SLIP-RESISTANCE AND ABRASION OF NEW & USED SHOE SOLES

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INTRODUCTION

The significance of slipping and falling has been well-established in the literature [1-3]. The factors affecting the slip-resistance of footwear such as footwear and floor materials, floor surface conditions, and shoe sole tread design have been discussed in the literature [4, 5]. However, most of the investigations were conducted using new footwear and floor materials. The new and used footwear may have different slip-resistance and other features. The objective of this study was to compare the coefficient of friction (COF) and abrasion of new and used outsoles for two types of footwear.

METHODS

Two type of footwear commonly worn both at workplace and daily activities were tested. One was a work shoes with hard rubber soles. The soles of rubber-soled shoes have a high Shore-A hardness value of 79.9 (±1.5). The other type of footwear was a sneaker with a shoe sole material of EVA with a shore-A hardness of 28.4 (±1.5).

Twenty adult male subjects were recruited for footwear usage test. These subjects were split into two groups. One group included office staffs in an organization. The other group comprised of college students. The age, stature, and body weight for the office clerks were 42.8 (±9.7) yrs, 168.7 (±7.7) cm, and 73.7 (±2.7) kg, respectively. The age, stature, and body weight for the college students were 22.0 (±1.1) yrs, 168.6 (±6.6) cm, and 73.7 (±17.3) kg, respectively.

The experiment involved the human subjects encompassed a longitudinal study. Each subject received one pair of shoes which fitted his feet size. The rubber-soled shoes with leather topping were distributed to the office clerks and the EVA-soled sneakers were distributed to the college students. The subjects were required to wear the experimental shoes for eight hours per day and three says per week (or equivalent to 24 hours per week) for 26 weeks. Each subject have worn the test shoes for at least 624 (26 week *3 day *8 hour) hours during the experiment. The subjects returned the shoes at the end of the test period. Ten shoe sole samples of each type of the used were prepared for the abrasion and COF measurements. Ten shoe sole samples for each type of new shoes were also prepared for the COF and abrasion measurements.

A NBS Shoe Sole Abrasion Tester was used to measure the abrasion of the sole samples. Measurement of abrasion followed those in the ASTM-D1630 standard [6]. Friction measurements of the shoe soles were conducted on both the terrazzo and vinyl floors. The R_a, also known as the center line average of surface heights (CLA), for the vinyl and the terrazzo floors were 0.66 (±0.23) μm and 1.12 (±0.33) μm, respectively. The surface conditions were either dry or wet. A Brungraber Mark II slipmeter was used for friction measurements. The standard test method published by the American Society for Testing and Materials [7] was adopted. The measurement protocol refined by Chang [8] was also used.

RESULTS AND DISCUSSION

Figure 1 show the mean (±std) COF for the new and used shoe soles under the floor, footwear, and floor surface conditions. Pair-wised student t-tests were conducted to compare the differences in COF between the new and used shoe soles for each floor-footwear-surface condition. The results of all the t-tests were statistical significant ($p<0.001$). The new shoe soles had significant higher COF then those of the used ones except for the wet vinyl and terrazzo floors tested using the rubber soles.

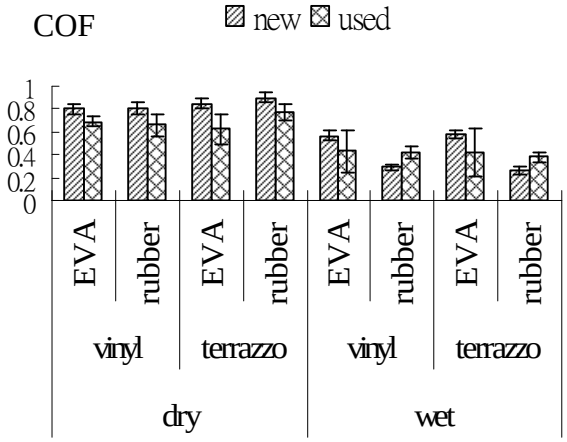

Figure 1: COF for the new and used shoe soles under floor, shoe sole, and surface conditions.

The abrasive indexes of the sole samples are shown in Figure 2. Pair-wised student t-tests were conducted to compare the difference in abrasive index between the new and used shoe sole for both of the rubber- and EVA-soled samples. The results for both tests did not reach the α=0.05 significance level. The difference between rubber and EVA samples for both the new and used samples were also tested. For both the new and used samples, the abrasive indexes for rubber were significantly (p<0.0001) higher than those of the EVA samples.

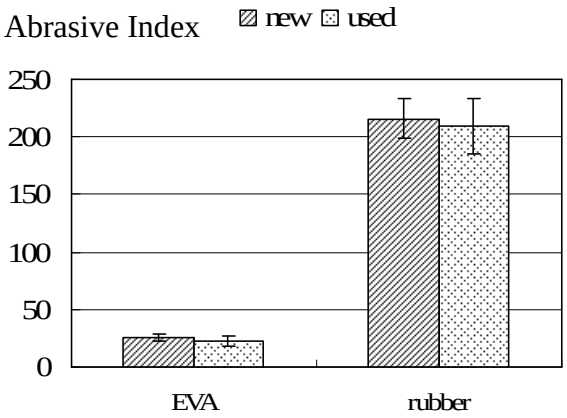

Figure 2: Abrasive index for new and used shoe soles for the types of footwear materials tested.

On dry vinyl and terrazzo floors tested, the COF values decreased after a six month usage for both of the rubber and EVA samples. The COF values also decreased for the same period for EVA samples under wet conditions on both floors. The COF of the used rubber samples increased, however, on wet vinyl and terrazzo floors as compared to their new counterparts.

CONCLUSIONS

The differences of abrasion between new and used shoe soles were not statistically significant. The used shoe soles, however, had significant lower COF values than the new ones except the rubber soles tested on wet vinyl and terrazzo floors.

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