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Improvement of Geotechnical Properties of Cricket Pitches

Hashir Usman*, Hamza MM, Hamid PM and Tanveer Ahmad

Civil Engineering Department, University of Engineering and Technology, Lahore, Pakistan

Abstract

This study involves research on the behavior of cricket pitches in Pakistan. Cricket pitches that are constructed in Pakistan are slow and dead relative to fast pitches of other countries. Pakistan's batsmen who are accustomed to play on slow pitches of Pakistan sometimes feel it challenging while playing on fast pitches of other countries. Therefore, the main purpose of this study is to develop fast and bouncy pitches in Pakistan so that our batsmen may not face any hindrance out there on any fast pitch. For this purpose, Nandipur soil also known as The Black soil is used because this soil is rich in clay content and clay is the main factor that yields hardness to the pitch and consequently fast speed and bounce are acquired 2 Sample pitches of 5 X 5 ft. are prepared having varied amount of silt and clay content and maintained according to prescribed standards of Pakistan Cricket Board(PCB). A number of parameters including the hardness, ball rebound, pace and the spin of each pitch are determined over a period of time to account for the effect of aging. Then computer aided analysis is carried out to represent the outcome of the research study. The tests reveal that silt content has inverse relation with the pitch's hardness and adding more clay leads to hard, fast and bouncy pitch. All the research study is indicative of the fact that fast and bouncy pitches can be developed here in Pakistan using proper clay content and appropriate technique of building and maintaining Cricket pitch.

Keywords: Clay; Cricket; Geotechnical; Pakistan; Pitches; Spin; Test match

Introduction

Cricket as a game of gentlemen

Cricket which is also known as "Game of Gentlemen" was invented by England 500 years ago. By the 17th century cricket had evolved enough to be recognizable as a separate distinct game. When Englishmen came in sub-continent, locals also became aware of this game and the people liked this game. This game has passed through to many evolutions and the cricket we see today is much different than it was in 90's. There was no concept of one day cricket or T20 matches, the only match format that was known to people was Test Cricket. There was no concept of colored uniforms only white uniform was used by all teams [1-3]. The first test match was played between England and Australia (Figure 1).

Cricket ball

A cricket ball is a hard solid ball having a cork inside that is covered by pure leather and production of these balls are regulated by cricket standards. The cricket ball weighs between 159.9 to 163.0 grams. In today cricket balls are developed scientifically and mechanically considering better aerodynamics and many other factors. In the past cricket ball were handmade and heavier than today's balls (Figure 2) In past red balls were used for both Test and One day Cricket matches but with the development of cricket modification of cricket rules also took place. Now-a-days red ball is used for Test matches and white ball is used in ODI match or T20 match [4-6].

Cricket pitch

The importance of cricket pitches cannot be denied because mostly it is the cricket pitches that decides the fate of any team by affecting its results. Cricket pitch sometimes favors the bowling side and at other times it abets the batting eleven. There are strict cricket rules for the shape and dimensions of pitch and these rules have to be followed while making cricket pitches. But there is no restriction of rules on the shape and dimensions of cricket ground which shows that pitch is the key factor in this game. Pitch is located at the center of cricket ground between wickets and the length of pitch is 22 yards or 20.12 meters or 2012 centimeters. Its width is 10 feet (3.05 meters or 305 cm). Sometimes it is covered with short grass which is removed at the end of match due to wear. Unlike other sports the pitch is not artificial, it is created on the natural ground with natural soil, so the playing conditions are not even even in all cases. Some pitches are hard and boucy, some are dry and cracked, some are dusty and dead. All these characterstics depend on how the pitch is constructed and where it is constructed, what are the weather conditions etc [7-11].

Protected area: There is Protected Area in a cricket pitch which needs to be protected. It is the central rectangular portion of the pitch 2 ft wide and starting 5ft from each popping crease. According to cricket rules a bowler must avoid running on this area during his follow-through after delivering the ball. This area is protected to keep fairness in game because if a bowler runs on this area, his shoes

Figure 1: First test match.

***Corresponding author:** Hashir Usman, Civil Engineering Department, University of Engineering & Technology, Lahore, Pakistan, Tel: +92 42 99029227; E-mail: ranahashir99@gmail.com

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Figure 2: Old cricket balls at The MCC Museum of Lords cricket ground.

may produce some undesireable patches which would result in some unexpected swing and bounce [12,13]. This rule is only applicable while uniterrupted followthrough but this rule does not stop bowler or any fielder to run on pitch while fielding the ball.

Grassy pitch: If a pitch contains longer and moist grass more than usual it is termed as Grassy pitch or Green pitch. This pitch favors the fast bowlers over batsmen because the ball can be made to behave eratically on longer and wet grass.

Sticky pitch: A pitch that has become wet and subsequently drying out, often rapidly in hot sun is called as Sticky pitch. It causes the ball to behave eratically particularly the slow or spin bowler . As a match progresses, the pitch dries out. The Laws of Cricket bar watering the pitch during a match. As it dries out, initially batting becomes easier as any moisture disappears. Over the course of a four or five day match, however, the pitch begins to crack, then crumble and become dusty. This kind of pitch is colloquially known as a 'dust bowl' or 'minefield'. This again favors bowlers, particularly spin bowlers who can obtain large amounts of traction on the surface and make the ball spin a long way. This change in the relative difficulties of batting and bowling as the state of the pitch changes during a match is one of the primary strategic considerations that the captain of the team that wins the coin toss will take into account when deciding which team will bat first and can accordingly finalize his decisions (Figures 3-6).

Dead pitch: A pitch that neither produces any bounce nor fast speed can be termed as dead pitch. It is very difficult to make runs on a dead pitch. This pitch is neither in the support of bowers nor in the favor of batsmen. This pitch is not desirable in any condition. It can also be termed as slow pitch.

Pitches in Pakistan

In Indian sub-continent pitches are usually slow and have ability to produce spin but not resulting in seam or swing. Pitches in Pakistan are dry and windy but these pitch also provide support to Fast bowlers to some extent. Such pitches had virtually no grass, afforded little assistance for pace, bounce, or lateral air movement, but created good turn. In Rawalpindi, Lahore, Peshawar the pitches also have the capability to provide reverse swing to its bowlers. Legends like Waqar Younis, Waseem Akram and Imran khan who set examples of reverse swing were played there in their early ages. Who does not know Shoaib Akhtar the King of Speed also belongs to Rawalpindi and he started his career as Fast bowler from there. Pitches in Pakistan become hard and flat in winters and gain bounce and speed supporting both batsman and fast bowler. In summer season due to dusty nature spinners find these pitches quite favorable [14].

Pitches in Australia

Pitches in Australia have traditionally been known to be good for fast bowlers because of the amount of bounce that can be generated on these surfaces. In particular, the pitch at the WACA Ground in Perth is regarded as being possibly the quickest pitch in the world. The Gabba in Brisbane is also known to assist fast bowlers with its bounce. However, these kinds of bouncy pitches also open up more areas for run-scoring, as they promote the playing of a lot of pull, hook and cut shots. Batsmen who play these shots well have a lot of success on these pitches. Other stadiums like Adelaide Oval and Sydney Cricket Ground have been known to assist spinners more as these pitches have more dustcover. This makes the stadiums an attractive ground for batsmen; teams on an average have scores of 300 or above in their first innings. The Melbourne Cricket Ground can assist seam bowlers initially, but it has a tennis-ball bounce which can negate the potency

Figure 3: Sandy layer.

Figure 4: Crush layer.

Figure 5: Gravel layer.

Figure 6: Nandipur clay.

of bowlers once a match progresses. Swing bowling can be a weapon in Australia, but unlike England, it depends upon the overhead conditions, similar to the Indian subcontinent. Batting in Australia is easier on most pitches. Most back-foot players tend to do well. The only difficulties lie in the unusual bounce of WACA and MCG [15].

Pitches in England

Green, swing promoting and humid conditions sums up the construction of English pitches but everything depends on whether e.g. in summer it may behave like Indian pitches too. Early in the season, most batsmen have to be on their guard as English pitches prove to be most fickle, like the country's weather. Later in the summer, the pitches tend to get harder and lose their green. This makes the task easier for batsmen and only genuine fast bowlers like those bowling in range of (135–150 km/h) and spinners can contain. Spinners prove less effective in the first half of the season and tend to play their part only in the second half. The humid conditions and little dust makes the grounds ideal place to practice reverse swing with a 50-over old ball. Of all grounds, the oval is the most dangerous as the ball reverse swings most there. Another reason for this is traditionally it hosts the last international test match of a touring side in a summer. By above discussions of pitches in different countries it is seen that dusty pitch produces spin and green hard pitches favor fast bowlers and also the weather can affect the characteristics of a cricket pitch, like in summer England's pitches behave same like that of Indian sub-continent's pitches. Hence there are several factors that affect the behavior of cricket pitch excluding its composition. Every pitch is prepared before match and after match proper renovation should be done to keep it in working condition.

Pre-match preparation

i. For first class pitches, this should ideally commence at least 14-10 days prior to the match.

ii. Select the position of pitch.

iii. Work your way across the pitch to complete the full width. Dependent on how much grass is present on the surface it may be necessary to repeat this operation.

iv. Scarification should be carried out between the popping creases, to reduce the density of grass using pedestrian or mechanical brush/rake machinery (not thatch removal or similar type tines), hand rake or a strong broom, care being taken not to disturb the soil surface. The bowling ends should not be scarified as this will assist in reducing the wear and tear, and aid recovery from the damage caused by players. Scarification should continue until the grass sward has been sufficiently reduced in density. There should be no mat of grass and the surface soil should be visible between the blades of grass.

v. Check for small scars or depressions, particularly on a length and repair where necessary. (Carefully lever up depressions. Do not simply fill hollows with loose soil as such would only disintegrate if struck by the ball).

vi. If the surface is dry, it is generally considered that water, either by rain or applied by irrigation, is essential in the preparation of a pitch in order to give it a firmer, solid surface for match play. Water copiously if necessary with the aim to soak the profile to a depth of 75-100 mm (3-4 inches). There is no fixed period for the watering of a pitch, but this should be done well in advance of a match in order to ensure that the pitch is completely dry at the start of play. Ideally this should start no less than 10 days prior to the match. The rolling of the pitch should commence with a light roller when all surface water has disappeared. As the pitch dries, the weight of the roller should increase. The grounds man should use the heavy roller at every suitable opportunity prior to a match whilst any moisture content remains. The heavy roller should not be used once all the moisture has gone from the pitch. In prevailing hot, dry weather conditions it may be necessary for further light irrigation or "flashing" nearer the match day although such a decision would rely on the experience and expertise of the Ground Authority as is the deployment of covers where provided to prevent unwanted wetting of the surface or control the rate of drying during the course of preparation. If the square has been consolidated before the season, pitch preparation is greatly assisted and possible rolling times reduced.

vii. For the remaining pre-match days during the course of preparation, mow every day or at least every other day between the popping creases and in combination with light scarification/brushing, progressively lowering the cylinder to the desired height of cut (typically between 3- 5 mm, (1/8 – 3/16 inches) or as low as possible, without scalping and the surface is not scarred or disturbed in any way.

viii. On the morning of the match, start early and brush, close mow and roll (Typically for around 15-20 minutes). Finally, if not done the previous day, Mark out the creases on the pitch, clearly, accurately and neatly with lines not more than 25 mm (1 inch) wide nor less than 12 mm (1/2 inch) using string lines or a marking frame if available. (see the paragraphs on marking out for details). Use a proprietary marking compound or whiting powder or combination of both. Finally set the stumps in the correct positions on the crease with a little water placed in the stump holes prior. This will ensure that the stumps remain firmly in place during the duration of the game. At the start of the match the pitch should not be excessively green in color to favor sideways, seam movement and be completely dry. This applies not only to the top surface but also progressively to a depth of 75-100 mm (3 - 4 inches). Weather conditions may make this difficult, but, if the weather is fine or with the correct use of covers, it should usually be possible to obtain complete dryness. A pitch which is completely dry at the start of a game is more likely to assist spin bowlers later in a game. A pitch prepared in the above manner should, given good ground and weather conditions, be expected to last for 3- 5 days of first class or 3-4 games of average club standard.

After match renovation

It is essential to proceed with repairs and renovations as soon as the pitch becomes available after play and not wait, as the whole square will soon be looking very sparse. Un-repaired ends on used/worn pitches can be dangerous and are not conducive to a good game of cricket. The selection and rotation of fresh pitches, of a good standard, will become increasingly difficult if the ends are not repaired promptly and correctly.

Maintenance and repair to foot-holes

The umpires shall see that wherever possible and whenever it is considered necessary, action is taken during all intervals on play (including designated drinks intervals) to do whatever is practicable to improve the bowlers' foot holes. In matches of two days or more, as soon as is possible after the conclusion of each day's play, bowlers' foot holes will be repaired If the pitch is to be used the following day they will need to be filled in using the following method:

i. Use a cricket clay loam that has been prepared a day in advance of a game. Make this up in a wheelbarrow. Screen two shovelfuls of soil into a wheelbarrow and sprinkle with water until there is sufficient moisture to have a light covering. Repeat this operation until the barrow is full. Keep under cover until required.

ii. Brush with a besom or a yard broom within the creases and slightly up the pitch (no further than the protected areas) cleaning out any loose material.

iii. The footholds need to be thoroughly drenched. Then using hands, remove all excess water. This dampening has the effect of creating a bond for the new soil to adhere to. By the addition of mixing some grass seed with the soil there will often be no need to remove the repair once the match has finished.

iv. When infilling a depression, ensure that it is done in one mass, if applied in layers, the soil will not bind sufficiently.

v. Start to consolidate from the outside of the foot hole and tread down with the foot, or with a heavy panner/thumper/'elephant's foot', preferably one made of metal.

vi. Ensure that the finished filled area is no higher than the rest of the surrounding surface within the crease by means of a suitable straight edge. This will help to prevent raised ends or 'saddles' from gradually forming.

vii. Brush some dry soil/dust over the repaired area and mark out afresh.

Above instructions must be observed so that pitch would be used efficiently. It must also be noted that there is not only one factor that affects the behavior of pitch, there are many other factors too that can change properties of the pitch and these factors are given below:

Factors affecting behavior of pitch

Clay/silt content: Percentages of clay and silt are the main factors affecting characteristics of a pitch. Proper percentages of Clay and Silt can make pitch harder, stronger and durable and this hardness is very necessary for getting required bounce and speed from the pitch. By looking on the composition of fast and bouncy pitches it is clear that higher content of clay is present in those pitches with very small quantities of silt. So if bounce and speed is required content of clay must be higher.

Pitch hardness: Pitch should neither be too hard nor too soft that it breaks easily. In fact, it should be of moderate hardness that allows cricketers to get maximum benefit from the pitch. Following points must be noted when any pitch has to be prepared:

1. **If the pitch is too soft**

- It will be slow.
- The ball will make indentations in the pitch.
- The ball may seem around slowly.
- The ball may popup dangerously.

2. **If the pitch is too dry**

- It will break up easily.
- It will crumble.
- It will take spin.
- It may have lots of small cracks that do not hold together.
- If it is too dry when you are rolling you will not get adequate compaction , infact ,you will break up the pitch But it may be noted that grass cover will help holding a dry pitch together.

3. **If the pitch is too hard**

- The pitch should not be too hard when the game just begins, our aim is to produce a proper hard surface. Hardness is a desirable characteristic and it is aimed to achieve it with good compaction in the rolling process.
- During the preparation stage the pitch should not dry out too much and become too hard. As this will induce stress on the grass, reducing the deeper drying effect the grass cover has in the pitch through transpiration.

4. **The ideal pitch**

- Allows Fast bowlers to get pace.
- Helps Fast Bowlers to get sufficient bounce.
- Also aids the spinners to throw their spells well.
- Will enable batsmen to play their shots.
- Will enable all fielders to be involved in the game.
- Has an even cover of turf grass.
- Has a straw colored appearance.
- Is neither too dry nor too wet.
- Will make audience enjoy the game.
- Has a shiny finish.
- Is visually appealing and gives the players confidence.
- Is neither too soft nor too hard.

Weather: Weather and environment surrounding the pitch also have effect on pitch properties. Dry weather is good for spin bowling whereas humid and cold weather (December to February) is best for swing and fast bowling. Weather can influence cricket pitches very much therefore curators use different techniques in different weathers. They do not sprinkle much water on the pitches in winter season because moisture present in the pitch is required to be dry up and sunlight has to serve this purpose but in Pakistan sun does not shine as brightly in winter as it shines in summer. Therefore heavy rollers are used for compacting and rolling to let moisture come on surface that is present in the pitch. And in summer extra moisture is required to keep pitches safe from cracks and drying up completely.

Cricket ball: Even after providing proper Clay and Silt content and weather is also in favor of Bounce and speed, desired speed and bounce are not obtained. The reasons behind it that the bowler may not be throwing ball with pace because to get some bounce you have to provide pace for that. Or there might be the reason that ball used is not according to international standards. The ball that is used in

international matches is 159.9 to 163grams heavy and this ball aids the bowler to get speed and bounce against the pace. Also new ball is very good for bouncing and swing whereas old ball does not give that bounce and speed but it is in favor of spin bowlers. In test matches therefore old ball is replaced with new ball after specified overs. Therefore it can be said that along with all other factors cricket ball also has significant effects on the results.

Literature Review

Silt

Silty soil is considered to be among the most fertile of soils. silt is found in river because the fine particles are washed downstream and deposit when the water flows more slowly. it is also soft and smooth, with individual pieces close together. It is too holds a lot of water, but the slightly larger particles make it a little better at draining then clay. It is composed of minerals like quartz and fine organic particles. It is granular like sandy soil. But it has more nutrients than sandy soil and offers better drainage. It offers better drainage and are much easier to work with when it has moisture. Silts are formed by physical weathering. Coarse silts are chemically inactive. Finer silts, which approach colloidal sizes, may exhibit some of the characteristic properties of clay. The particles adhere to one another, and have a large surface area giving them a capacity to hold some water and nutrients.

- Our material which we brought contains 95% silt and 5% sand. It means that we can say our material is silt and local name is GHASSO.
- We performed hydrometer and liquid limit tests on it and after finalizing results we used it in our project.
- The main purpose of silt is to change the properties of pitch with respect to standard pitch.

Sand

Sands have small surface areas and have an almost negligible role in the chemical activity of the soil, i.e. they are chemically insert or inactive. Sand acts as the framework for the active particles, i.e.: silts (fine) and clay. Sand does not hold much water because the particles act as single grains. In a soil the sand particles affect the size of voids. They tend to increase the size of the voids allowing freer movement of water and air. Therefore, sandy soils are well drained and well aerated. Sands are easily warmed because they are will aerated and do not retain much water. Sands do not compact underweight. Having little ability to supply or hold plant nutrients, the native or added nutrients are readily lost by leaching (downward movement of water through profile).

Gravel

Gravel is composed of unconsolidated rock fragments that have a general particle size range and include size classes from granule. Large gravel deposits are a common geological feature, being formed as a result of the weathering and erosion of rocks. The action of rivers and waves tends to pile up gravel in large accumulations. This can sometimes result in gravel becoming compacted and concreted into the sedimentary rock called conglomerate. Gravel is often produced by quarrying and crushing hard-wearing rocks, such as sandstone, limestone, or basalt. Quarries where gravel is extracted are known as gravel pits. The size of gravel which we used in our project is 1.5" to 2".

Crush

Crushed stone is one of the most accessible natural resources, and is a major basic raw material used by construction, agriculture, and other industries. It is distinct from gravel which is produced by natural processes of weathering and erosion, and typically has a more rounded shape. Angular crushed stone is the key material for macadam road construction which depends on the interlocking of the individual stones' angular faces for its strength. Properties for crushed stone are strength, porosity, and the ability to resist volumetric change in freeze/thaw conditions. The size of crush which we used in our project is 0.5" to 0.75".

Black soil/Nandipur soil

We would like to present this soil having characteristics to assist the preparation of cricket wickets in Pakistan. We sincerely hope that this knowledge will aid in the development of cricket as a growing sport within our State. Going back to the basics, there are good reasons for choosing a rich black soil, rich in clay, for our cricket wickets. This material is so much helpful in preparing bouncy and fast pitches. It enhances the properties of cricket pitch by imparting it its characteristics which are given below:

- Allows the penetration of water to produce initial plasticity and expansion.
- Enhance the movement of water through the material by capillary action.
- Permits the evaporation of water through its surface.
- Has sufficient permeability to allow water to be drawn down through it by gravity.
- Changes in density through the increase or decrease of water content.
- Increases its density by application of pressure through rolling.
- Gets dry in a uniform manner to produce a firm consistent surface that will last for days.
- Contracts after drying, to leave a pattern of small even cracks over its entire surface.
- Provides an excellent medium and range of nutrients for growing green couch.
- Accepts green couch as an effective binding and reinforcing plant.
- Withstands regular regeneration and renovation to produce a desirable playing wicket.
- Be reduced to powdered form to allow the application of additional material to the wicket surface.
- Be purchased and laid as a wicket very economically.
- Produces exciting bounce when used as a cricket wicket.

Tests

Not all black soils are the same and it is important that the soil you plan to use, or even the soil on your own wicket can serve the purpose well. To be sure some tests are to be performed to check that whether this soil can be used as a wicket or not. So there are several tests that are described here:

Test no 01: This test is also known as Soil Strength (ASSB Test). The results of the soil strength tests indicate the ability of the soil to bind together when prepared as a pitch by rolling. Soils that have a breaking strength of less than 35 kg will not hold together when dry under impact of the ball and therefore such soils should never be allowed to dry out. Soils that break between 45 kg and 55 kg can be allow to dry

out but preparation must be very good. Soils with a breaking strength of 56-75 kg fis ideal for club cricket and provided they are prepared well can be allowed to dry out.

A "Motty" (ASSB) test should be carried out to ascertain the soil strength and binding quality. To make motties take approximately 150–170g (5-6oz) of air dried soil passed between a 5 mm screen (assuring any organic debris is removed), moisten slowly and mould the mixture into a plastic state. Then roll into a cylindrical shape of approximately 20 mm (3/4 inch) diameter. Cut into 25 mm (1 inch) lengths and roll carefully into smooth spherical balls of approximately 25 mm diameter. Retain 6 of the most evenly shaped and allow to dry at room temperature (not in direct sunlight) for a period of 4 days. When dry and using suitable bathroom scales, place the motty between 2 firms, flat surfaces and press down to determine the weight required to break the ball. Our motties bear the load of 85 kg it shows the soil is also good for international matches and can be used in international pitches.

Test no 02: There is another easy test using a test kit as simple as a glass of water. This test will give you an early indication as to whether you should do any further testing or get any more advice on your sample. This test can also be done on a sample taken from an existing wicket. Simply roll a sample of soil into a ball about 30 mm in diameter. Place into a glass of water and let it sit for several hours. A suitable sample should settle into three distinct layers; clay, fine silt and medium silt. It should reduce in size gradually and evenly. If your sample decays quickly, you can be sure it has too much silt and too little clay. It is therefore unsuitable for use in a wicket (Figures 7 and 8).

Test no 03: There is also a drying test. Again, roll the sample into a small ball and let it dry naturally in the atmosphere but not in the direct sunlight. If it holds together it is good. If it crumbles when handled you know that the silt content is too high. But we cannot decide merely on the basis of this test that this soil can be used in wicket or not.

Test no 04: Another test can be applied to established wickets. Just by cutting a 40 mm deep sample core from a wicket, an experienced eye can pick up problems that often occur in the soil through poor practice; e.g. The problem of organic material in upper layers. This helps examining the cracks produced inside the wicket and also aids to know the binding of the soil layers just by seeing. There are further more sophisticated tests that can be perform on the material to get extra sure about the behavior of cricket pitch like:

i. pH test.

ii. Hydraulic conductivity.

iii. Organic content.

iv. Optimum moisture content.

v. Cation exchange capacity for clay test.

vi. Ions ratio like $Ca^{+2}/Mg^{+2}/Na^{+}$ etc.

But even after these tests one cannot be get assured about these parameters because after pitch is prepared, creases are marked with limestone which also changes the condition of cricket pitch and can affect the pH. So above tests are more necessary than these tests.

Type of soil and top dressing

The use of the right soil is most important for the production of pitches of optimum playing performance. The soil must have strong binding qualities and this is dependent on the percentage of clay content in conjunction with the other constituents of the soil structure. The soil selection is dictated by the standard of pitch required.

Mostly clay content affects the properties of a wicket. Because it helps in binding the material together and on drying it becomes too hard and provides proper pace and bounce. On research it is to be found that the Australian Pitches have more amount of clay than silt, sand etc. Proper Clay content is very necessary for making desired fast and bouncy pitches. Australian wickets contain more than 50% clay content. The following table describes various materials' contents in different cricket grounds of Australia (Table 1). Following is the graph showing the pitch contents of different Australian pitches. We can see clearly that in all pitches the clay content is higher than the other materials. This is the key point that if we use high clay amount in pitches, we can get our desired bounce and pace out of the pitch (Table 2).

Methodology

We used Nandipur's Black soil for making wickets for our project

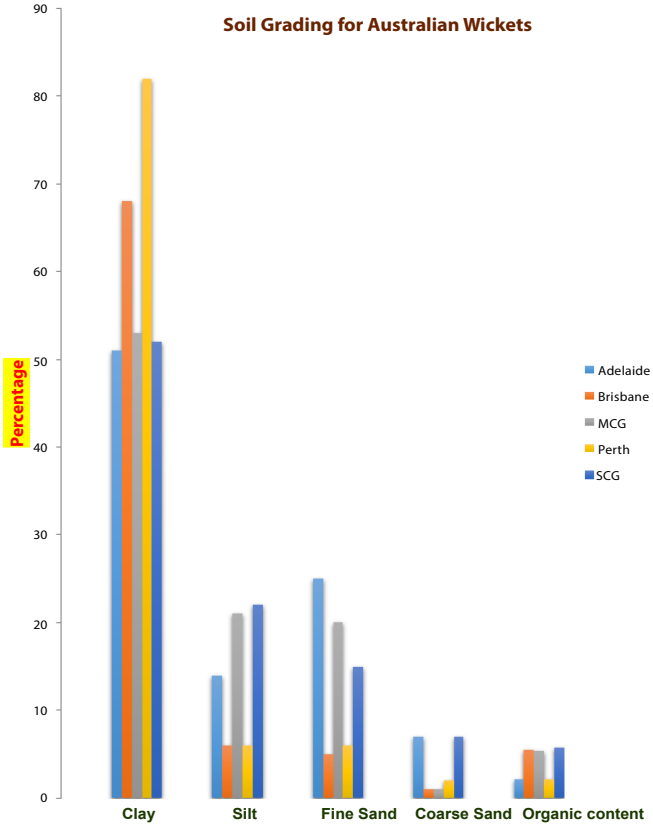

Figure 7: Strength test.

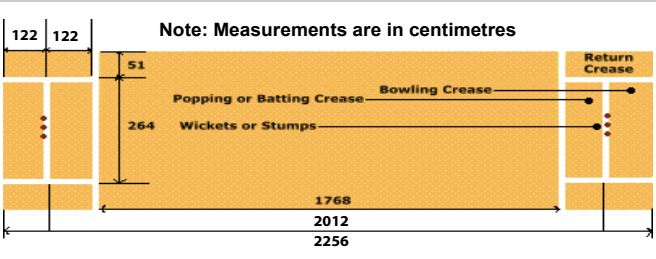

Figure 8: Pitch dimensions.

Soil Content	Adelaide	Brisbane	MCG	Perth	SCG
Clay	51	68	53	82	52
Silt	14	6	21	6	22
Fine Sand	25	5	20	6	15
Coarse Sand	7	1	1	2	7
Organic Material	2.2	5.5	5.4	2.1	5.7
(NZSTI Guide to Cricket Pitch Preparation).					

Table 1: Soil contents of Australian cricket pitches.

Length	80 Feet
Width	10 Feet
Depth	14 Inches

Table 2: Standard pitch dimensions (1).

Length	5 Feet
Width	5 Feet
Depth	14 Inches

Table 3: Sample pitch dimensions (2).

because this soil is highly rich with clay content. Sample pitches are prepared by us of above dimensions. We could not prepare pitches of standard dimensions because of lack of resources (Table 3). These wickets are constructed by following steps:

Selection of site for pitch

Selection of suitable site is very important for construction of a pitch. While selecting the site for the pitch this thing should be kept in mind that during the match the sun should not come in front of batsman's eyes at any time. After the indication of right position of sun the pitch should be made in north-south direction. We selected the UET Stadium for construction of our pitches.

Marking boundary for wicket

Before the construction of pitch is started the suitable place for the pitch is decided. And then marking is made by using white powder (for most of the time we use lime for this purpose), so that during excavation of the soil the marks are clearly visible and excavation is correctly done.

Excavation

When the site is selected and demarcation is done, we decided that the depth of pitch should be of the soil up to 14 inches. It is decided by keeping in view the underground water level in mind i.e. if the water level is not near the surface at the site then more excavation is done so that a durable pitch is made. When the excavation up to 14 inches is done then fills it with sufficient amount of water. It is left as it is for two days so that water can get completely dried. After water is completely dried compact it with the electrical vibrator. But we did manual compacting (Figure 9).

Check properties of water

Water on the site where pitch is to be constructed is analyzed carefully so that we can quantify that how much salt is present in the water, which may affect our pitch. These things are very much important for construction of good quality cricket pitch. Durability of a pitch is indicated by these parameters. Due to heavy water pitch is broken and cracks appear on it. If at the site where the pitch is to be constructed heavy water is present, then it is necessary that before its construction heavy water should be cleaned by using gypsum. But in our case we did not face any issue like that.

Sand

Sand layer is laid at the lowest layer of pitch and such type of sand is used which has negligible amount of clay in it so that water can pass through. We laid two inches thick layer of sand and filled it with water, after the water is dried we compacted it by using manual compacter.

Gravels

After sand layer has been placed, the compressive strength of gravel is determined and the gravel capable of bearing the load of roller is used to place 4 inches thick gravel layer. For compacting the gravels a thin layer fully, stone dust is placed and water is sprayed so that gaps are eliminated but it should be kept in mind that extra water should be drained off.

Crush

When the gravel layer has been placed a crush layer of 2 inches is laid. It should be noted that crush being used is not adopting powdered shape, for this we should test the crush before using it so that pitch base is stable.

Clay

When the crush becomes stable, place the clay layers which are finally 6 inches thick. In order to achieve a 6 inches thick layer we provided 3 clay layers of 3 inches thickness so that after compaction the final thickness achieved is of 6 inches. According to PCB standard procedure of pitch the whole 6 inches layer should be of Nandipur clay but we used different combinations of Nandipur clay and silt to study the effect on bounce and speed of ball. We used two different patches in which clay content is varying with silt content. The details of silt and clay contents are given in table below (Tables 3 and 4).

Leveling

First we placed dried grass on the surface of final layer of pitch which consists of clay and used the plain roller for compaction so that clay should not stick to the roller. After fully compaction of the pitch the grass is removed we get finished layer of pitch in its final form. According to Pakistan Cricket Board PCB specifications, after compaction thickness of clay layer should be of 6 inches. Our layers are approximately 6 inches (Figures 10-12).

Rolling

After leveling a pitch must be compacted by rolling. Rolling helps

Figure 9: Excavation.

Patch No.	Clay (percentage)	Silt (percentage)
1	100	0
2	50	50

Table 4: Clay/silt content in sample pitches.

Figure 10: Pitch during preparation (1).

Figure 11: Pitch during preparation (2).

Figure 12: Pitch while rolling.

wicket to compact and become dry because due to rolling the moisture present inside the pitch comes on surface and gets dried. If the pitch is wet and rolling is carried out then due to high clay content the material of wicket sticks with the roller and comes off. A depression is created at that place. This problem is mostly encountered in the winter season when sun does not shine brightly and it does not have that much warmth as in summer season. So in winter sprinkling of water should be done carefully because excess moisture would keep pitch wet for a long time. On talking to the curator of UET stadium he told us that grass is thrown on wicket to prevent pitch's material to stick with roller because grass forms a blanket over wicket and sticks with wicket. And grass is very useful for swing and pace so it serves several purposes.

There are three types of rollers for rolling:

I. Light Roller: up to 254 kg.

II. Medium Roller: up to 508 kg.

III. Heavy Roller: 1014 kg (1 ton) or more.

We used light and medium rollers on our pitches. We rolled the pitch in every direction, starting from one side of the pitch and coming on the other side. Rolling also helps in mitigating the problem of cracks that appear on the surface of the pitch. Rolling is done for several days until the pitch is properly consolidated. In winter pitch gets moisture from atmosphere and does not dry up easily. When the pitch is ready we performed the tests on it. When pitch becomes ready one can simply judge merely by one's eyes that pitch is ready or not.

Experiments

After the pitches are ready we performed the following tests:

1. Bounce test.

2. Pace test.

3. Compaction test.

4. Checking the behavior after the rain fall.

Bounce test: In this experiment we checked bounce of our pitches. In our case we have two patches with different proportions of clay layer. We dropped the tennis ball from 6 feet height in all two patches but the bounce was different in each case. The patch which has the 100% clay showed the larger bounce as compared the others.

It showed the bounce of 2.3feet and 50% clay patch showed the bounce of 1.8 feet (Table 5).

Pace test: We performed this test to check the variations of pace with respect to clay content. It was not easy to observe the pace variation but after repeating our test and observing again and again we took a result that pace was directly related with clay content. We observed the pace through both directions and got result that with 100% clay patch showed greater pace as compared to others.

Compaction test: After performing the previous tests we checked the behavior of compaction of patches after some period of time. It was quite easy to observe the compaction after some period of time. Compaction became less as compared to final compaction which we made for final pitch it means that the compaction depends on time period and for every match we will have to make sure that the pitch has good compaction.

Checking the behavior after rain fall

Similarly to compaction the behavior was different with respect to initial preparation. Due to change in compaction w.r.t time, the strength and hardness were less after rain fall. It was due to the moisture content increment. We know that moisture content differs inversely with the strength and pace. That is why pitches of international standards are covered during rainfall.

Clay Percentage	100%	50%
Bounce	2.3 ft	1.8 ft

Table 5: Bounce test results.

Results and Discussion

In this chapter, we will discuss all the results of the experiments performed as a part of the current research. Mainly graphs are discussed; their behavior and their importance are explained in the context of this study. Also, all the basic type of experiments and their results are discussed in the light of their importance in contributing towards this study. All the experiments are discussed separately, with their results pointing to the main conclusions of the research.

Normal moisture content

The normal moisture content of the soil sample from Nandi Pur was based on the average of three samples tested for moisture content in the drying oven. The normal moisture content came out to be 7% for Nandi Pur soil. The moisture content is a very important factor for predicting swelling soil behavior, because if moisture is less i.e. soil is drier, than there are more chances of swelling as compared to the state when soil is wet, because swelling is due to the inhibition of water into the pores of swelling soil.

Sieve analysis

The sieve analysis showed that the soil from the Nandipur site had a very small fraction of coarser particles i.e. 1%. The soil mainly consisted of finer fraction i.e. 99%. This very high clay content is an indicator of swelling soils.

Atterbergs limits

Atterbergs limits tests were performed on the soil sample passing sieve No. 40. The results were checked twice, to have justified values. According to the tests the Liquid Limit for the Nandipur Soil came out to be 64% and the Plastic Limit came out to be 22%. Hence the plasticity Index was 42%. Such high values of Liquid limit and plasticity Index are the direct indicator of a swelling soil. Usually swelling soils have Liquid limit greater than 50% and their plasticity index exceed 20% (Figures 13 and 14). Hence Nandipur Soil is termed as very high swelling soil because its plasticity index is high.

Soil classification: On the basis of the sieve analysis and Atterbergs limits, the Nandipur soil was classified as CH (USCS), high plasticity clay.

Unconfined compression test: Two unconfined compression test were performed for the Nandipur soil. Then there average value came out to be 500 kPa. This high value of compressive strength indicates that the Swelling soils are very hard in dry conditions. That's why it is very good to use it in pitches because when ball collides with the pitch it provides a hard and strong surface to provide bounce and pace to ball with undergoing breakage.

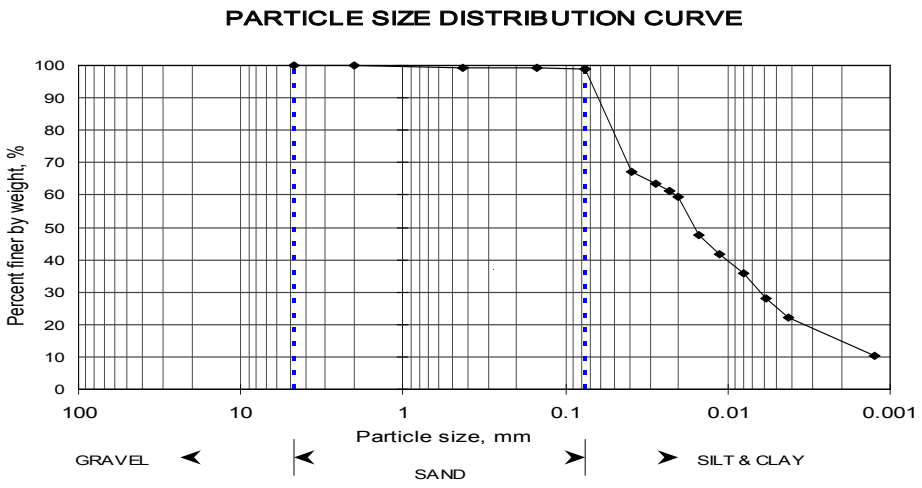

Figure 13: Particle size distribution curve.

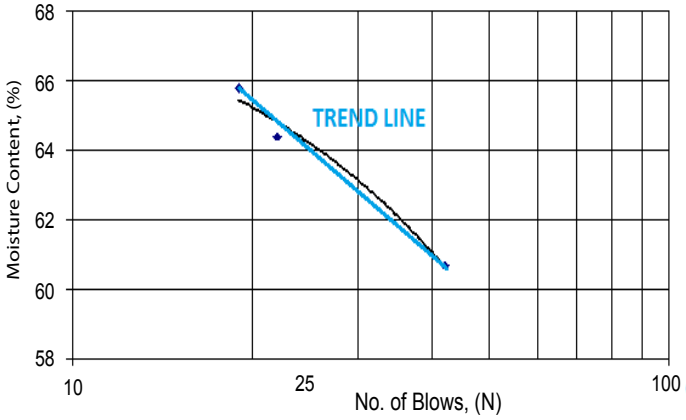

Figure 14: Moisture content vs. no. of blows.

Compaction tests: As the main research area deals with Initial placement conditions, which includes both initial dry density and initial moisture content. And, these two parameters are found by compaction tests, as the compaction curve gives us the maximum dry density and the optimum moisture content for a specified compaction energy. Therefore, a series of compaction tests were performed with varying compaction energies. The results of compaction tests performed with different compaction energies are shown in form of the compaction curves: Following are the compaction curves with different number of blows per layer (Figures 15-17).

Maximum Dry Density = 94 pcf.

Optimum Moisture Content = 25%.

Maximum Dry Density = 101 pcf.

Optimum Moisture Content = 19%.

It is seen that increase in number of blows increases maximum dry density and in result optimum moisture content decreases. We further increase number of blows to 25 per layer and its graph is given below:

Maximum Dry Density = 105 pcf.

Optimum Moisture Content = 12%

So the maximum dry density came out to be 105pcf and optimum moisture content is 12%.

Now it is clear that by increasing the compaction maximum dry density increases and the optimum moisture content decreases. Therefore to get better results pitch constructed from this clay must be highly compacted and this is done by using rollers. And it may also be noted that curators do not perform these types of tests because it is obvious that by compacting of a material its density will increase so depending upon their experiences they use different types of rollers for compacting the pitch. The curator of UET stadium's cricket pitch told us that he mostly uses heavy rollers for compacting the pitch and letting the moisture present inside the pitch to come out resulting in drying the pitch and making it hard.

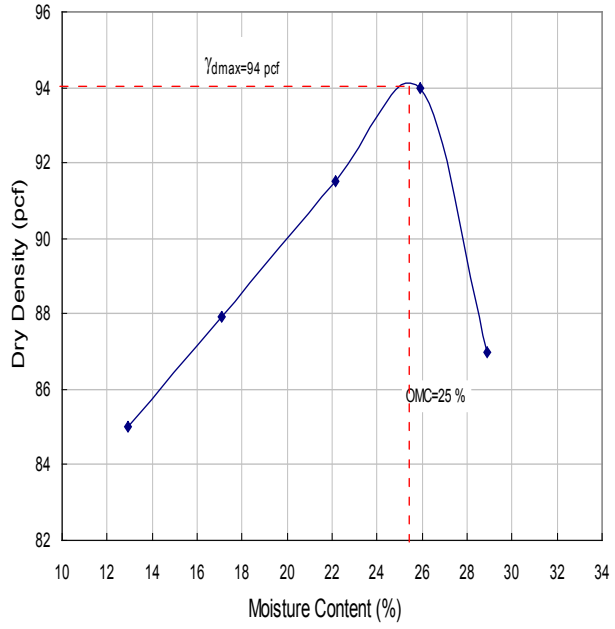

Figure 15: 12 blows per layer (Total 3 layers).

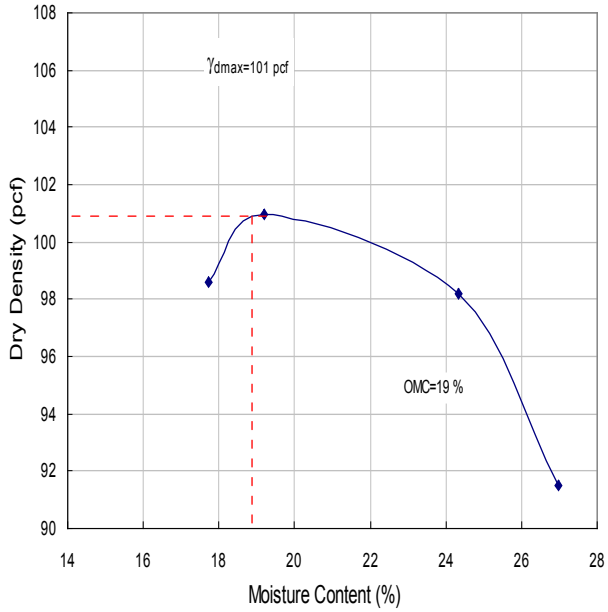

Figure 16: 14 blows per layer (Total 3 layers).

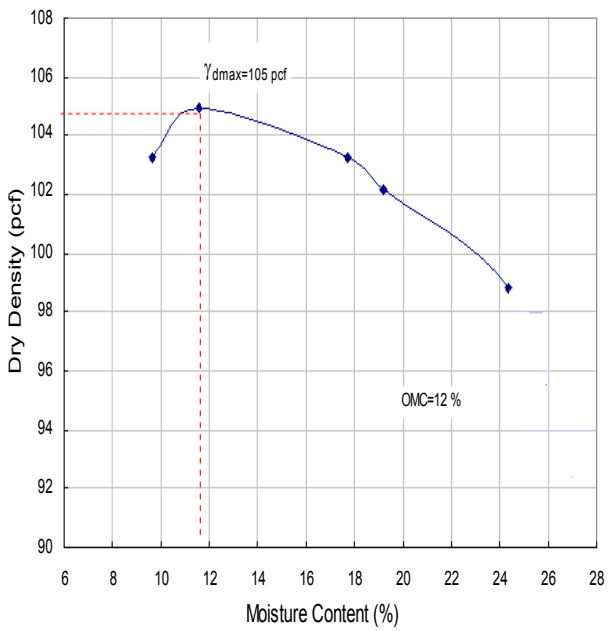

Figure 17: 25 blows per layer (Total 3 layers).

Swelling of clay: Cohesive soils mostly have this property of swelling. These soils swell upon wetting and shrinks upon drying. But in case of cricket pitches this factor is not as important as in the case of building's foundations where swelling can cause serious problems. In a pitch soil is present in the form of a single layer of thickness nearly six inches so it does not have that much amount of swelling as in case of foundations. And even if it swells, the regular rolling with the help of rollers mitigates this problem, Therefore, curators do not consider the swelling factor while making cricket pitches.

Layering: All pitches should be free of horizontal layering since this deadens the pitch (and so reduces bounce and pace), promotes shallow rooting (since roots will penetrate to the layer and then grow

horizontally instead of proceeding into the next layer) and results in uneven moisture distribution through the pitch profile. Layering is caused by the incorporation of organic matter into the profile, as when topdressing is applied on a pitch which has a quantity of plant material on the surface (to form an organic matter sandwich); when different types of bulli are laid on top of each other; and when a pitch is rolled when its surface is dry but the bulli below the surface is moist. Layering can also be caused by using a vibrating roller, particularly when the pitch is relatively dry.

Irrigation: Irrigation or moisturizing the pitch also plays an important role in its performance. If a pitch is moisturized properly then its qualities will get enhanced and its performance gets flourished. So it's a very important factor. Following are few points for irrigating the pitch properly:

1. Irrigation is best done by using sprinklers which give a fine mist spray. Large droplets are likely to cause 'potholes' on the pitch.

2. Avoid pools of water lying on the pitch surface. Water penetrates bulli very slowly.

3. After irrigation, grass cuttings often collect at certain points on the surface. These cuttings must be brushed off the pitch.

4. A hessian or bidum cover on the pitch in hot, dry, windy weather ensures good moisture retention by the pitch.

Cracking: Cracks are often on a pitch. Cracks cannot be completely removed but these can be made as minimum as possible by proper maintenance of the pitch. Following are few points about cracks and their removal:

1. As a pitch dries, the bulli shrinks and so cracks develop. These should disappear when the pitch is again wetted.

2. The impact of cracking is to reduce bounce and pace, and increase variability. It should also increase the amount of spin that a pitch will take, but turn in badly cracked pitches is likely to be inconsistent.

3. The cracking pattern will influence the behavior of a pitch. It would clearly be undesirable for cracking to become so severe that the blocks of bulli between the cracks become unstable. This is likely to occur if the pitch is layered close to the surface. We believe, however, that a pattern of many fine cracks is preferable to only a few large cracks.

4. As mentioned earlier, a strongly rhizomatous grass is preferable to a surface grower as the rhizomes can be extremely effective in holding the pitch together.

Conclusion and Recommendations

Conclusion

By all the above research and tests it is blatant that there is a huge scope for preparation of Fast and Bouncy pitches in Pakistan of international level which will be good for both batsman for playing strokes and for bowler as well for getting maximum speed and bounce. Pakistan weather is also favorable in making these types of pitches because humidity affects the characteristics of a pitch. Along with pitch components and weather, there are several other factors that influence the behavior of the pitch like type of ball, whether ground grass is wet or dry, whether match is played in day time or at night etc. So depending upon a single factor and predicting the behavior of pitch according to it is not a wise option. But as beginners we focused mainly on the components of pitch to determine its behavior.

So, from the tests carried out (mentioned earlier) and their results, following conclusions can be drawn:

1. Using soil with high content of clay instead of local soil with silt as dominating material, hard pitches can be produced which are bouncy and fast.

2. Nandipur Soil is composed of clay and is fit for making pitches of international level.

3. Grass on a pitch is very useful, it helps pitch in drying easily and prevents pitch material to stick with roller while rolling.

4. As compaction increases, maximum dry density increases and optimum moisture content decreases; making the pitch hard and strong.

5. Swelling is not trouble maker in case of pitches.

6. Compaction energy is directly proportional to the performance of a pitch.

7. Weight of roller is related directly to the compaction of the pitch.

8. At optimum moisture content the density of soil will be maximum. It is shown in the following graph (Figure 18).

Recommendations

1. Regular rolling of the pitch is very important for making it good enough and durable.

2. Careful moisturizing is very necessary.

3. After the construction pitch starts deteriorating and its life starts to decrease. A pitch's performance decreases with every passing day. Its proper maintenance can impart few more days to its life.

4. Grass cover is very important. It saves clay from pitch to stick with the roller while rolling and also let inside moisture to leave the pitch through grass.

5. Never lay down pitch in layers because it deadens the pitch and renders uneven moisture distribution.

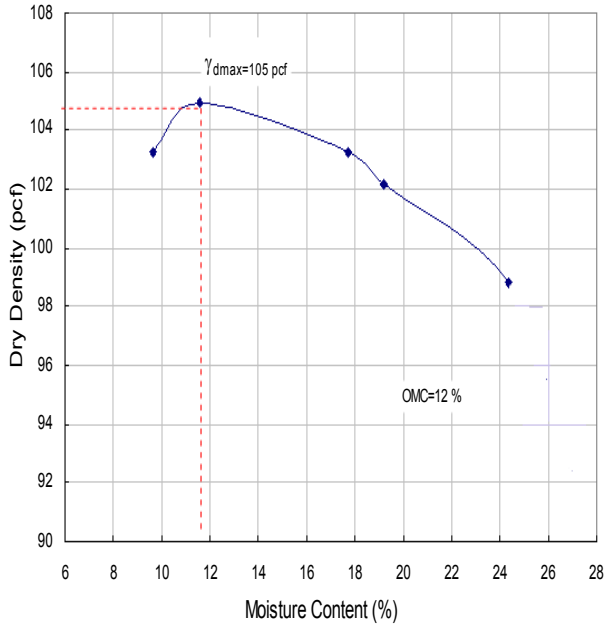

Figure 18: Moisture content vs. dry density.

6. Cracks can turn a fast pitch into a slow one. Therefore, provide water to it in the form of sprinkles.

7. Apply more clay to the pitch time-to-time to repair damaged areas.

8. Prepare pitch before the match for playing.

9. After the match cover the pitch with some sheet.

Each clay soil will ultimately require a separate preparation package for best results. It is essential that the clay material meets quality standards to afford the grounds-man a reasonable opportunity of producing a good pitch.

Thereafter the process requires attention to detail without taking short cuts. The basics of a level surface, even grass cover, even application of water and the correct use of the roller can produce very satisfying results.

The process of preparing a cricket pitch involves Natural Science. The combination of nature and science needs to be understood and fully exploited to achieve the best results. Experience gained from a process which has a scientific base as the foundation will benefit any progress in all endeavors relating to these activities.

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