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LABORATORY FOR THE EXPERIMENTAL RESEARCH OF THERMO-MECHANICAL INSTABILITIES OF DISC AND DRUM BRAKES

LABORATOŘ EXPERIMENTÁLNÍHO VÝZKUMU TEPELNĚ MECHANICKÝCH NESTABILIT KOTOUČOVÝCH A BUBNOVÝCH BRZD

Abstract

The contribution introduces a newly developed laboratory for the experimental research of thermo-mechanical instabilities of disc and drum brakes of personal cars. The laboratory consisting of two testing stands belongs to the University of West Bohemia in Pilsen. The first one, automobile testing stand, enables measurement of processes on car, the second one, brake testing stand, contains only parts where tribological processes occur. Various moments of inertia, driving mode, control strategy based on measured quantities (deceleration, pressure and torque) can be used. The overall experimental set-up of the laboratory, parameters of individual systems and capabilities of their experimental usage are discussed.

Abstrakt

V příspěvku je představena nově budovaná laboratoř pro výzkum tepelně mechanických nestabilit kotoučových a bubnových brzd osobních automobilů. Laboratoř je budována na Západočeské univerzitě v Plzni. Součástí laboratoře jsou dva nezávislé testovací systémy. Automobilový stav umožňuje sledovat procesy přímo na automobilu, brzdový stav obsahuje pouze ty části automobilu, kde probíhají tribologické procesy. Lze definovat setrvačné hmoty a jízdní režim, který je řízený dle zvolené měřené veličiny (zpomalení, tlak, kroutící moment). Popsáno je celkové uspořádání experimentálních systémů, jejich parametry a možnosti jejich využití.

1 INTRODUCTION

Thermo-mechanical behaviour of disc and drum brakes of personal cars is usually investigated on the testing stands. The stands enable repeating experiments under the same conditions. It is important for the fatigue tests of the brake system components, for developing brake components, measuring system and testing methods. The first group of testing stands is focused on the investigation of only the parts where tribological processes occur (brake disc or drum, brake caliper, brake pads) [1,3], the second group includes in addition some nearest parts of cars (wheel, axle

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damper, wheel spring, …) [3] and the third group enables to test all cars [2,3]. The all car testing reveal the car behaviour on the road, on other hand it is experimentally difficult to measure all components which are in relation with brake parts and distinguish their influence on braking processes. The brake basic parts testing in order to determine their behaviour during braking processes (important for producer of the parts – tests of new design, new materials, etc.) on other hand does not simulate behaviour of the car on the road, where the relationship between components is significant.

2 THE TESTING STANDS CONCEPT

Concerning the old testing stand (shown in Fig. 1) it is used for simple brake disc tests and for the development of thermo-mechanical instabilities measuring system [4] at the University of West Bohemia in Pilsen. The system is based on old electric motor Schrage type with power 25 kW and 2500 rpm, the control is made by to push-buttons. The brake disc is directly mounted on motors flange. The brake calliper is fixed on robust support. The hydraulic system consists of the hydraulic pump, hydraulic piston and electromagnetic valve controlled by industrial computer. The piston makes pressure in the brake hydraulic circuit due to mechanical contact with car brake cylinder. The reference variable of the control system is the pressure in the brake hydraulic circuit; the control system allows keeping constant pressure value. Maximum pressure in the brake circuit is limited by the electric motor power and is approximately 10 bars. It allows perform only brake tests simulated braking during long downhill grade, typical braking mode on mountains. The brake disc and calliper are covered and the air with dust from the chamber is exhausted through filter out.

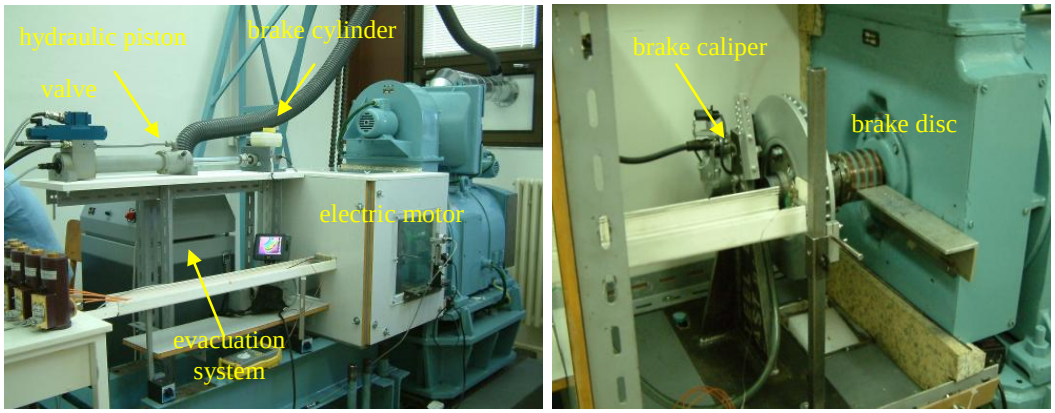

Fig. 1 The old experimental system – experimental set-up

The new laboratory is situated in the building of the Plzeň Science and Technology Park. The laboratory consists of the room for experiment preparation, room with test stands and control centre as is shown in Fig. 2. The laboratory has special air input and output and the floor is made from massive spring loading concrete block.

The automobile testing stand consists of wheels with variable inertia, diameter is 1,2 m, inertia is equal to car weight from 1100 kg to 2200 kg. The wheels are fixed on the truck back axle; the differential gear output is connected through electromagnetic coupling with electric motor. The motor power is 18 kW; it allows maximum surface speed of wheels 30 km/h. Higher test velocity is reached by the automobile motor. The differential lock provides the possibility to investigate stopping power of each brake separately. The three independent fans are used for the cooling brakes and the automobile radiator. The brake dust is evacuated out from car wheel space by evacuation system with maximum flow 7000 m^3/h., the flow is continuously regulated. The evacuation system has G4 and F7 class filters, the filtered air goes out of the building. The stand has the emergency air brakes.

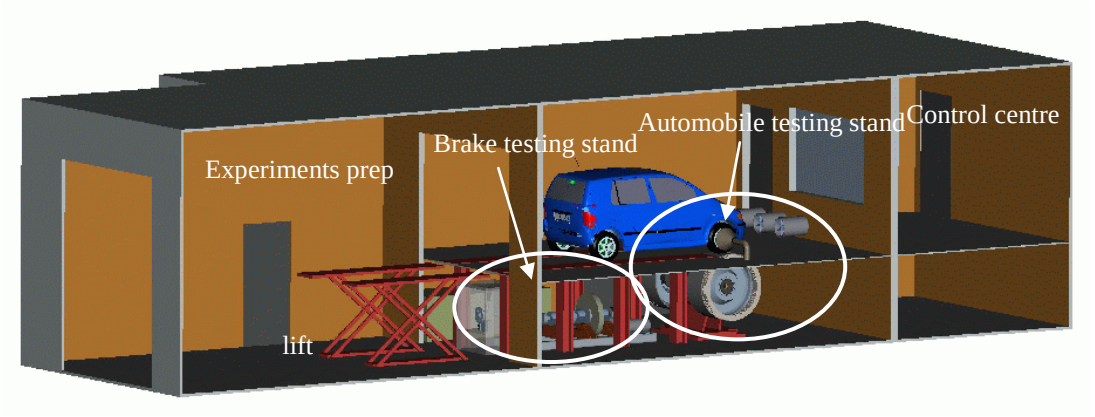

Fig. 2 The new experimental systems

Compressed air is used for differential lock control, too. The laboratory is equipped with exhaustion of exhaust gases and concentration health dangers gases are monitored. All systems of the stands are controlled by industrial computer; the scheme is shown in Fig. 3.

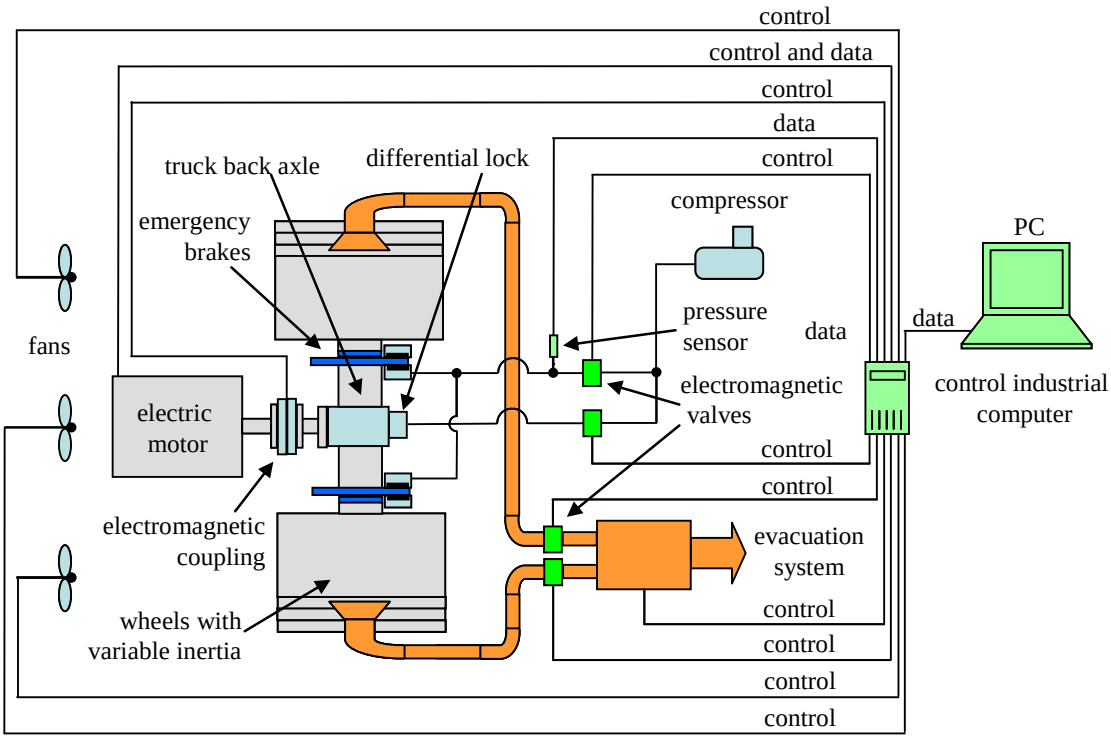

Fig. 3 The automobile stand – simplified scheme

The brake testing stand consists of electric motor (power 19 kW and 1450 rpm), electromagnetic coupling, variable fly wheels (inertia is equal to car weight from 1100 kg to 1800 kg), and torque meter with measured range up to 5 kNm. The stand allows installing brake disc or drum and other parts of brake system with complete pitman. The hydraulic part of the stand is the same as for the old brake stand. The air with brake dust is exhausted to the same evacuation system as from the automobile stand. All systems of the stand are controlled by industrial computer, the scheme is shown in Fig. 4. The driving mode is possible to define in relations to the measured quantities (deceleration, pressure and torque).

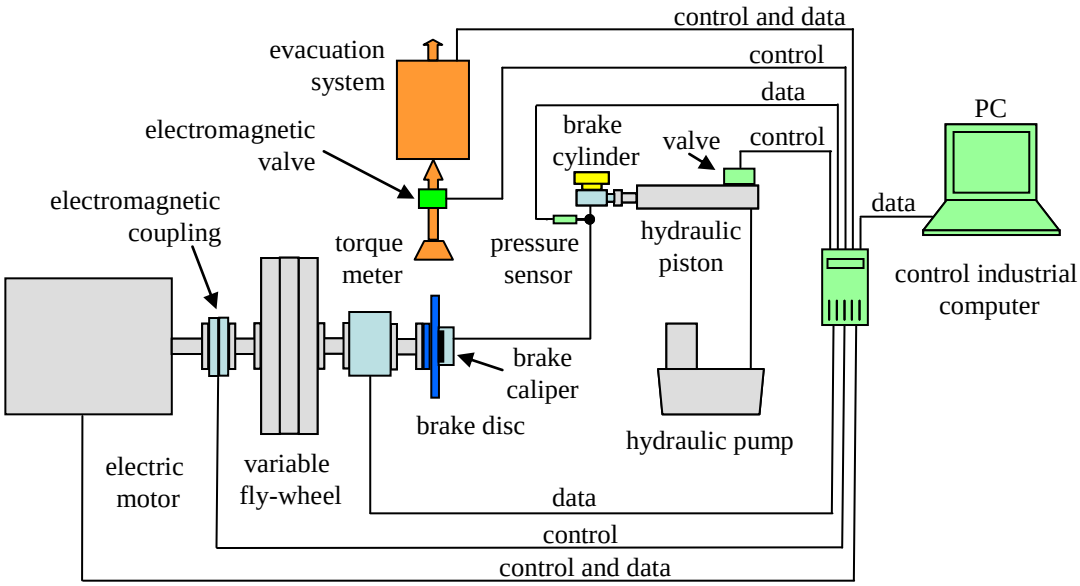

Fig. 4 The brake stand – simplified scheme

5 CONCLUSIONS

This paper introduces current and newly developed laboratory of the University of West Bohemia in Pilsen for the experimental research of thermo-mechanical instabilities of disc and drum brakes of personal cars. The new laboratory enables to perform dynamic brake tests of the whole car and separately only parts of a car where tribological processes occur. The new test stands are fully controlled by industrial computers. The driving mode is possible to define in relations to the measured quantities. The laboratory is equipped with instruments that guarantee safe work for staff.

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