Friction tests on clayey soils for fast and bouncy cricket pitches in Sri Lanka

Les essais de friction sur les sols argileux pour fast et de la souplesse de cricket au Sri Lanka

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ABSTRACT: "Fast" and "slow" are the main types of cricket pitches in the game of cricket. Fast pitches are usually bouncy while the slow pitches are usually low in bounce when considering the ball behaviour. Friction in between the top surface of a cricket pitch and the cricket ball is a critical factor which decides the pitch a fast or slow. This research was conducted to determine the coefficient of friction (μ value) in between the soil surface and the cricket ball. Higher frictional coefficient implies the higher resisting force acting on the cricket ball by the pitch. Therefore, the cricket pitch may behave slower due to the friction caused by the rough pitch material. Compacted model pitches were prepared from three locally available clay samples. "Grumusol" soil sample from Murunkan (MU) and a sample from Kotawehera (KO) along with the conventional clay used in Sri Lanka Cricket (SLC) pitch preparation at Tyronne Fernando Stadium (TY) were used in the friction model tests varying the top grass conditions. Model test results showed low μ values for KO and MU when compared with that of TY. Therefore, it could be proposed to conduct further studies in field scale models with MU and KO soils to develop Fast and Bouncy cricket pitches in Sri Lanka.

1 INTRODUCTION

Cricket is an interesting sport in which the inherited unpredictable nature of the game itself catches the hearts of the spectators. Though it seems like a battle between bat and the ball, cricket pitch plays a hidden role which decides the day's winner.

Playing characteristics of different pitches varies with each other due to several reasons. Previous studies on the same have found out that the soil grading, clay content, sand content, organic matter content, moisture content, clay mineralogy and the grass content of the top 125mm layer of a cricket pitch are the major governing factors of the playing character of different pitches (Nawagamuwa, et al., 2009).

Higher sand contents and lower clay contents are also factors which increase the surface roughness and consequently the friction and velocity ratio during an impact with the turf. During an oblique impact with pitch, rebounce of a cricket ball is affected by three major factors; vertical restitution (energy loss) between the ball and the pitch, the surface friction between the ball and the pitch, and the level of pitch deformation during ball impact. Also it was argued that the coefficient of Friction, μ has a strong negative correlation with velocity ratio. The μ value has a strong positive correlation with top spin gained. A high level of friction would cause the ball to grip more during impact and allow it to gain top spin (Carré et al., 1999).

In the previous approaches (Perera and Nawagamuwa 2015), introduces "Grumusol" soil from Murunkan (MU) as a Fast pitch clayey soil. Later seven different type of soils from various locations were tested (Perera et al., 2016) and three locally available clays from those (Murunkan, Kotawehera (KO), Batticaloa A) showed promising signs for making of fast and bouncy pitches having higher plasticity index (PI) lower organic matter content, lower sand content and higher dry density (γ_d) etc. which are the soil properties of fast pitches in Australia (Nawagamuwa, et al., 2009). However, Batticaloa A sample is found to be a less reliable source since the deposit is restricted to a small area. Therefore, for the further study of pace and bouncy pitches, MU and KO were selected along with the conventional pitch making soil used in the Tyronne Fernando (TY) stadium in Sri Lanka. After the initial tests on soil properties, those three soils were tested for interface friction between clay surface and ball surface via friction tests.

In previous studies, a friction test was carried out using a sledge consisting of two triangular plates and a loading system connected with it to quantify the friction force on each soil surface (James et al., 2005). A similar method with few alterations was adopted in this experiment to quantify the surface friction of each three soils since surface friction is an important parameter to distinguish velocity ratio of a cricket pitch.

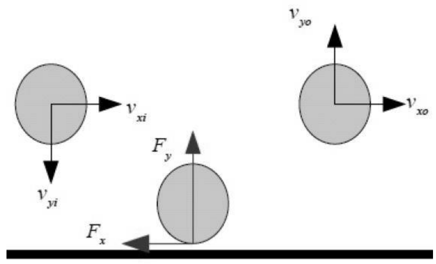

Figure 1 Impact between ball and pitch (Nawagamuwa, et al, 2009)

2 FRICTION TEST

2.1 *Preparation of the laboratory model*

In order to conduct model tests, soil samples were prepared in a 150mm×150mm×150mm standard cement concrete cubic moulds. Two local soils (MU and KO) having ideal clay properties of a fast and bouncy cricket pitch material selected from the soil tests along with the conventional clay used in SL cricket pitch preparation (TY) were selected to continue with the model tests. Moreover the three selected samples were tested varying the grass conditions as with/without grass on the top surface. Following steps were followed to prepare the laboratory model.

Selected standard cubic moulds were cleaned and filled with loosened ant clay of 50mm. Then the soil was compacted up to 30mm to be compatible with the international standards (Shannon, 2010).

Locally available running grass was selected as the surface grass since it could survive and perform well in tropical climate conditions in SL pitches. In order to plant grass 25.4mm × 25.4mm grid was drawn at the compacted surface of the ant clay layer and small holes were made by a screw driver to penetrate the grass roots inside the ant clay and then the grass was planted as four plants per one node.

Optimum moisture content of the samples (MU =19%, TY =31.5%, KO=17%) obtained from the Proctor compaction tests was maintained before the initial compaction and the load application.

Then clay was added and compacted in three separate layers maintaining one layer thickness as 40mm. 10kN force (444.4 kPa) was applied on each model by CBR testing machine for 2 minutes until it gets well compacted and no water was added for five days during the tests to observe the behavior of the real game.

2.2 *Introduction of the Friction Test*

μ Value for the interface between clay and standard cricket ball was determined varying the clay type, grassy and ball conditions. Loads were applied at two places (R_f & F_R). Coefficient of friction (μ) was determined by the gradient of the graph (Rf. & FR as X and Y axes respectively). A schematic diagram of the setup is shown in figure 2.

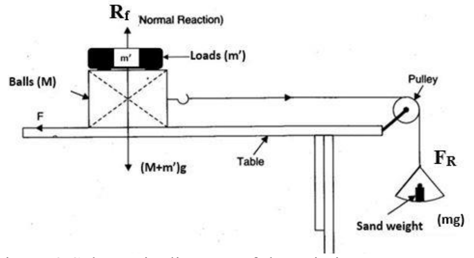

Figure 2 Schematic diagram of the Friction test

2.3 *Methodology*

Three standard cricket balls having same surface conditions were combined by a binding wire (Sledge of three combined balls) and placed on the sample as shown in Figure 2. Three different ball conditions were used in each sledge as new, 30 overs and 60 overs used balls. The horizontal dial gauge was placed where the gauge head of the spindle was touching the back end of the unit of a combination of balls. Sand bucket (Load represented by F_R) was attached by a thread and the combination of balls unit.

Ball unit was loaded from top by 5kg increments (F_R). Sand bucket was filled with sand until the ultimate limit state was achieved for each reaction force (R_f) caused by the top loading. Horizontal displacement measuring dial gauge (D1) was monitored during sand loading and the initial sliding movement of the combination of ball was taken by the change of the D1 reading.

Results were plotted between F_R and R_f and the coefficient of friction (μ) was calculated by the gradient of the graph shown in Figure 3.

$$\mu = F/R \quad (1)$$

3. RESULTS AND DISCUSSION

According to Fig. 3, MU and KO show lower μ values than TY which shows the reason for the current SL pitches being slow.

According to Fig. 4, KO and MU are exhibiting lower μ value w.r.t. TY after first 2 days. Initial moisture of TY was higher than KO and MU. Therefore, the initial μ value was lower for TY. However TY surface got dried faster than the rest. But the moisture evaporation of KO, MU was low when compared to TY. Pressure was applied on soil surface on each day before commencing the tests. As a result of the pressure application m.c. trapped inside the samples moved out making the surface wet hence reducing the μ values.

Table 1 is a comparison of percentage change of μ values w.r.t. TY for MU & KO (without grass) using different ball units. Results shows after the 2nd day, both KO and MU shows less frictional resistance on the ball when compared to with TY. Having less frictional resistance would generate extra pace in pitches made of KO & MU than TY.

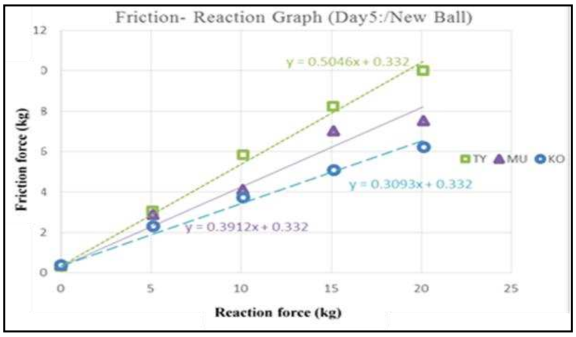

Figure 3 typical Friction force - Reaction force graph

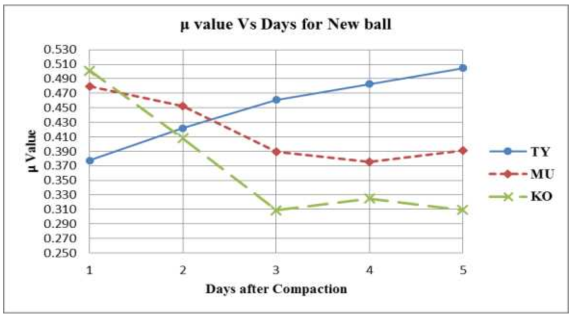

Figure 4 Typical value vs day graph for new ball and samples without grass

Day	New		30 overs		60 overs	
	MU	KO	MU	KO	MU	KO
1	27	33	10	10	3	3
2	7	-3	1	-3	-2	-1
3	-16	-33	-1	-20	-7	-19
4	-22	-33	-9	-26	-4	-26
5	-22	-39	-19	-37	-17	-34

Table 1 Percentage change of μ w.r.t. TY for samples without grass

4 CONCLUSION

Results given by the friction tests revealed that low friction force was generated by MU & KO clay surfaces on the cricket ball than TY. Low friction forces may reduce the energy dissipation of a cricket ball and make the pitch fast.

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