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COMPRESSION STRENGTH TESTING FOR AUTOMOTIVE BRAKE PADS USED IN EARTHQUAKE ENERGY DAMPERS

BY

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Abstract. In order to calibrate a friction damper which uses automotive brake pads it is necessary to determine the compression behaviour of the friction material. This paper summarizes the experimental results obtained for a set of automotive brake pads made in Romania. These results are useful in order to determine the slip load level in a seismic energy dissipation mechanism which uses this type of friction pads. The paper presents the experimental set up and the compression behaviour curves obtained for a set of four commercial brake pads. The testing was performed by the author as a part of his research work, using a hydraulic compression press.

Key words: friction dissipation; compression behaviour; friction dampers.

1. Introduction

The experimental research presented in this paper wants to establish the general behaviour of the friction material found on the Romanian made automotive brake pads, when it is subjected to significant compression loads. The behaviour of this composite material is necessary to determine the maximum level of bolt tightening (N_b) in a slotted friction damper (Fig.1) [1], [2].

Once the compression behaviour known, it is possible to calibrate the maximum slip force (N_{slip}) developed in the friction damper equipped with automotive brake pads [3], which is related with the level of the bolt tightening

(N_b). After the calibration, the friction damper may be used in seismic isolation applications for buildings [4],…,[8].

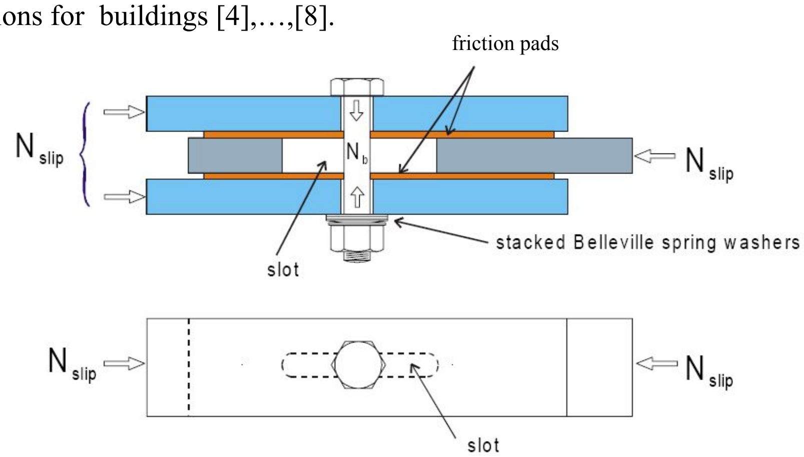

Fig. 1 – Basic slotted friction damper.

2. Test Set Up

The testing was performed on a set of four automotive brake pads made in Romania, using a 300,000 daN hydraulic press in the Laboratory of Steel Structures Department, Technical University of Civil Engineering, Bucharest.

2.1 Friction Material Characteristics

The automotive brake pads to be tested were carefully measured in thickness and in area (Fig.2). The thickness for the friction material and the steel base plate were measured using sliding calipers; the area was determined graphically only for the friction material (the grey surface in Fig.2) by dividing its surface in small unit areas, which were then summed for each pad in the set.

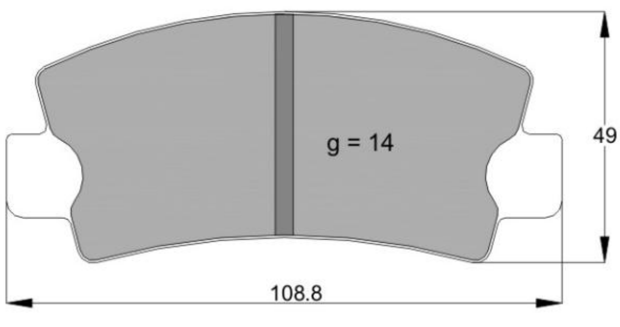

Fig. 2 – Tested brake pad layout.

The results obtained for all the automotive brake pads tested are presented in Table 1.

Table 1
Friction Pads Geometric Data

Friction pad no.:	1	2	3	4
Thickness, [mm]	14.01	14.00	14.00	14.00
Area, [mm^2]	3,682	3,681	3,681	3,680

The physical and mechanical characteristics of the friction material used on the brake pad were provided by the producer in the technical card of the product [9]. The friction material is an ecological non-asbestos composite material, made of mineral fibers, inorganic powders, synthetic rubber bonded with a fenol-formaldehide resin. It has a very good friction behavior (friction coefficient, μ , between 0.19 and 0.46). The composite friction material has a mass density of 2,450 ± 200 kg/m^3 and its Brinell hardness is 18 ± 3 HB.

2.2 Testing Facilities and Conditions

A 300,000 daN hydraulic press was used for the compression testing of the automotive brake pads. Due to the small thickness of the brake pads, it was necessary to insert a special device (a solid steel cube with two dial extensometers placed laterally) between the press jaws, which is presented schematically in Fig. 3.

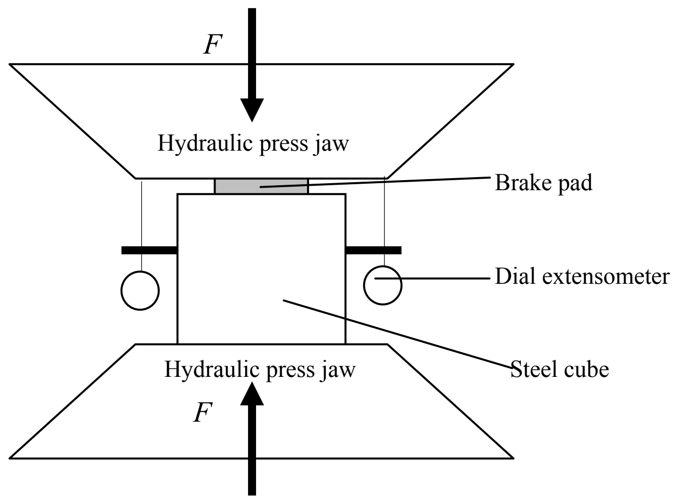

Fig. 3 – Device inserted between the press jaws.

The experimental program was realized in monotonous loading paths, with a speed of 50 kN/min, up to the fracture of the friction material of the brake pads. The force–displacement curves, obtained using the output of the hydraulic press, were verified during the testing with the readings on the dial extensometers. The general layout of the testing is presented in Fig. 4.

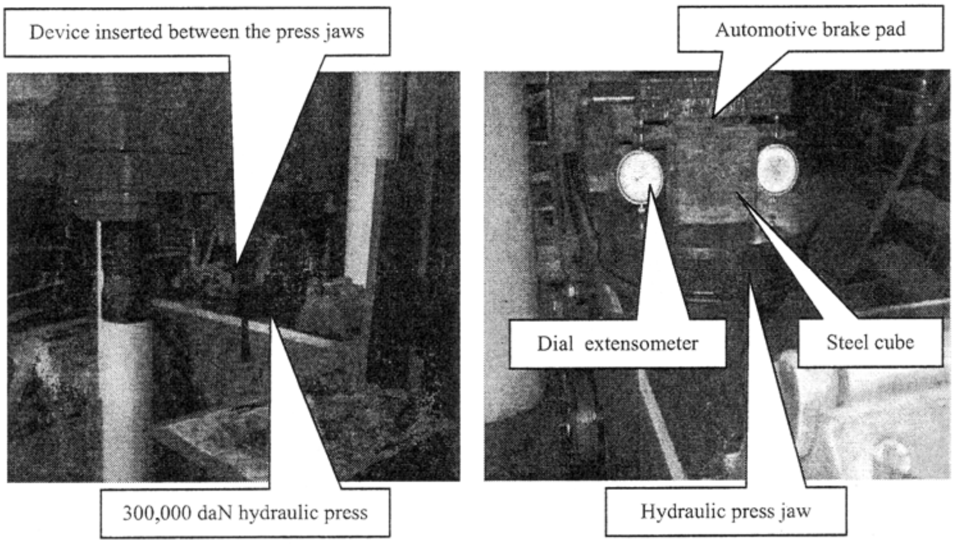

Fig. 4 – General layout of the testing (left) and detail (right).

3. Testing Results

For each friction pad, the testing revealed the behaviour curves *F vs.* Δ (Fig. 5). For small compression loads (under 200 kN) the behaviour of the friction pad material is nonlinear, which may be due to the initial porosity of the material. After the small pores in the material are crushed (between 200 kN and 800 kN) the behaviour of the material becomes elastic. The compression failure of the friction material appears at around 950 kN and is visible due to lateral fractures. The remanent displacement after the occurrence of failure, measured in the central area of the friction pad, showed a medium 2 mm value.

Using the geometric data measured for each sample (Table 1) it was possible to determine the behaviour curves, σ *vs.* ε, for all the tested brake pads. These results (Fig. 6) showed a linear elastic behaviour between 50 N/mm^2 and 200 N/mm^2.

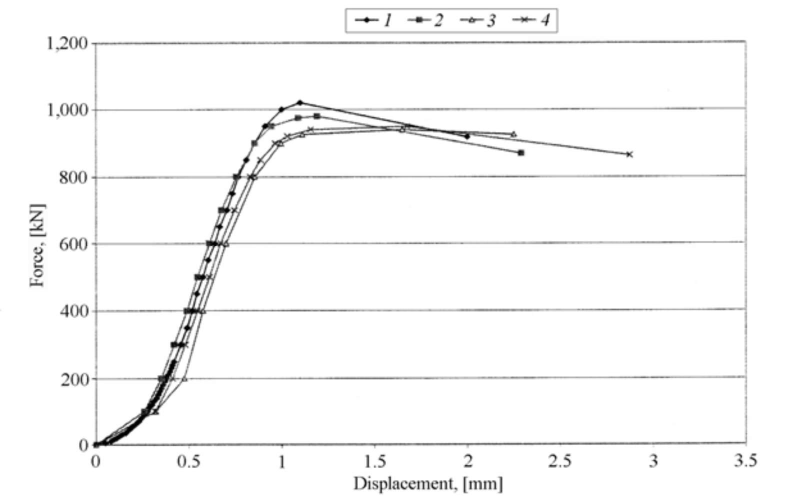

Fig. 5 – Compression behaviour for the friction material of the brake pads.

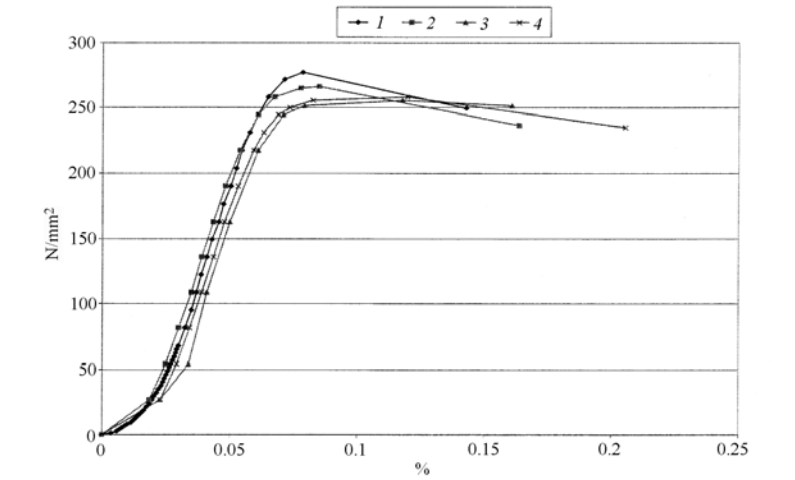

Fig. 6 – Behaviour curves for the friction material of the brake pads.

5. Conclusions

From the compression testing results obtained for the friction material of the Romanian made automotive brake pads, it is possible to draw the following conclusions:

1. The results are consistent for the small number of samples tested and may be extended for the behavior of most cases.

2. The compression strength for the friction material is comparable to the mild steel yield strength.

3. The displacement is quite large for low loading, showing a clear nonlinear behaviour in the beginning of all curves. This behaviour may generate problems if the brake pads are not used symmetrically in the friction damper.

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TESTAREA CAPACITĂŢII LA COMPRESIUNE A PLACUTELOR DE FRÂNĂ AUTO UTILIZATE ÎN ALCĂTUIREA MECANISMELOR DE DISIPARE A ENERGIEI SEISMICE PRIN FRECARE

(Rezumat)

Pentru calibrarea strângerii dispozitivelor de disipare a energiei prin frecare care utilizează plăcuțe de frână auto, este necesar să se determine comportarea la compresiune a materialului de fricțiune al acestora. Cunoaşterea comportării la compresiune a acestui material conduce la stabilirea limitei de alunecare a dispozitivului.

Se prezintă dispozitivul de încercare al unui set de plăcuțe auto şi rezultatele obținute în urma testului la compresiune. Testarea s-a facut utilizând o presă hidraulică şi a constituit o parte a cercetării autorului.