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FRICTION COEFFICIENT BETWEEN CLOTHES AND CAR SEAT COVERS

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ABSTRACT

The present work discusses the friction coefficient displayed by clothes sliding against car seat covers. The frictional performance of two groups of covers, the first was contained five different types of synthetic leather and the second contained nine different types of synthetic textiles, was measured. Measurement of friction coefficient is, therefore, of critical importance in assessing the proper friction properties of car seat covers and their suitability to be used in application to enhance the safety and stability of the driver.

Based on the experimental results, it can be concluded that, synthetic leather displayed relatively higher friction coefficient than synthetic textiles when sliding against dry polyester clothes, where the highest friction value exceeded 0.6. Generally, friction coefficient slightly decreased with increasing load. At water wetted sliding, significant drop in friction coefficient was observed for synthetic leather specimens. Synthetic textiles showed relatively higher friction than synthetic leather. For the sliding of dry cotton clothes, significant friction increase for synthetic leather was observed, where values of friction could reach 0.6. Synthetic textiles displayed relatively lower friction. In the presence of water film covering the sliding surfaces remarkable friction increase was observed for the test specimens. Textiles test specimens showed friction values up to 0.85.

In addition to that, friction coefficient displayed by the sliding of dry (50 % polyester + 50 % cotton) clothes displayed relatively higher values than that presented by 100 % polyester and 100 % cotton. The majority of the test specimens showed acceptable friction values. At water wetted surfaces slight friction decrease was observed. That behaviour recommended those materials to be used as car sear covers in humid environment. Besides, wool clothes displayed the highest friction coefficient when sliding against synthetic leather, (0.88). Textiles test specimens displayed relatively lower friction than synthetic leather, (0.58). Generally, wool clothes experienced the highest friction values among the tested clothes at dry sliding. In the presence of water film, friction coefficient slightly decreased.

KEYWORDS

Friction coefficient, polyester, cotton, wool, clothes, car seat covers.

INTRODUCTION

It is well established that there is an increase in car accidents. It is necessary to introduce laboratory and simulating studies to ensure the safety of the different elements from which the car is constructed. Although a number of studies were related to safety of the driving of the car, no attention was actually taken up that can indicate safety and stability of the driver in terms of frictional behaviour between driver clothes and car seat covers. An acceptable value of friction should be obtained to keep the driver stable on the seat. It is necessary to measure the friction coefficient of the driver clothes sliding against dry and water wetted car seat covers. In recent studies, friction coefficient displayed by bare foot and rubber footwear soles sliding against the brake pedal rubber pads of different hardness in dry, sand contaminated, water and oil lubricated conditions was discussed, [1]. At dry sliding, friction coefficient slightly decreased with increasing the hardness of the rubber pad. For the transverse direction of sliding, friction coefficient displayed relatively lower values than that observed for longitudinal sliding. In the presence of sand particles between the foot and the rubber pad, friction coefficient significantly increased with increasing the hardness. Bare foot sliding against water wetted pedal pads displayed friction coefficient relatively higher than that shown for surfaces contaminated by sand particles. For oil lubricated pedal pad, friction coefficient significantly increased with increasing the hardness of the rubber pad, at longitudinal and transverse sliding directions respectively. Rubber footwear soles, slid against the tested pedal pads, displayed lower friction values than that observed for bare foot at dry sliding. In the presence of sand particles on the sliding surfaces friction coefficient significantly increased, while decreased for water wetted pads with increasing the hardness of the tested pad. Friction coefficient of rubber footwear soles sliding against oil lubricated pedal pad increased with increasing the hardness of the rubber pad. The values of friction coefficient were relatively lower than that displayed by bare foot. It seems that adhesion of oil into the rubber surface was stronger compared to bare foot.

The effect of the treads width of the brake pedal rubber pads on the friction coefficient was investigated, [2]. Experiments of the sliding of bare foot against the pedal pad showed that friction coefficient of dry sliding significantly decreased with increasing the tread width. The sliding direction has no effect on the friction coefficient for the tested pads. In the presence of sand particles separating the two contact surfaces, load had no influence on friction coefficient. Friction coefficient slightly decreased with increasing the tread width. For water wetted pedal pad, friction coefficient displayed higher values than that observed sand particles contaminated surfaces. Friction values showed consistent trend with increasing the tread width. Friction displayed by oil lubricated pedal pads was the lowest and the sliding condition could be considered as unsafe. When rubber shoes slid against the tested rubber pads friction coefficient displayed relatively lower values than than that displayed by bare foot. Besides, sliding in the transverse direction displayed higher friction values than longitudinal one at dry sliding. In the presence of sand particles, the shortest tread width displayed the highest friction. Sliding against water wetted pedal pad, the highest values of friction coefficient were displayed

by 2 mm tread width due to the water leakage from the contact area. The friction values displayed in the transverse direction were relatively lower than that displayed in the longitudinal direction. Sliding against oil lubricated pedal pad showed relatively low friction values which were considered as unsafe sliding.

The friction coefficient, displayed by bare foot and footwear soles sliding against polypropylene brake pedal pads, was discussed, [3]. The frictional performance is compared to that obtained from the rubber conventional pads. Measurement of friction coefficient is, therefore, of critical importance in assessing the proper friction properties of brake pedal pads and their suitability to be used in application to enhance the safety of the vehicle. The reduction in friction coefficient displayed by bare foot and rubber footwear soles sliding against the tested brake pedal pads in dry, sand contaminated, water and oil lubricated conditions is discussed.

Friction measurement is one of the major approaches to quantify floor slipperiness. Investigations on friction measurement have been focused on liquid contaminated conditions. It was expected that wet surfaces had significant lower friction coefficient values than those of the dry surfaces, [4]. The friction coefficient difference between the dry and wet surfaces depended on the footwear material and floor combinations. Friction measurements under liquid contaminated conditions were very common. The squeeze film theory explains the effects of the liquid on the measured friction. Measurements of the static friction coefficient between rubber specimens and ceramic surfaces were carried out at dry, water lubricated, oil, oil diluted by water and sand contaminating the lubricating fluids, [5 - 8]. It was observed that, dry sliding of the rubber test specimens displayed the highest value of friction coefficient. For water lubricated ceramics, the value of the friction coefficient decreased compared to dry sliding. For oil lubricated ceramic, friction coefficient decreased with increasing the height of the grooves introduced in the rubber specimens. As for ceramic lubricated by detergent and contaminated by sand, friction coefficient increased significantly compared to the sliding on ceramics lubricated by water and soap.

The factors affecting friction coefficient measurement are the material, surface geometry of the footwear as well as floor, floor contamination conditions and even the slipmeter used, [9 - 12]. Investigators have concentrated on the friction coefficient measurements on liquid contaminated floors because most slip/fall accidents occur on the surfaces of such floors, [13 - 16]. When stepping on a wet or lubricated floor, a shoe sole cannot touch the floor surface without squeezing the liquid out of the contact area. The liquid between the floor and the sole isolates the two contact surfaces, thus reducing the friction between them. The liquid drainage time between the two contact surfaces depends on the viscosity and pressure between the two surfaces. The higher the viscosity is, the longer the time is required for the film thickness to decrease, [17]. A longer drainage time increases the risk of slipping due to the short time available to prevent a slip after the heel touches the floor. The effect of surface roughness of ceramic on the friction coefficient, when rubber and leather are sliding against it, was investigated, [18]. Glazed floor tiles of different roughness ranging from 0.05 and 6.0 μm were tested. The

test results showed that, friction coefficient decreased down to minimum then increased with increasing the surface roughness of the ceramic surface.

The analysis of load dependence of the hysteresis friction coefficient of sliding rubbers over rough and self-affine surfaces was discussed, [19], to demonstrate the influence of height distributions of different road tracks within the corresponding friction model. Special attention is devoted to contact situations that correspond to slipping tires and tread deformations during ABS-braking. The V-shaped tread design, either perpendicular or parallel to the friction force direction, on the rubber soles provided no advantage in improving the slip resistance on wet and glycerol-contaminated conditions except for the flat glycerol contaminated floor surface, [20]. The floors with grooves perpendicular to friction force direction had the highest friction coefficients among all the flooring conditions on both the wet and glycerol-contaminated cases except for the wet/flat sole/10° case.

In the present work, the friction coefficient displayed by the dry and water wetted of polyester, cotton and wool clothes sliding against car seat covers of synthetic rubber and synthetic textiles was tested.

EXPERIMENTAL

Experiments were carried out using a test rig to measure the friction coefficient between clothes sliding against car seat covers. The frictional performance, of two groups of covers the first contained five different types of synthetic leather and the second contained nine different types of synthetic textiles, was carried out using a test rig designed and manufactured to measure the friction coefficient displayed by the sliding of the tested specimens against each other through measuring the friction force and applied normal force, [1].

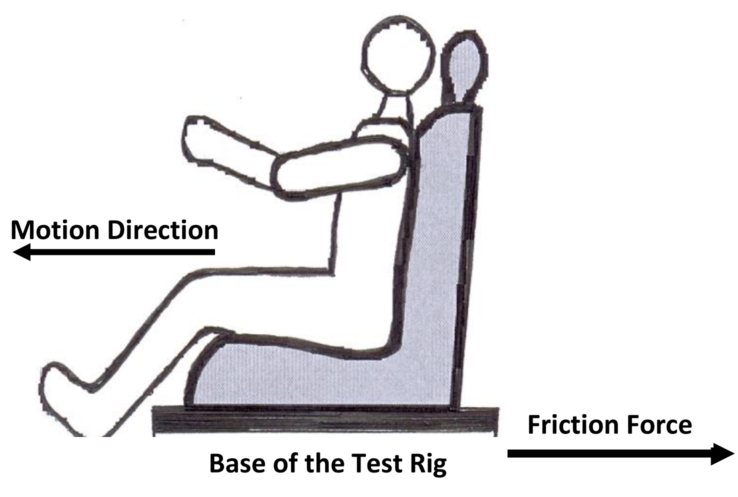

Fig. 1 Measuring procedure.

The tested materials were placed in a base supported by two load cells, the first can measure the horizontal force (friction force) and the second can measure the vertical

force (applied load). Friction coefficient is determined by the ratio between the friction force and the normal load.

Fig. 2 the tested synthetic textile and leather car seat covers.

The materials of textiles were polyester, cotton, (50 % polyester + 50 % cotton) and wool. The test specimens of car seat covers were of two groups the first was synthetic leather (A1), (A2), (A3), (A4) and (A5) and the second was synthetic textiles, (B1), (B2),

(B3), (B4), (B5), (B6), (B7), (B8) and (B9), Fig. 2. The tested car seat covers were adhered to the base of the test rig through a part of the car seat. Friction test was carried out at different values of normal load exerted by eight operators of weight ranged from 500 to 1100 N. The relationship between friction coefficient and load was plotted for every test then the values of friction coefficient were extracted from the figures at loads of 600, 800 and 1000 N. Experiments were carried out at dry and water wetted sliding surfaces.

RESULTS AND DICUSSION

Friction coefficient displayed by the dry sliding of polyester clothes against car seat covers is shown in Fig. 3. Synthetic leather group (A1, A2, A3, A4 and A5) displayed relatively higher friction coefficient than synthetic textile group (B1, B2, B3, B4, B5, B6, B7, B8 and B9). A4 test specimen showed the highest friction value which exceeded 0.6. The best result experienced by test specimens of synthetic textiles was displayed by test specimen B4 followed by B3. Generally, friction coefficient slightly decreased with increasing load. It is well known that as the value of friction coefficient increases both the stability of the driver and the safety of the vehicle increase. All the friction values were above 0.2. At water wetted sliding of polyester clothes against car seat covers, significant drop in friction coefficient was observed for synthetic leather specimens, Fig. 4. The friction decrease might be attributed to the fact that the water sprayed on the polyester formed a film partially covered the sliding surface, where a part of the contact area was polyester/synthetic leather and the other was water lubricated surface. As a result of that friction coefficient decreased. Synthetic textiles showed relatively higher friction than synthetic leather. Specimens (B7) and (B9) showed the highest friction values which exceeded 0.6. The friction increase observed for textiles could be from the ability of fibres to absorb water and make the sliding surfaces more drier.

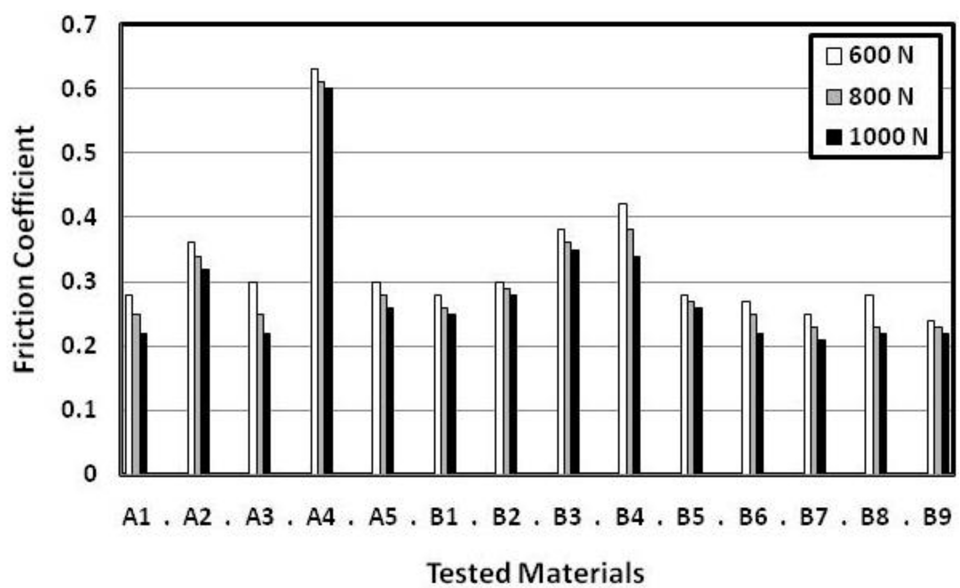

Fig. 3 Friction coefficient displayed by the sliding of dry polyester clothes against car seat covers.

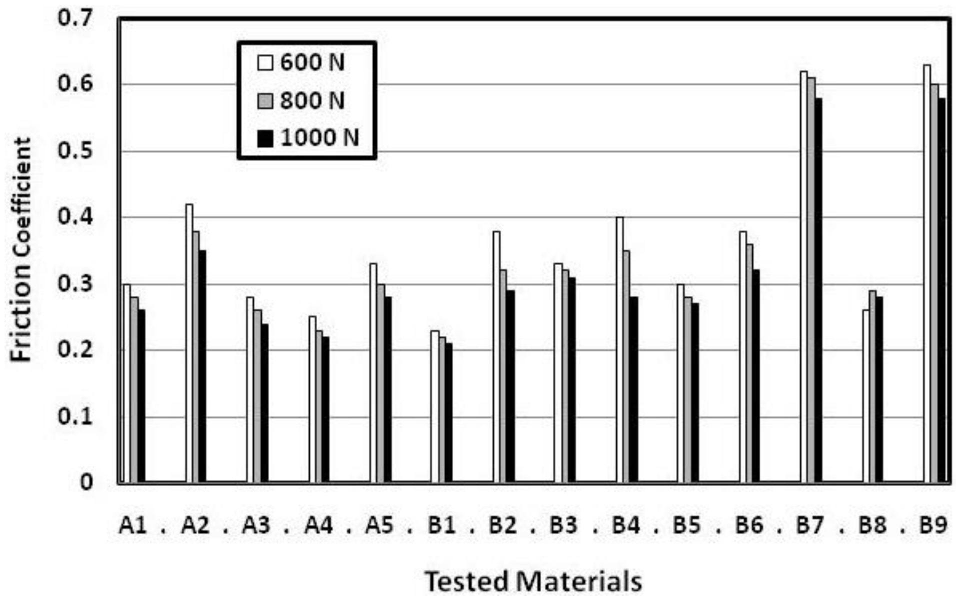

Fig. 4 Friction coefficient displayed by the sliding of water wetted polyester clothes against car seat covers.

Frictional behaviour of dry and water wetted cotton clothes sliding against car seat covers is illustrated in Figs. 5 and 6 respectively. Friction coefficient displayed by the sliding of dry cotton clothes showed significant friction increase for synthetic leather, Fig. 5. Values of friction reached 0.6 for test specimens (A2) and (A5). Synthetic textiles displayed relatively lower friction, where test specimens (B1), (B6) and (B7) showed values lower than 0.3. Among the textiles group (B4) displayed the highest friction coefficient followed by (B5), (B8), (B9) and (B2). Test specimens (B1) showed the lowest friction values. In the presence of water film covering the sliding surfaces remarkable friction increase was observed for the test specimens, Fig 6. Test specimen (A2) represented the highest friction values, for leather test specimens, of 0.7, 0.68 and 0.6 at loads of 600, 800 and 1000 N respectively. Textiles test specimens showed friction values up to 0.85 displayed by test specimen (B4). In general, test specimens (B1), (B2), (B3), (B4) and (B5) showed friction values higher than 0.6, while (B6), (B7), (B8) and (B9) showed values lower than 0.4. The friction increase may be attributed the common ability of cotton fibres to absorb the water from the sliding surfaces and decrease the water wetted contact area.

The results of testing the frictional behaviour of the textiles clothes (50 % polyester + 50 % cotton) are shown in Figs. 7 and 8. Friction coefficient displayed by the sliding of dry (50 % polyester + 50 % cotton) clothes against car seat covers displayed relatively higher values than that presented by 100 % polyester and 100 % cotton. The majority of the test specimens showed acceptable friction values. The enhancement occurred in friction coefficient might be from the homogeneous distribution of the cotton fibres at the sliding surfaces. Sliding of the test specimens at water wetted surfaces caused slight friction decrease, Fig. 8. It seems that the ability of cotton fibres to absorb water from the sliding surfaces decreased when mixing with polyester. Test specimens (A4), (B6)

and (B8) showed relatively high values of friction (0.82). That behaviour recommends those materials to be used as car sear covers in humid environment.

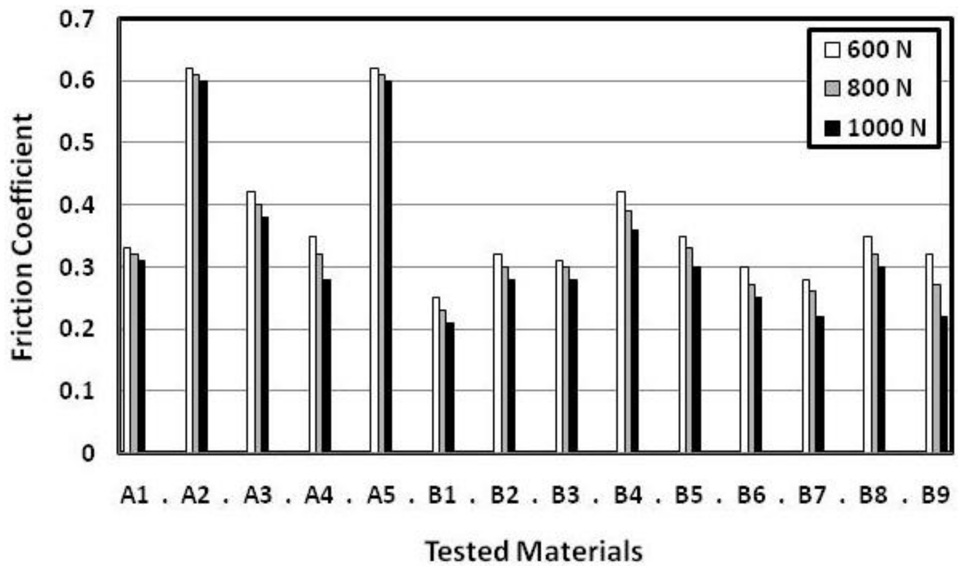

Fig. 5 Friction coefficient displayed by the sliding of dry cotton clothes against car seat covers.

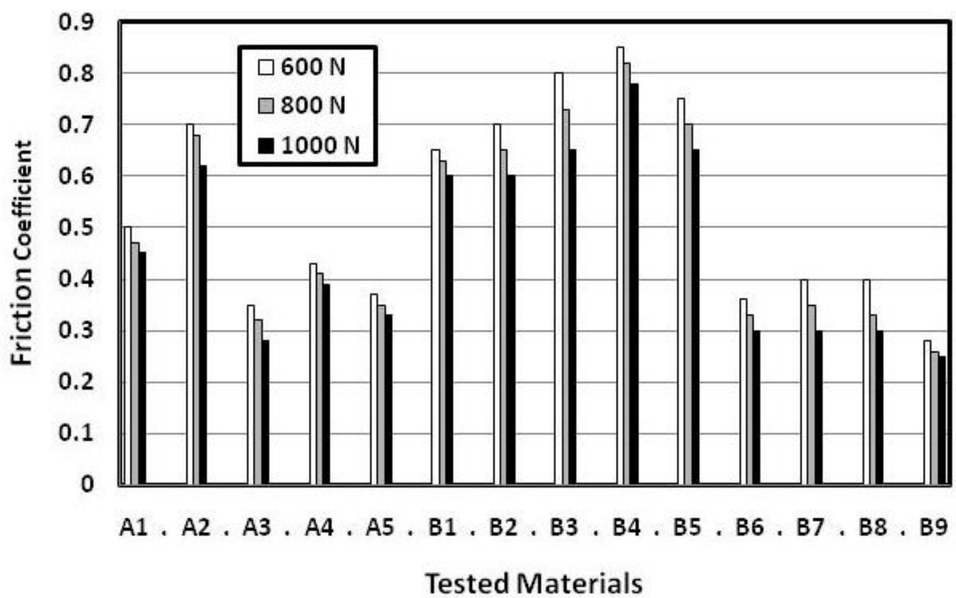

Fig. 6 Friction coefficient displayed by the sliding of water wetted cotton clothes against car seat covers.

Wool clothes displayed the highest friction coefficient when sliding against synthetic leather, where test specimens (A2) showed values up to 0.88, Fig. 9. Textiles test specimens displayed relatively lower friction than synthetic leather, where (B6), (B7) and (B8) showed values higher than 0.58. Generally, wool clothes experienced the

highest friction values among the tested clothes at dry sliding. Friction coefficient displayed by the sliding of humid wool clothes against car seat covers is shown in Fig. 10. In the presence of water film, friction coefficient slightly decreased. Test specimen (A4), (B3), (B4) and (B5) displayed the highest friction coefficient among the tested specimens.

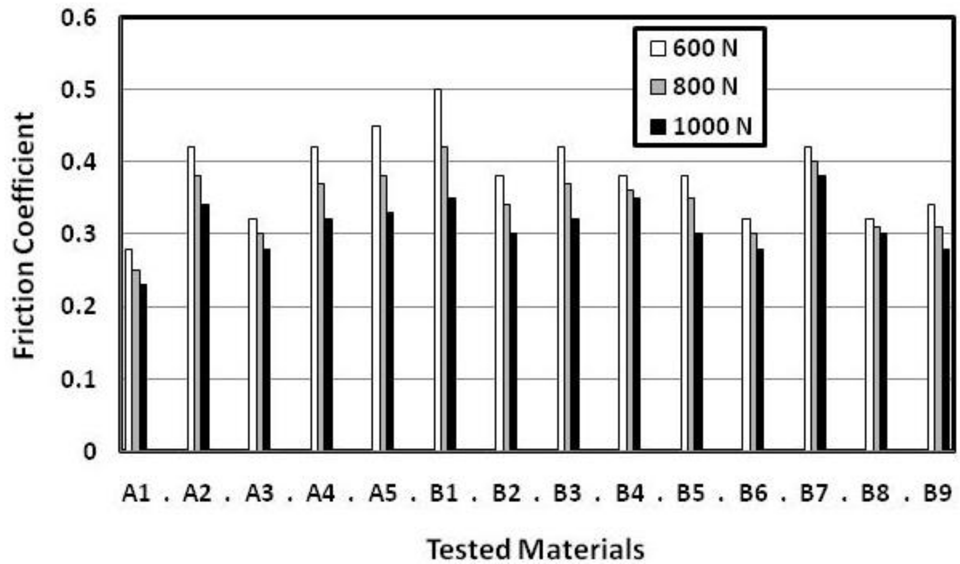

Fig. 7 Friction coefficient displayed by the sliding of dry (50 % polyester + 50 % cotton) clothes against car seat covers.

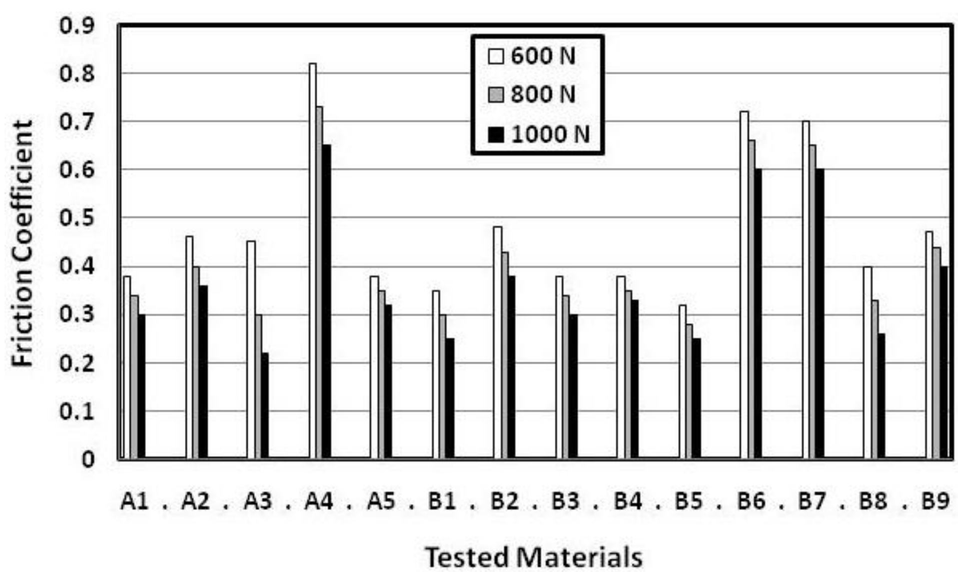

Fig. 8 Friction coefficient displayed by the sliding of water wetted (50 % polyester + 50 % cotton) clothes against car seat covers.

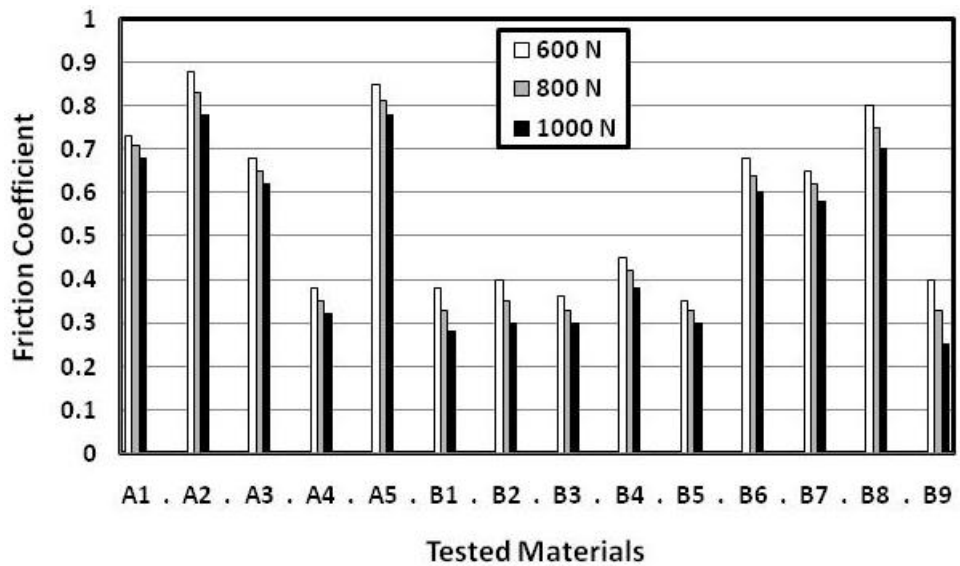

Fig. 9 Friction coefficient displayed by the sliding of dry wool clothes against car seat covers.

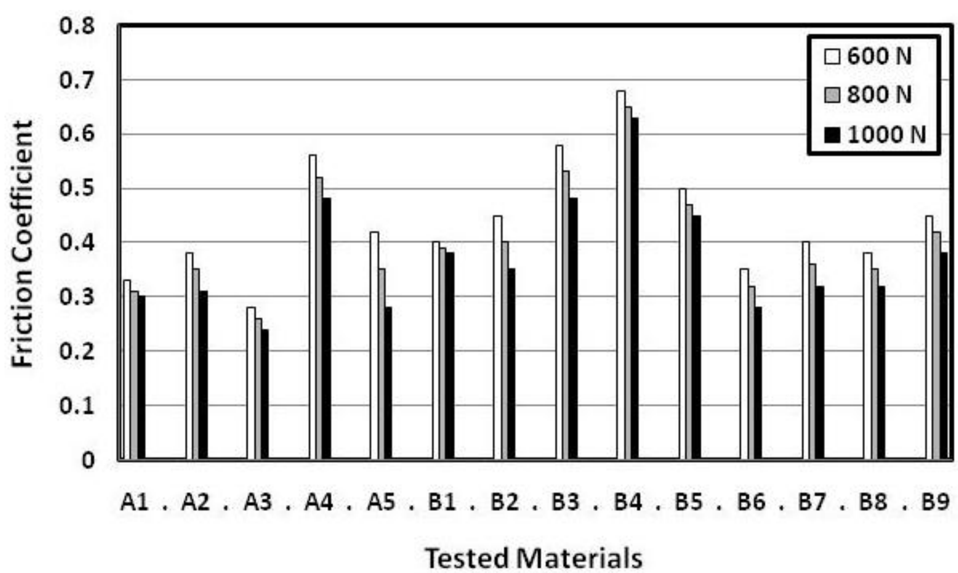

Fig. 10 Friction coefficient displayed by the sliding of water wetted wool clothes against car seat covers.

CONCLUSIONS

1. Synthetic leather displayed relatively higher friction coefficient than synthetic textile when sliding against polyester clothes. The highest friction value exceeded 0.6. Generally, friction coefficient slightly decreased with increasing load. At water wetted sliding, significant drop in friction coefficient was observed for synthetic leather specimens. Synthetic textiles showed relatively higher friction than synthetic rubber.

2. Friction coefficient displayed by the sliding of dry cotton clothes showed significant friction increase for synthetic leather. Values of friction could reach 0.6. Synthetic textiles displayed relatively lower friction. In the presence of water film covering the sliding surfaces remarkable friction increase was observed for the test specimens. Textiles test specimens showed friction values up to 0.85 displayed.

3. Friction coefficient displayed by the sliding of dry (50 % polyester + 50 % cotton) clothes displayed relatively higher values than that presented by 100 % polyester and 100 % cotton. The majority of the test specimens showed acceptable friction values. Sliding of the test specimens at water wetted surfaces caused slight friction decrease. That behaviour recommends those materials to be used as car seat covers in water wetted environment.

4. Wool clothes displayed the highest friction coefficient when sliding against synthetic leather, (0.88). Textile test specimens displayed relatively lower friction than synthetic leather, (0.58). Generally, wool clothes experienced the highest friction values among the tested clothes at dry sliding. In the presence of water film, friction coefficient slightly decreased.

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