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SELECTION OF WORKING GLOVES BASED ON FRICTION COEFFICIENT

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ABSTRACT

Handling of materials is extensively used in industrial applications such as production lines and product assembly. It is demanded to test the friction coefficient to secure the gripping process, where the grip force can be minimized by increasing friction coefficient. The aim of the present study is to rank the materials of the gloves based on their friction coefficient in order to increase the safety of material handling. Friction measurement was carried out. Five different glove materials of were tested by sliding against steel, glass and wood sheets at dry, water and detergent wet conditions.

The experiments revealed that polyamide, polyester and polyethylene glycol gloves are suitable to handle steel sheets, while polyethylene glycol and aniline formal resin coated gloves are convenient for handling glass. Handling wood surfaces can achieved safely by polyethylene glycol and polyamide gloves. The relatively high variation in the friction values in different sliding conditions confirms the proper selection of the glove materials.

KEYWORDS

Manipulators, material handling, friction coefficient.

INTRODUCTION

Tactile behaviour is one of the critical properties that control the safety of materials handling. The tested materials based on their friction coefficient in order to increase the safety of glass handling were screened, [1]. Friction measurements were carried out to eight different materials by sliding against glass sheet at dry, water wet and oily conditions. Sensors that can reveal tactile were developed in order to equip robot hands with such a sense, [2, 3]. Development of the materials used in robots is a critical factor for increased safety and efficiency. Gripping forces may be reduced using high-friction surfaces, [4]. Thus, we selected foamy polymers as a suitable type of friction-enhancing material for grippers of the climbing robot. Friction coefficient of the contacting surfaces can control the safety of material handling through increasing the gripping force. The friction coefficient of the tactile sensor was tested, [5].Variety of materials such as foamy polymers and sandwich-like microstructures were tested as shoe soles for potential robot, [6 , 7]. The friction coefficient displayed by hands sliding against the

surface of the steering wheel covers was discussed, [8]. Measurement of friction coefficient is of critical importance in assessing the proper friction properties of steering wheel covers and their suitability to be used in application to enhance the safety and stability of the steering process during car driving. Experiments showed that friction coefficient displayed by the dry sliding of hand against the tested steering wheel covers decreased with increasing normal load. Besides, friction coefficient showed significant increase for covers compared to wheel without cover. In addition to that, friction coefficient drastically decreased due to the presence of the grease film covering the sliding surfaces.

It is well established that there is an increasing rate 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, stability and control of the steering wheel. An acceptable value of friction should be obtained to prevent slip between the hands of the driver and the surface of the steering wheel. It is necessary to measure the friction coefficient of the driver's hands sliding against dry, water wetted and greasy steering wheel covers. The knowledge of steering-wheel grip force characteristics of the drivers may benefit the automobile designers and manufacturers to improve the quality of their products in terms of comfort and driving performance. The steering-wheel grip force of male and female drivers driving an automobile was studied, [9, 10]. Results indicated that the vehicle speed and the road condition did not significantly affect these response variables.

In a recent study, friction coefficient, displayed by clothes sliding against car seat covers, was discussed, [11]. 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. It was found 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. 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.

The aim of the present study is to determine the friction coefficient of the materials of the working gloves in order to increase the safety of material handling. Five different types of gloves were tested by sliding against steel, glass and wood sheets at dry, water wet and oily conditions.

EXPERIMENTAL

The friction coefficient was evaluated using a test rig, Fig. 1, through measure the friction coefficient through measuring the friction force and applied normal force. The tested counterface such as steel, glass and wood sheets were assembled to the base of the test rig. Loads were applied by hand wearing glove acting on the sheet in the normal direction. Friction force generated from moving the finger on the tested sheet in the horizontal direction. The different types of glove materials are illustrated in Table 1.

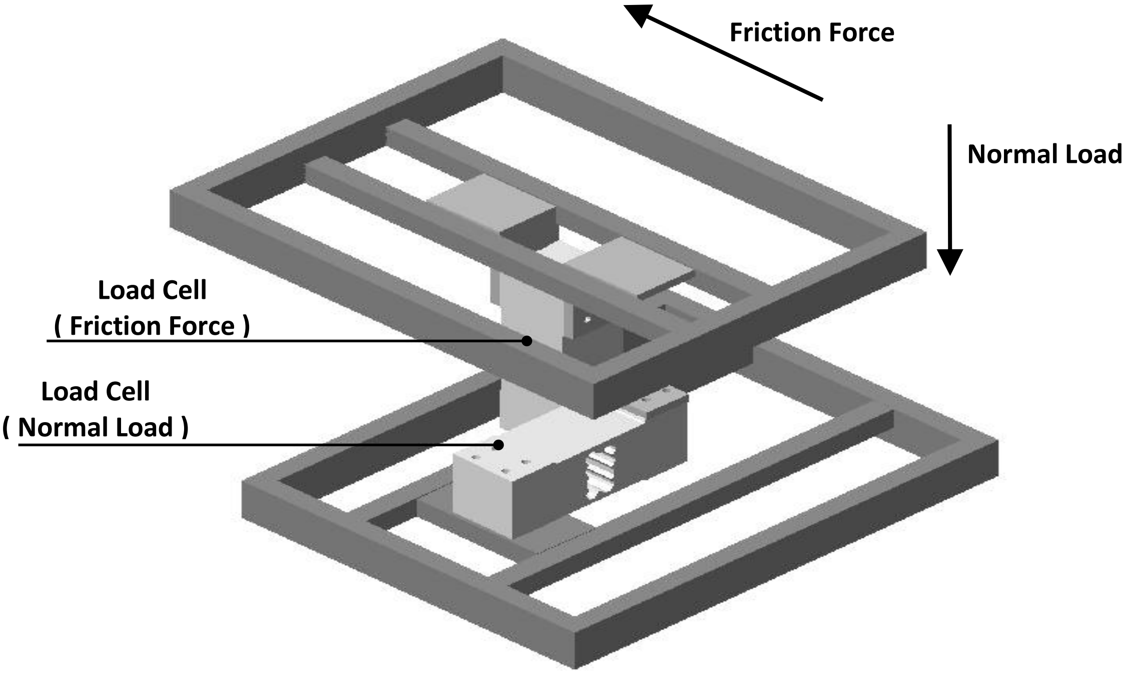

Fig. 1 Arrangement of the test rig.

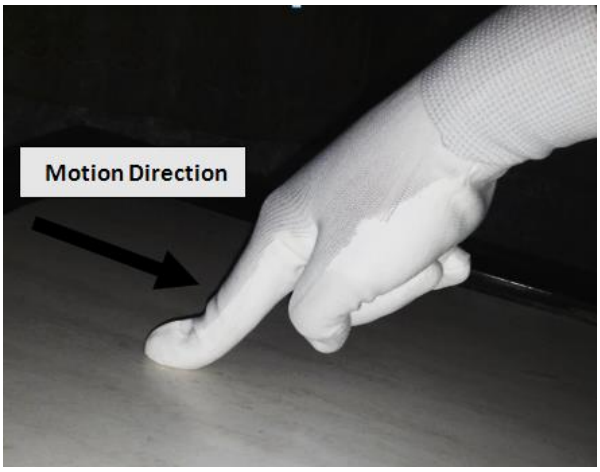

Fig. 2 Arrangement of the measurement of friction force.

Table 1 The tested glove materials.

No.	Materials of Gloves
1	Polyester.
2	Polyethylene glycol.
3	Polyamide.
4	Aniline formal resin.
5	Cotton.

RESULTS AND DISCUSSION

Handling of materials depends on the friction grip, where two plates grip the object by mean of friction. The grip force (F) can be minimized by providing the gripper by soft surface to provide higher gripping contacts to increase friction surface. Besides, increasing the value of the friction coefficient (μ) can decrease the gripping force, Fig. 3, where W is weight of the object.

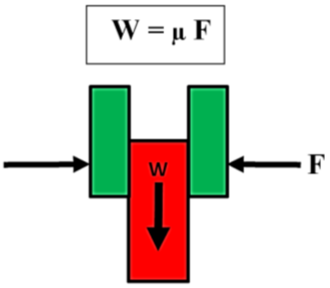

Fig. 3 Illustration of the mechanism of gripping process.

Friction coefficient between polyester glove and steel is illustrated in Fig. 3. Dry sliding showed significant friction increase compared to water and detergent wet sliding, where values of friction coefficient reached 0.83 at 1.4 N load. Friction coefficient showed drastic decrease with increasing normal load. Detergent wet sliding showed the lowest friction values. Sliding of polyester glove and glass against glass showed lower friction values than that observed for steel, Fig. 4. It seems that the relatively smoother surface of glass is responsible for the decrease. The lowest friction values were displayed in the presence of detergent on the glass surface, where the values reached to 0.22. Based on that observation, polyester should be avoided to reduce slip of the object.

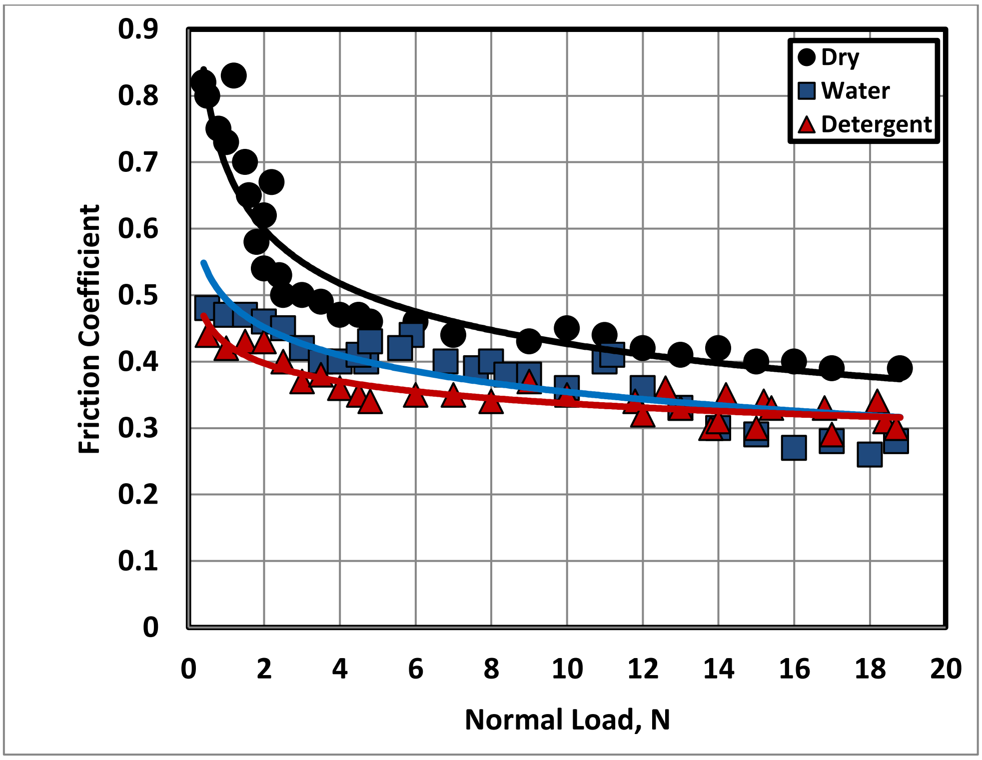

Fig. 3 Friction coefficient between polyester glove and steel.

Water wet sliding showed the highest friction when polyester glove slid against wood, Fig. 5. Dry and detergent wet sliding showed lower friction than water wet sliding. It seems that the squeeze action may be the factor that increased friction coefficient. This result suggests the use of polyester in the application of water wet gripping.

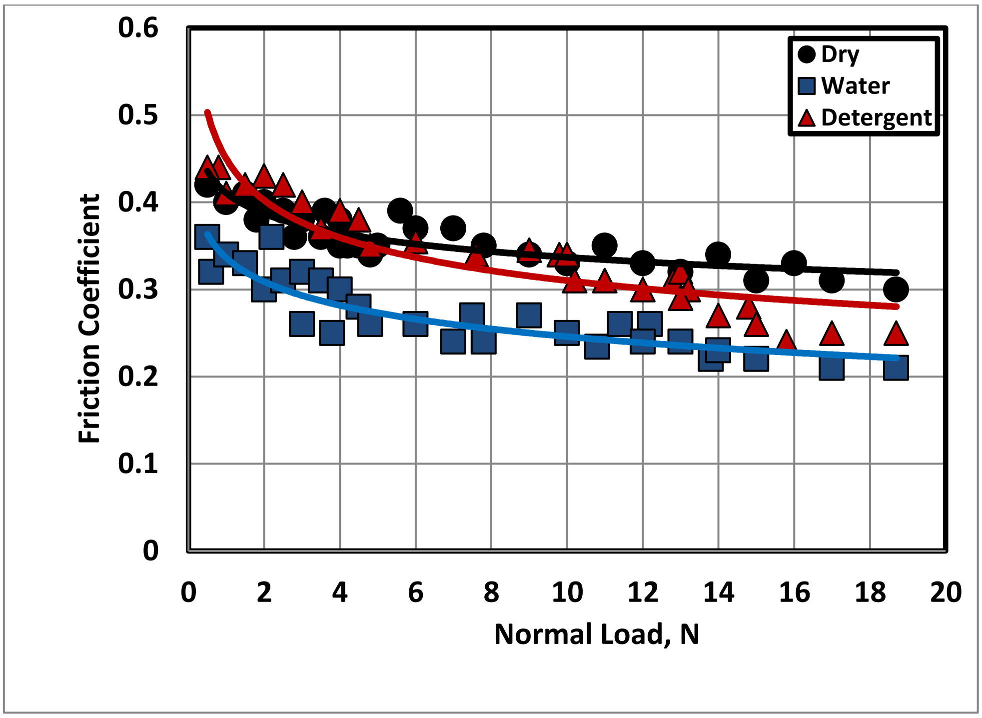

Fig. 4 Friction coefficient between polyester glove and glass.

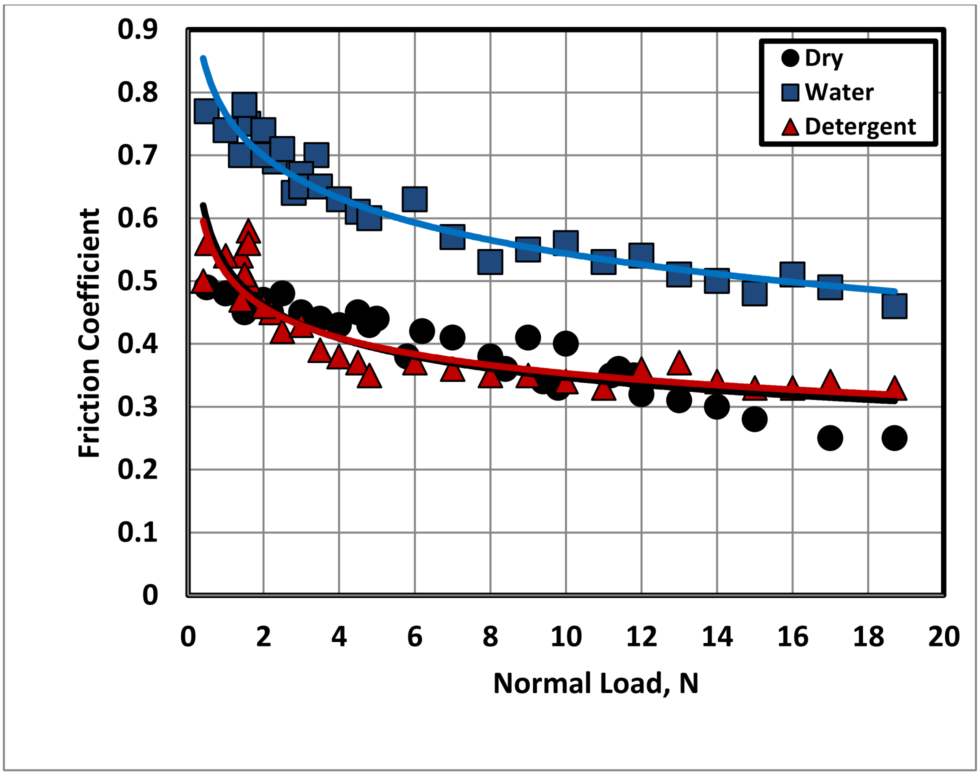

Fig. 5 Friction coefficient between polyester glove and wood.

Polyethylene glycol glove displayed significant increase in friction coefficient as the load increases at dry and water wet sliding, Fig. 6. The highest friction coefficient reached 0.9289 at 0.3 N. At detergent wet sliding, slight decrease was observed for the friction coefficient with load increase, where the values were relatively low down to 0.25. Those values decreased the gripping force, therefore it is recommended to avoid such types of gloves at detergent wet applications when handling steel. Friction coefficient between polyethylene glycol and glass recorded very high values at dry sliding, Fig. 7, while water and detergent wet sliding showed lower values. Based on that observation, it is proposed to use that material in the surface of gloves in that application. The trend of the high values of friction was observed for the sliding of polyethylene glycol against wood, Fig. 8. Values of friction coefficient were ranging between 1.39 and 0.62 for dry sliding. Water sliding relatively lower values, where the values ranged between 1.0 and 0.6. Those values showed the suitability of the tested glove material for dry and water wet sliding. Detergent wet sliding showed very low friction values.

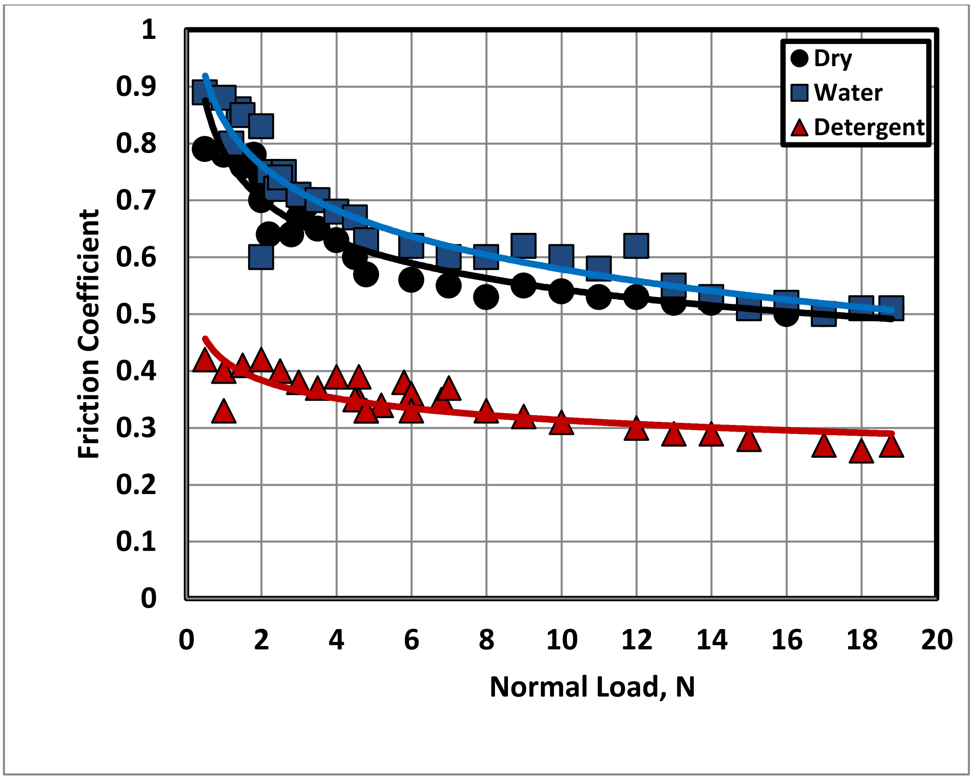

Fig. 6 Friction coefficient between polyethylene glycol and steel.

Polyamide glove slid against steel, Fig. 9, displayed relatively higher friction coefficient at dry, water and detergent wet sliding. The values of friction coefficient at the three siding conditions were convergent indicating that polyamide can be used in different sliding applications. When sliding against glass, polyamide showed relatively lower friction values than that observed for sliding against steel, Fig. 10. Dry sliding displayed the highest friction, while water and detergent wet showed drastic decrease in friction. Water wet sliding of polyamide against wood showed considerable friction increase, Fig. 11. It is interesting that dry sliding showed the lowest friction values compared to wet sliding. Careful attention should be considered to the squeeze mechanism and generation of electrostatic charge on the sliding surfaces.

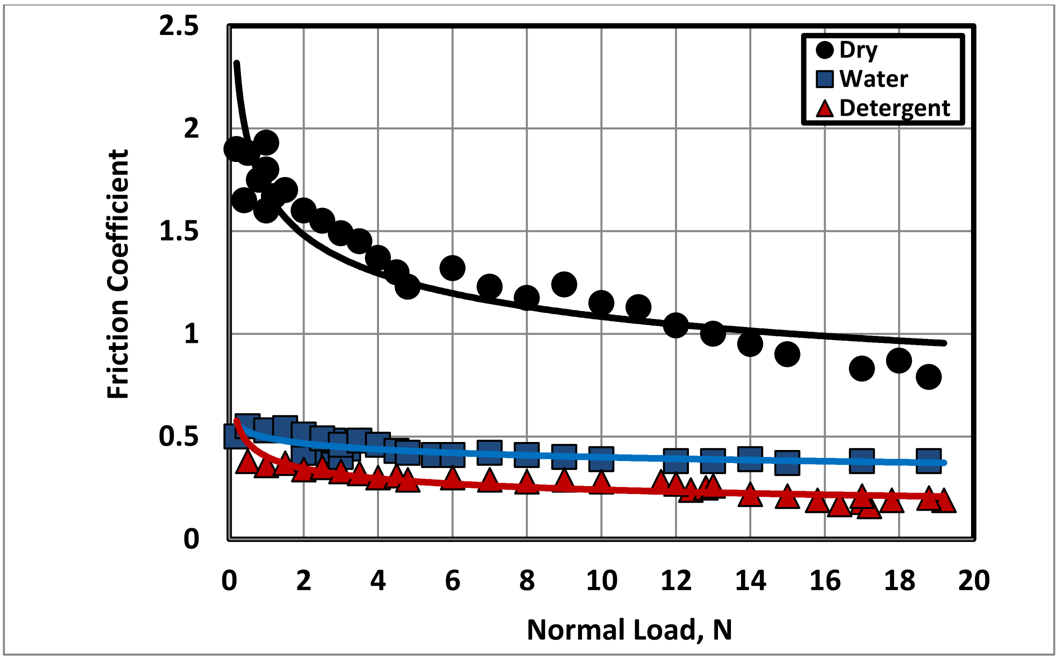

Fig. 7 Friction coefficient between polyethylene glycol and glass.

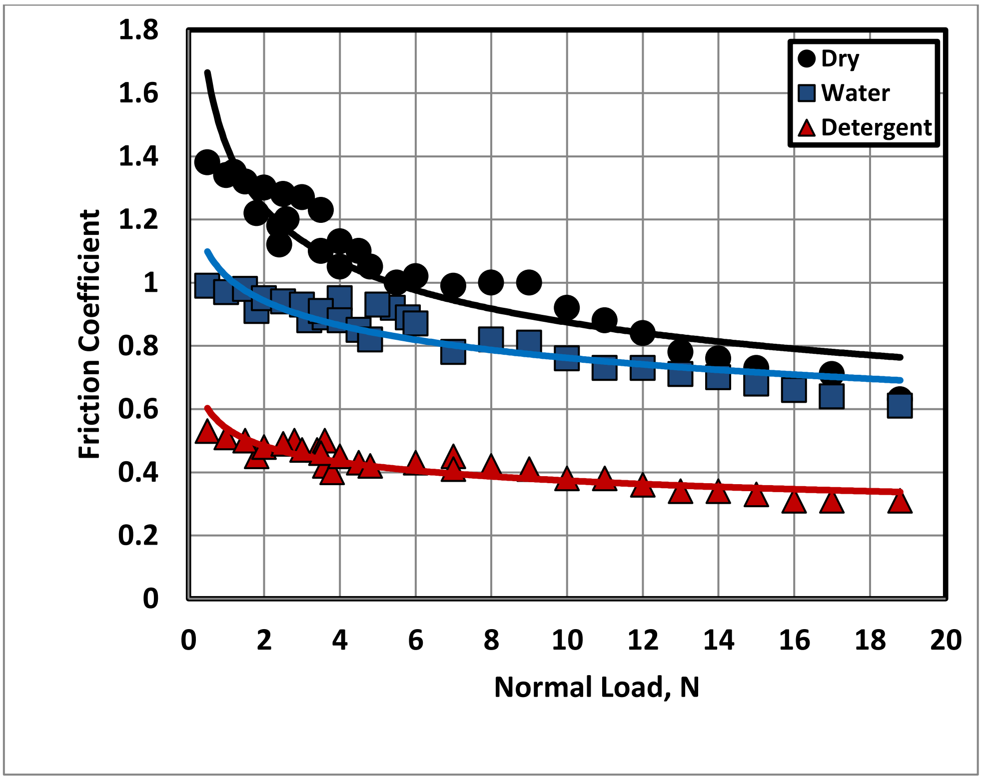

Fig. 8 Friction coefficient between polyethylene glycol and wood.

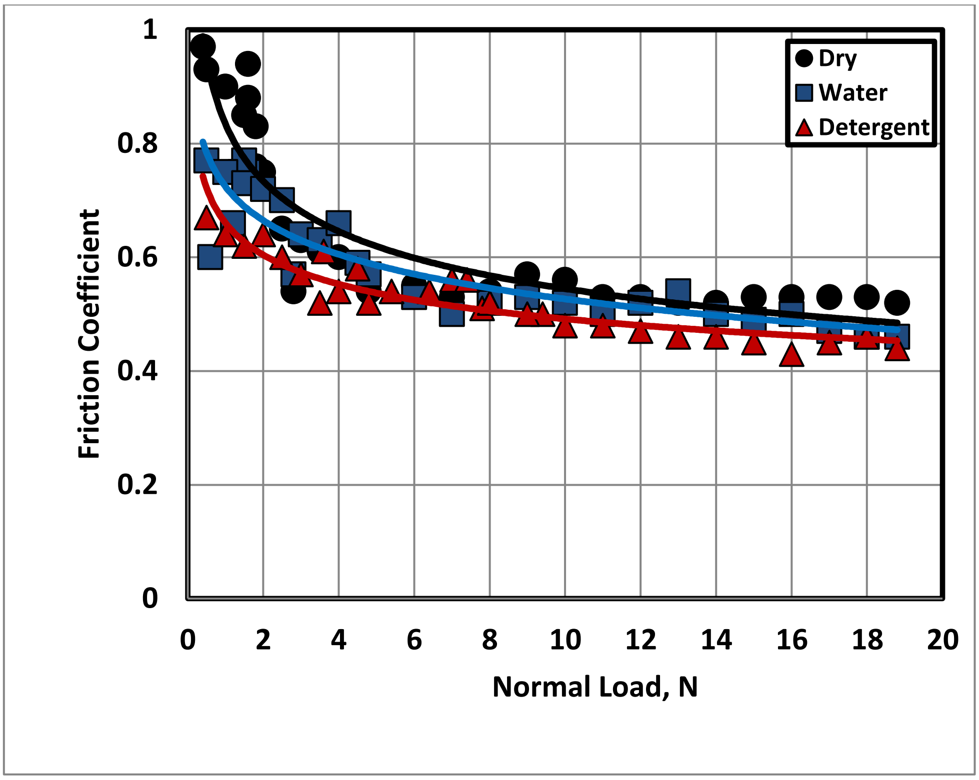

Fig. 9 Friction coefficient between polyamide and steel.

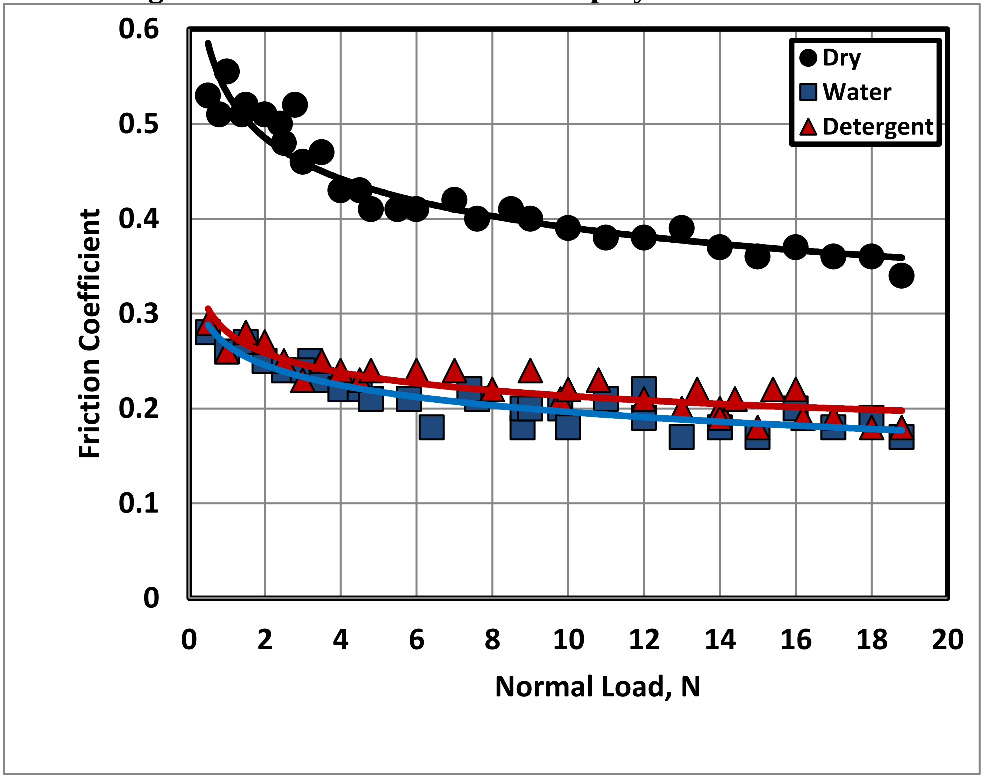

Fig. 10 Friction coefficient between polyamide and glass.

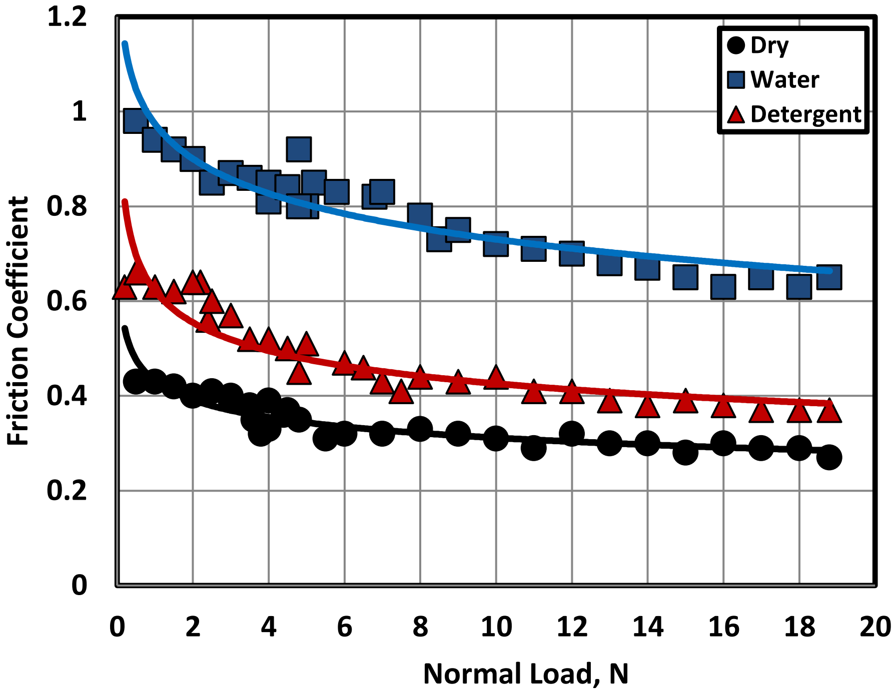

Fig. 11 Friction coefficient between polyamide and wood.

Friction coefficient displayed by aniline formal resin glove sliding against steel sheet showed drastic friction decrease with load increase, Fig. 12. In the presence of water film on the sliding surfaces, slight friction decrease was observed. The friction decrease might be attributed to the formation of the water film on the contact area. Detergent sliding caused slight friction increase. It seems that the ability of glove material to generate electrostatic charge on the sliding surface influenced the value of friction coefficient. Friction coefficient between aniline formal resin and glass showed relatively higher friction values at dry sliding, Fig. 13, while wet sliding displayed very friction values. At dry application aniline formal resin can be recommended as coating material for the working gloves to handle glass sheets. Water wet sliding against wood, Fig. 14, showed higher friction than that observed for dry and detergent wet sliding. It seems that the tested surface scavenged the water and fed it out of contact area.

Cotton slid against steel sheet displayed higher values of friction coefficient at water wet sliding than that observed at dry and detergent wet sliding, Fig. 15. The friction increase might be attributed to the presence of water film that homogeneously distributed the electrostatic charge all over the surface and consequently the generated electric force increased the normal load and the adhesion between the two sliding surfaces. Drastic decrease in friction was observed at detergent wet sliding, where the values were ranged between 0.43 and 0.3. Cotton slid against glass sheet showed lower values of friction coefficient, Fig. 16. Dry sliding displayed the lowest friction values, while detergent wet sliding showed the highest ones which were ranging from 0.38 to 0.22.

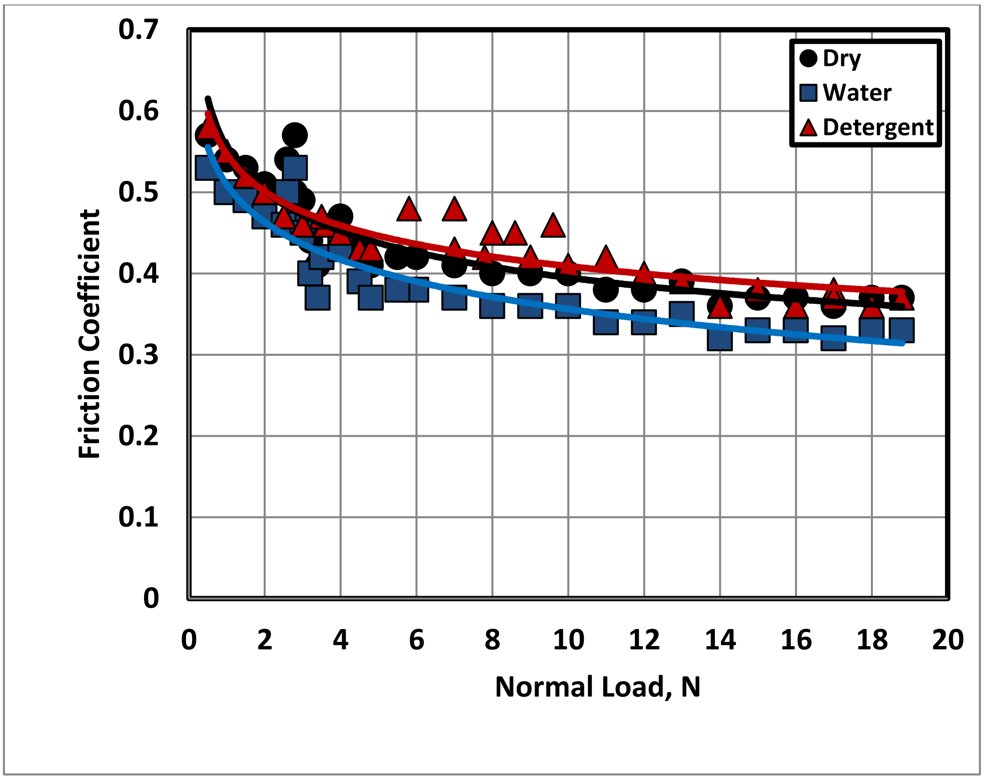

Fig. 12 Friction coefficient between aniline formal resin and steel.

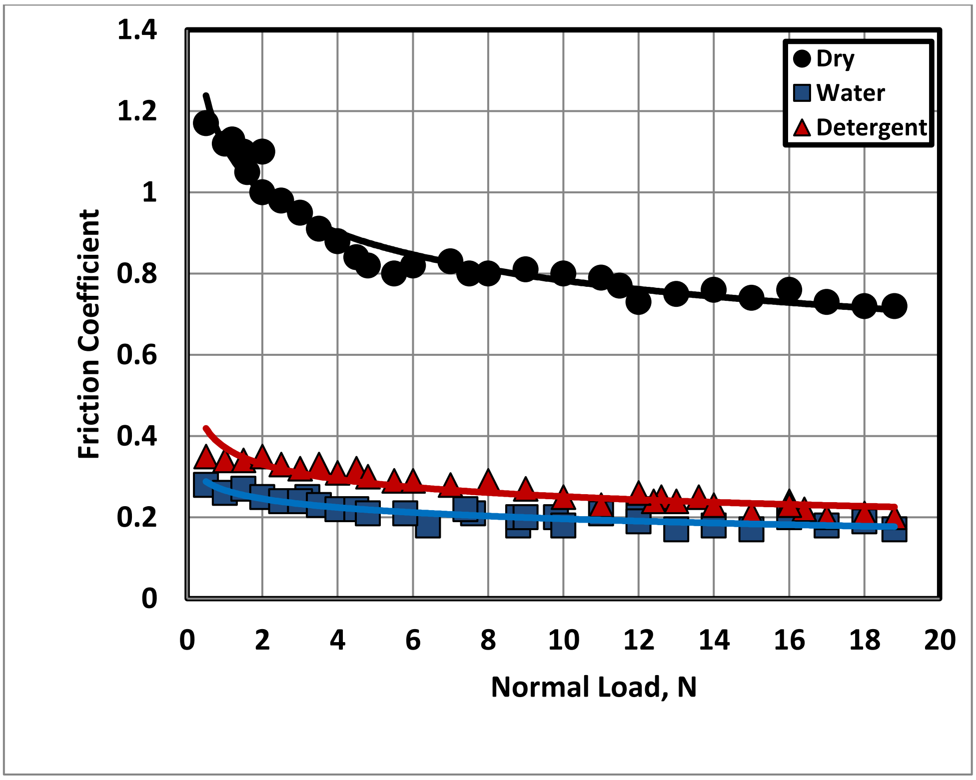

Fig. 13 Friction coefficient between aniline formal resin and glass.

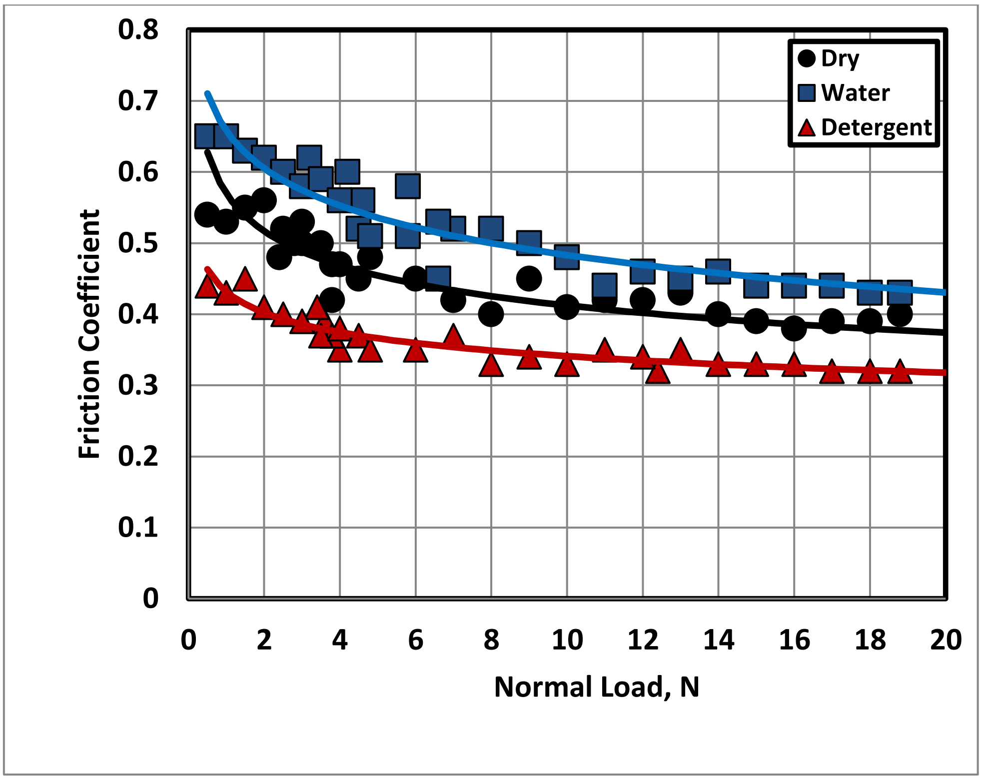

Fig. 14 Friction coefficient between aniline formal resin and wood.

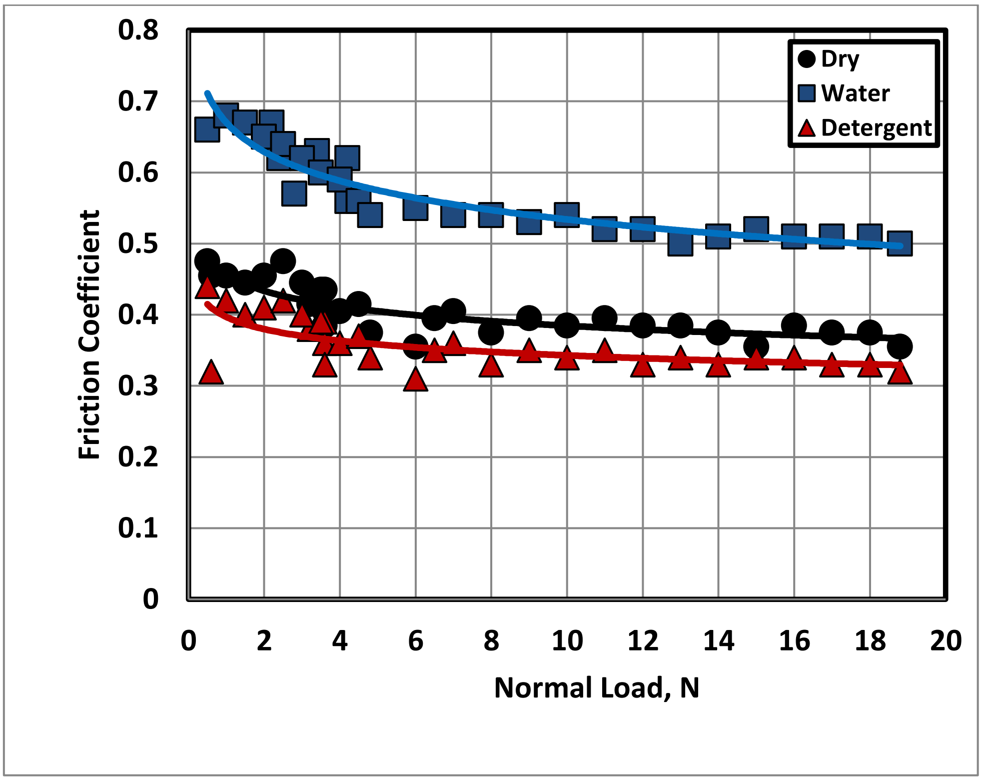

Fig. 15 Friction coefficient between cotton and steel.

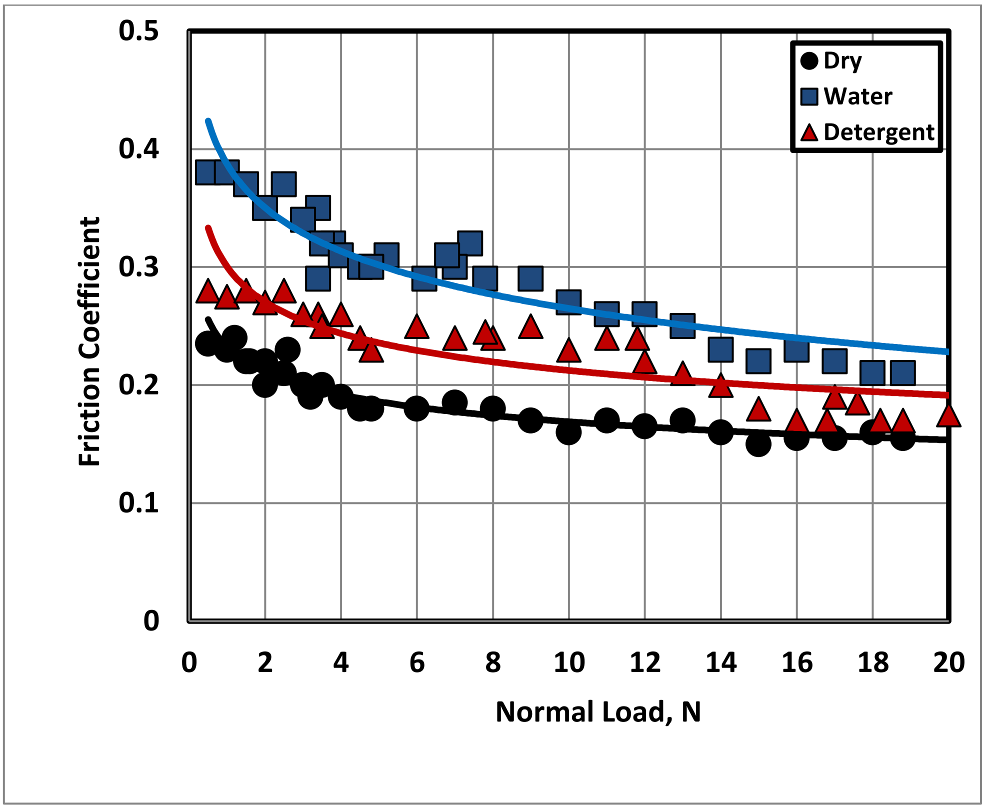

Fig. 16 Friction coefficient between cotton and glass.

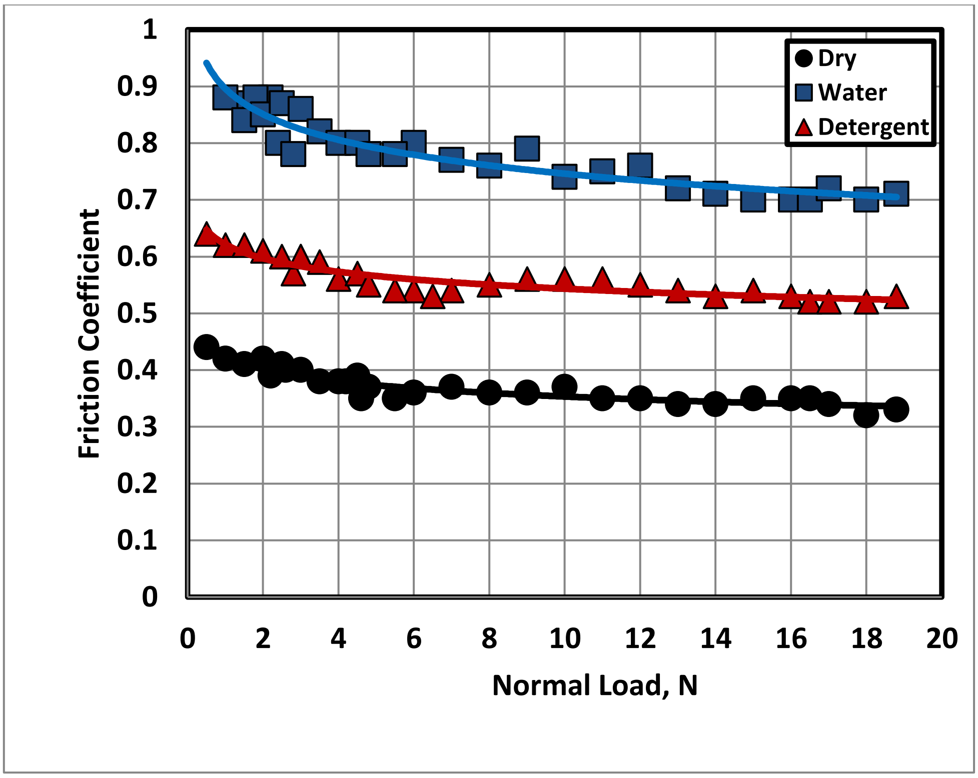

Fig. 17 Friction coefficient between.

The relatively high friction difference among the tested sliding conditions highlights the importance of proper choice of the applications. Friction coefficient displayed by cotton sliding against wood sheet is shown in Fig. 17. Water wetted glove displayed the higher friction coefficient than that shown for dry and detergent wet sliding. It seems that the ability of the cotton fibres to absorb water was responsible for that behaviour. The relatively high friction difference between the tested sliding conditions confirms the necessity of careful and proper choice of the applications.

CONCLUSIONS

1. Friction coefficient between polyester glove against steel at dry sliding showed significant increase compared to water and detergent wet sliding. Friction coefficient showed drastic decrease with increasing normal load. Sliding of polyester glove against glass against glass showed lower friction values than that observed for steel. Water wet sliding showed the highest friction when polyester glove slid against wood. Dry and detergent wet sliding showed lower friction than water wet sliding.

2. Polyethylene glycol glove displayed significant increase in friction coefficient as the load increases at dry and water wet sliding. At detergent wet sliding, slight decrease was observed for the friction coefficient with load increase. It is recommended to avoid such types of gloves at detergent wet applications when handling steel, while it is proposed to use that material in the surface of gloves in handling glass and wood.

3. Polyamide glove slid against steel displayed relatively higher friction coefficient at dry, water and detergent wet sliding.

4. Friction coefficient displayed by aniline formal resin glove slid against steel sheet showed drastic friction decrease with load increase. At dry application aniline formal resin can be recommended as coating material for the working gloves to handle glass sheets.

5. Cotton slid against steel sheet displayed higher values of friction coefficient at water wet sliding than that observed at dry and detergent wet sliding. Cotton slid against glass sheet showed lower values of friction coefficient. The relatively high friction difference among the tested sliding conditions (dry, water and detergent wet) highlights the importance of proper choice of the glove material.

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