Working tests simulate brake loading during working with repeating working cycles, which come after in very short periods. Tests are composed of set of repeatable test cycles, when the brake disc starts running to the maximum speed, then follows controlled slowing down of the brake along linear sinking speed ramp and short delay at the rest. Force effects and sliding velocity are measured

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during the sinking speed ramp. Acquired values in this way are compiled. Size of friction coefficient depending on sliding velocity and brake performance is then determinate.

The brake and its friction couple temperature rises during the long set of working cycles and stops at the stable value, which is not increasing any more. This temperature growth allows establishing of force friction transfer parameters at different temperatures. Stable temperature working allows to judge temperature brake parameters in conditions of constant transformed energy flow.

3 STRAINING OF BRAKE MECHANISM

Another field of brake testing is measuring and describing of brake controlling mechanism straining during working. It is supposed loading with force, which pushes the brake lams of controlling mechanism and couple of brake plates to the brake disc and also friction force rising at the friction couple. Getting data for mechanism optimization is the goal of the testing.

Straining mechanism determination has computing and experimental parts. In the computing part model of the brake mechanism is designed and then subjected to the finite element method (FEM) to obtain stress behavior corresponding to supposed strain with controlling and friction force during brake working. Model of the brake mechanism for finite element method computing is in the figure 1.

The computation is used as a base for determination of measured stress positions by means of strain gauges. Brake mechanism stress behavior by supposed working load conditions acquired from finite element method is in the figure 2.

Stress behaviors gotten by this analyses show critical mechanism positions with maximum strain values. Strain gauges are installed in these positions. Strain gauge installing on the brake mechanism is in the figure 3.

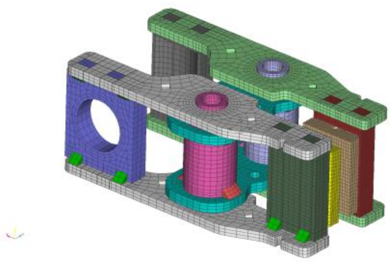

Fig. 1

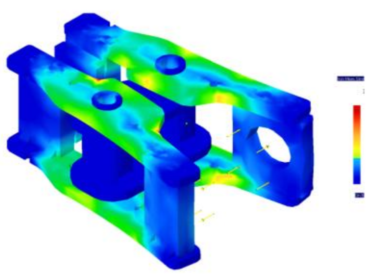

Fig. 2

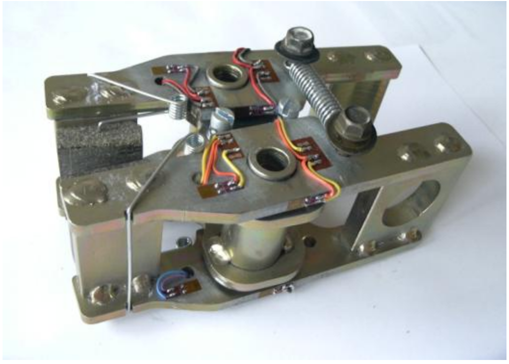

Fig. 3

4 TESTING STAND

Brake testing is realized on automated testing stand. Driving of the shaft with the brake disc is provided by asynchronous electromotor, controlled by frequency converter. Disc speed decreasing along linear sinking ramp is provided by this way. Tested brake is fixed on bail arm and rising braking force is measured by force sensor on which the bail arm is hanged on. The scheme of mechanic part of the stand is in the figure 4. Real design of testing stand is in the figure 5.

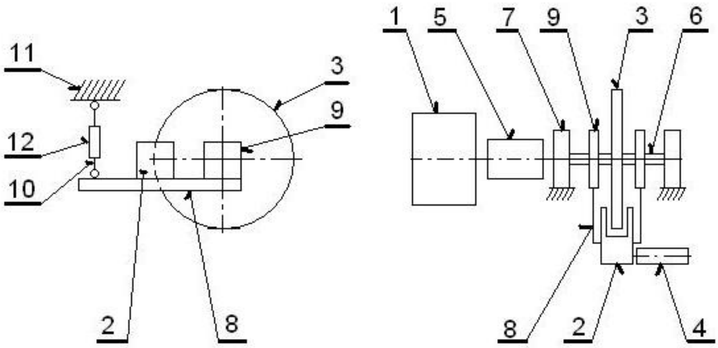

Fig. 4

1. Electromotor Siemens 1 LA 7 163 – 4 AA 66 – Z (11 kW, 1460 rpm)
2. Testing brake
3. Brake disc
4. Brake controlling hydraulic cylinder
5. Double-row jaw clutch
6. Brake disc shaft
7. Shaft bearings
8. Bail arm of the brake
9. Bail arm bearings
10. Bail arm swivel
11. Supported frame
12. Force sensor

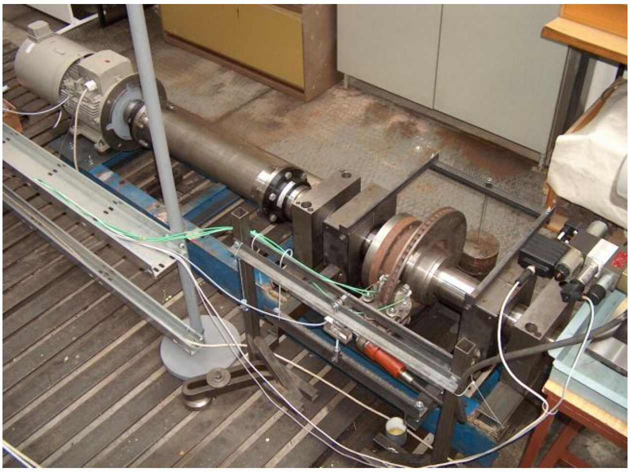

Fig. 5

Rising friction force, pressure size in the cylinder, which pushes brake plates to the disc, disc brake speed and brake mechanism temperature were measured during tests. Controlling and data collection of the test is provided by PC by controlling software created in LabView developing environment.

5 CONCLUSIONS

Described testing stand allows experimental establishing of friction coefficient for different materials of friction couple by its different sliding velocity and temperature of friction. Also allows investigate brake thermal behavior during its intensive loading. By this testing is also possible to establish dimension and style of loading to get data for brake mechanism optimization and verification of stress analyses done by using FEM. Testing stand is possible to use for different designs and brake sizes of similar type during comparable working load conditions.

REFERENCES

[1] MOSSÓCZY, P., ČEŠPÍRO, Z. Grafické vývojové prostředí LabVIEW jako podpůrný prostředek pro měření vlastností pohonných mechanismů. Stať ve sborníku – *XLIII. Medzinárodná vedecká konferencia katedier časti a mechanizmy strojov*, Zvolen, 2002

[2] ČEŠPÍRO, Z., MOSSÓCZY, P. Zvyšování spolehlivosti strojních pohonů experimentální simulací. Stať ve sborníku – *Konference Transfer 2002*, Trenčianská univerzita A. Dubčeka, Trenčín, 2002

[3] ČEŠPÍRO Z., POVA F. Návrh zkušebního stavu a metodiky zkoušek průmyslových hydraulických brzd. Stať ve sborníku – *XLIV. konference kateder částí a mechanismů strojů,* Praha, 2003

[4] ČEŠPÍRO,Z., MOSSÓCZY,P. Development of Equipment for Testing of Drive Parts and its Monitoring Application of Work, Heat and Reliability Parameters. *Acta Mechanica Slovaca 1/2006,* Košice 2006

[5] ČEŠPÍRO,Z., MOSSÓCZY,P. Vývoj zkušebních metod průmyslových kotoučových brzd a hodnocení jejich třecích, výkonových a tepelných charakteristik. Stať ve sborníku – *48. medzinárodná konferencia katedier častí strojov a mechanizmov,* Bratislava, 2007

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