Procedure

for

Construction Of Hammer / Discus Concentric Circles

Endorsed by

uk:athletics

Contents

1. Introduction

This procedure has been written to provide guidance on the required standard for the construction of Concentric Hammer / Discus throwing Circles in the UK.

Historically throwing circles have been constructed of standard concrete mix which has been the same as the mix used to set the throwing rim. This has ultimately led to a wide range of differing throwing surfaces which has created problems for throwers when dry as they are too grippy and when the top surface has been worn shiny pebbles are exposed causing the circle to become slippery and lethal when wet.

Poor circle quality produces substandard performance but also increases risk of athletes falling and injuring themselves, aborted throws increasing risk to officials, and long term skeletal joint damage caused by the increased torque produced on knees, hips and lower back of the athletes.

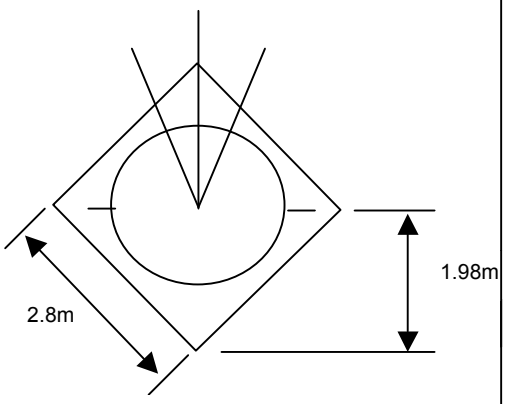
To ensure heavy throw athletes are given the best opportunity to perform at the highest level this standard should be followed for new and replacement throwing circles.

This procedure has now been used at many of the major stadiums around the country including the Olympic stadium for London 2012

2. Circle Construction

2.1. Setting Out

The preferred method adopted by many track construction teams is to mount the circle within a square hole. This provides an easy method of aligning and shuttering the hole in preparation for pouring the concrete.
The corners of the square should be aligned through the centre line of the sector this also forms the centre line of the circle perpendicular to the centre line of the sector on which the boundary lines marking the front half of the circle can be painted.
The size of the square hole should be 2.8 m minimum across the sides this allows for 25mm shuttering boards and maintains 100mm distance between the rim of the circle and the edge of the concrete at its minimum points.



Layout of excavation relative to sector

Mark the four corners of the square using wooden pegs and lay the rim within the marked off area. Check the distance from the centre of the circle to where the net of the cage will hang, there should be 3.5m between the centre of the circle and the net around the back half of the circle. Check there is sufficient distance between the cage and the track if the cage is not yet installed. There should be minimum 3 m between the net of the cage and the edge of the track to allow free access around the back of the cage during competition.

Run a string line into the centre of the field from the centre of the circle and ensure the sector alignment is correct if necessary use the 20 x 20 x 12 rule (measured from the centre of the circle) to mark out a sector using wooden pegs.
It is essential to mark the centre line of the sector with wooden stakes at the back and front of the circle and again either side of the circle aligning with the other corners of the square and perpendicular to the centre line of the sector. These stakes should be located well clear of the excavation (2 to 5m) to allow alignment of the shuttering and the mounting of the circle rim once the excavation is complete. Hammer a single clout head nail in the top of the stake aligned with the sector centre line. This will be used to attach a string line for alignment of the shuttering later.
Once the alignment of the circle has been checked prepare to excavate the hole.

2.2. Excavation

2.2.1. Excavation Safety

If digging on an established ground an underground services check may be required to establish if there are any services such as water, lighting cables, communication cables for the public address system, sewers or land drains that may run through the excavation. Drawings of the underground services are normally held with the facility or the city architect department if council owned.

Most services will be buried below the excavation depth of the circle but if pipes or cables are unearthed during the excavation it should be brought to the attention of the project or stadium management for further investigation by a competent person.

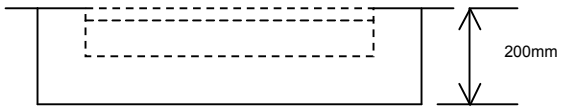
2.2.2. Excavation Depth

The excavation depth depends on the consolidation of the ground on which the circle is to be built and the method of slab construction used.
There are basically two methods of construction of the slab.

2.2.3. Construction Method One - Solid Slab

A thicker slab of concrete is poured straight onto the earth base of the excavation or a base of minimal consolidated base coat. This is favored by building contractors who utilize ready mix concrete as it is quick and easy to complete. The problem for the maintenance of the circle is that there are no drain holes in the circle and no soak away formed by the hardcore base. Water will not naturally drain from the throwing surface and increases the risk of standing water during training and competitions if raining and also increases the risk of frost damage to the surface from frozen water in the winter months.

Method 1 – Drawing shows depth of excavation & concrete

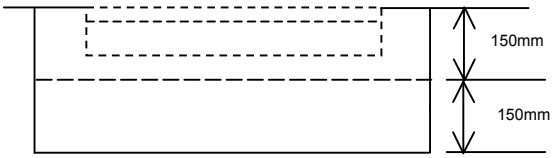


NOTE:
Where the base of the excavation is not consolidated, either wet and boggy or friable loamy soil, further excavation is required until a solid surface is achieved and the hole backfilled with consolidated sub base hardcore until the required concrete depth is achieved.

2.2.4. Construction Method Two - Slab With Sub Base

A slightly deeper hole is dug until consolidated earth is reached this is then back filled with hardcore to form the foundation on which the concrete circle is laid. This allows for drainage holes to be inserted into the circle permitting surface water to drain naturally through the sub base. Drainage holes also present a problem if allowed to become blocked with grass and debris as the water will not drain from the surface.

Method 2 – Drawing shows depth of excavation. ½ the excavation depth will be backfilled with compacted hardcore



2.2.5. Depth of Throwing surface below Rim

The throwing surface of the circle should be finished 20mm ± 6mm below the top of the rim of the circle

2.3. Drain Holes

If the surface of the circle is constructed of granolithic concrete there is little change in coefficient of friction between wet and dry surface and the finished surface is hard wearing and frost resistant.
A decision to fit drain holes is to be taken with the user and the constructor.

Drainage holes if possible are best tied into a land drain if there is one located in the close vicinity to the circle. The holes should be placed at the edge of the circle and away from the start and finish positions of the throw. The best location for the drain holes is adjacent the lines that mark the back and front halves of the circle. The drain holes should be formed out of none metallic material. 25mm round electrical conduit is suitable for this duty. Drain pipes should be located into the sub base before pouring the

concrete. It is best if a small hole is made in the sub base and filled with pea gravel to assist with the soak away action if not tied into a land drain. This area around the drain pipe should be covered over with plastic before pouring the concrete as the concrete slurry will seep through the pea gravel mix and block the pipes.

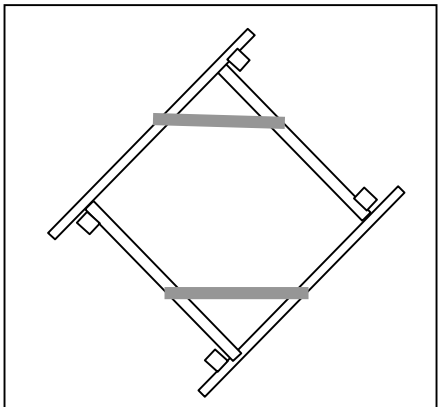
2.4. Sub Base

Using ***construction method two*** a sub base is required to form a foundation on which to lay the concrete slab.
This consists of hardcore (crushed bricks, concrete or stone) compacted with a “Wacker” or vibrating plate compactor and then topped with a layer of sharp sand or ballast – called blinding – to fill any gaps and stop the cement matrix seeping into any voids in the sub base structure.

In constructing the sub base, it is important that the specified density be achieved to avoid any subsequent problems associated with consolidation and non-uniform support. Sub base should be placed in uniform layers, generally not exceeding 150mm. To achieve the minimum 150mm depth it is recommended that the hardcore should be applied in two layers and the first layer consolidated down using the Wacker before applying the second layer.

Before tipping in the first course of hardcore it is recommended that wooden stakes are driven into the ground the top of which should be at the sub base hardcore finish level. The wooden stakes should be at the sides of the excavation such that they will not interfere with the operation of the wacker plate. These stakes may be removed when the finished depth of sub base is achieved.

2.5. Shuttering


Shuttering construction showing corner stakes and diagonal temporary supports

Shuttering for circle should be constructed using solid planks of wood. This provides a clean edge to tarmac or pave up to once the shuttering is removed. Two lengths of the timber should be cut to 2.7m in length and two lengths should be slightly longer around 2.8m. The 2.7m planks can then be nailed inside the longer planks leaving a slight overhang at each end of the longer planks. This allows for a stake to be driven into the ground in the corner to provide a solid fixing and a stable shuttering. Ensure the shuttering is square before mounting in the hole. This can be achieved using the 3:4:5 rule. Measure from one corner 90cm and mark the top edge of the shuttering. Measure from the same corner along the adjoining plank 120cm the distance between the two marks across the diagonal should be 150cm. Adjust the box until this is achieved. Nail a lathe across the corners to hold the box square. Leave the nail heads protruding slightly to allow easy removal once the shuttering is located in position. A further check of squareness can be achieved by measuring corner to corner across the diagonal, these two lengths should be the same distance approx 3.82m.

Locate the shuttering in the hole and check the alignment with a string line using the centre line markers that were installed prior to the excavation of the hole. Drive in the four corner stakes that will support the shuttering once satisfied that the alignment with the sector centre line is correct.

Using a spirit Level and the edge of a straight plank of wood ensure that the finish level of the circle shuttering is slightly higher than the surrounding ground and allow for fall away from the circle if the surrounding area is to be tarmaced or finished with rubber track material. This will stop the water running back and pooling in the finished circle. Fall around the circle should be around 1:40 within the

cage area as this will avoid standing water and reduce the risk of the net rotting from laying in pools of water when lowered. The fall may go down to a minimum of 1:80 but any lesser ratio of fall and you will run the risk of pools of water forming around the circle and water running back into the circle from the surrounding area.

Secure the shuttering to the corner stakes using screws, as nailing the shuttering may damage the alignment. Supplementary stakes may be required at the centre of each board to provide extra support.

Once the shuttering is installed and fastened to the stakes, the lathes used to ensure the shuttering shape was maintained may be removed using a claw hammer or other suitable tool.

Once the shuttering is secured in place re-check the excavation depth or depth to the finish level of the sub base, adjust depth where necessary.

2.6. Precautions When Using Cement

Contact with wet cement can damage skin and/or eyes. Always wear protective gloves before handling, and avoid contact with the eyes, or uncovered skin.

2.7. Ready Mix Concrete

When ordering ready mix concrete there are a few items to note

- The strength of the concrete
- How much water is in the mix (the Slump)
- The size of the aggregate
- Amount required

Ready mixed concrete is preferable for quantities of 1m³ or greater. By mixing each delivery in one operation, the batch-plants can guarantee the strength and slump (a measure of how 'wet' a concrete is), ensuring that all the concrete cures to the same uniform strength, and that the ratio of fines to aggregates is correct. The only drawback to ready-mix is that it may start to set before it can all be used.
There are two sources of ready mixed concrete. Firstly, the national concrete companies with local depots who deliver and discharge, such as Tilcon Trumix, RMC and Pioneer. These companies will supply a given quantity of concrete of guaranteed strength, and leave you to do the hard work. They will deliver any quantity you require, from 1 m³ upwards, in multiples of half cubic meters. Many will offer free, technical advice - look in Yellow Pages for local companies.
Note
Ready-mixed concrete is sold by volume (m³) and not by weight. The concrete wagons usually carry 6m³, or sometimes 8m³, and you may be charged £20-£25 for each cubic meter not carried.

There are also 'mix and move' contractors, who mix the quantity of concrete you require on their specially adapted wagons, and then barrow, or pump, the concrete to exactly where you require it. This

concrete may not meet the quality standards required of the larger national contractors, but will be ok for the circle base construction. Expect to pay more per m³ than the delivered ready-mix, but then, they are doing a lot of the hard work for you! These contractors can also be found in Yellow Pages or the Thomson Local.

2.7.1. Concrete Strength

When ordering concrete, you may be advised by the technical staff to order a prescribed mix, such as C20P or a special-purpose mix, such as PAV200 for hard standings and drives. Concrete is graded in strength using a system based on the compressive strength after 28 days of curing. This generates a value in Newtons per square millimeter (N/mm²) which results in mixes being referred to as, for example, C7.5 or C20, which means that a particular mix will achieve a *minimum* compressive strength of 7.5N/mm² or 20N/mm² after the 28 day curing period. Weaker, bedding concretes are Class 7.5, or C7.5. Strength grade increases up to very strong, C40 concretes for civil engineering purposes. For throwing circle base construction, a C20 mix is usually adequate. This is roughly equivalent to a 4:2:1 mix**.**

It's also worth noting that the new European standards introduced on December 1st 2003 complicate the simple strength classification described above, but the "older" spec terms will continue to be understood by the trade for many years to come.

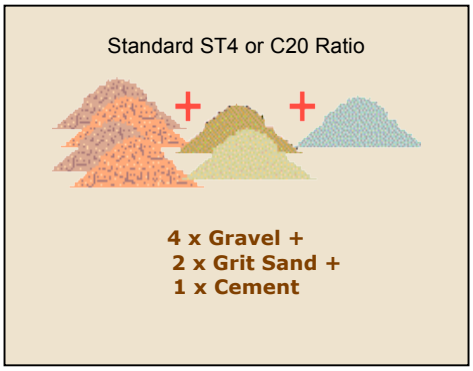
2.7.2. Concrete Slump Test

You will also need to specify how 'wet' you want the concrete to be when delivered. 'Wetness' is measured in mm of slump; that is, how far a given measure of the concrete will slump or slip in a cone test. For the base of the circle a 50mm slump should be fine. A 100mm slump will give a pourable, sloppy concrete. This will require extra time to allow the base coat to set before the throwing surface can be applied. Delivery wagons usually carry extra water on board that can be added to the mix if it is too dry or stiff. If the concrete is too wet, you're stuck with it!

NOTE:
The addition of too much water to a designated mix can weaken the end-strength - try to order the correct 'slump', so that the batch plant can guarantee 28-day strength.

2.8. Mixing On Site

Small quantities of concrete can be mixed on site. generally speaking, if more than 2m³ of concrete is required, it is recommended that it is brought in as Ready Mix. If 1m³ or less is required, it will usually be mixed on site; for quantities between 1m³ and 2m³, the site conditions, access and cost will be weighed-up and a decision made on the mixing method (see circle construction quantities **Table 3**).



Although concrete can be mixed by hand, on boards or in a wheelbarrow, it is much, much easier to use a powered mixer, and a more regular, consistent mix will be achieved. Mixing more than ¼m³ by hand is hard work - 0.25m³ of fresh, unset concrete weighs in at around two-thirds of a tonne, and that two-thirds of a tonne will need to be turned over at least 5 times to ensure all the ingredients, the sand, cement, gravel and water, are thoroughly mixed. Two-thirds of a tonne lifted and turned 5 times comes in at over 3 tonnes ... and that's a *minimum* figure!

ST4 is a medium-strength mix equivalent to a C20 mix.

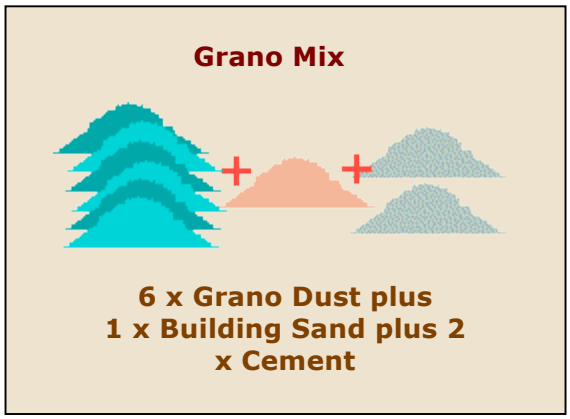
Sand and gravel mix are supplied by most builders merchants in 15 - 25 Kg bags or 1 m^3 sacks this mixture is known as 'ballast'. This sand gravel mix is normally sold in ratio to provide a C20 mix (4 parts gravel : 2 parts grit sand) when mixed with one part cement.

6 parts of ballast mix to 1 part cement provides a C20 strength concrete. This can be made stronger if a 5 : 1 ratio is used. Mix all these dry aggregates together before adding any water.

The finished mix should be wet, but firm, not sloppy. Use a bucket or similar to measure out the quantities, this is a bit more time consuming but provides a consistent mix.

2.9. Granolithic Throwing Surface

Granolithic concrete is a fine-grade concrete. It is used extensively in the construction industry, for making up small areas of concrete and for benching in sewers and manholes, where its hard-wearing properties, its ability to be applied thinly (as thin as 6mm in certain conditions) and its low cost make it a popular and resilient surface. This granite concrete material forms a hard wearing surface that can be used to construct the circle throwing surface. Use of this material allows for easy repair and surface dressing should the concrete matrix become worn.



Known as 'Grano' in the trade, it is composed of a fine, hard aggregate, often, but not exclusively a granite. To this is added a small amount of sand, and ordinary portland cement.

Mix together 6 units of Grano with 1 unit of sand and 2 units of the cement. Mix dry, as above, before adding water, strengthening agents and dyes can be added as required. It can be mixed by hand or in a mixer.

The finished mix should be able to flow in the mixer but should not be too wet as this reduces the final strength. If the mix is too stiff it is difficult to level in the circle area.

The mixed Grano should be placed with a trowel, or spade for larger quantities, and smoothed with a steel float. The small quantity of sand increases the amount of matrix (known as 'fat') available to create a very smooth surface.

Once the circle area has been generally smoothed it should be allowed to stand until the concrete mix has stopped bleeding (water coming to the surface). Once the surface has gone off to the point where the mix does not stick to the palm of the hand when placed on the surface it is ready for finishing (see Section 3.1).

3. Circle Surface Finishing

3.1. Finishing

Many of the problems associated with the performance of concrete throwing circles are caused by poor finishing procedures. **During the compacting, leveling and floating of the circle surface, a layer of cement-rich mortar is inevitably brought to the surface. This surface laitance should not be allowed to become too thick by excessive working of over-wet concrete. A slab with a thick layer of surface laitance will wear rapidly, possibly craze, and dust badly.** The use of fully compacted, low-slump concrete followed by the floating and trowelling operations at the correct times will avoid the production of an excessively thick layer of laitance, and result in a durable circle surface.

It is essential in the direct finishing of throwing circles that no floating or trowelling operations be commenced while bleed water continues to rise or remains on the surface. The incorporation of bleed water into the surface layer will significantly increase the water-cement ratio of the concrete in that surface layer, resulting in a weakened surface prone to dusting.
The use of a mixture of cement and stone dust (known as driers) to absorb bleed water will also produce a very poor wearing surface, and this practice should not be permitted in the finishing of the circle surface.

Once the surface has stopped bleeding and the concrete mix does not stick to the palm of the hand when placed on the surface then finishing can commence. Once the mix starts to harden it will occur very quickly and will be then difficult to finish. Keep a careful eye on the surface following initial laying.

The surface of the circle should be finished with a steel float to an almost polished marble finish, this will ensure the surface lattice is well compacted and surface air concrete ratio is reduced to a minimum, leaving a hard, durable, frost resistant surface that should provide many years of pleasure.

A practical test to check the readiness for each trowelling operation is to press the palm of the hand onto the concrete surface. If mortar sticks to the palm when the hand is taken away from the surface, the concrete is not yet ready for trowelling.
NOTE :
The finishing of a circle should not be rushed as the final trowelling of the surface may be 0.5 to 1 hour after setting the final surface (depending on the weather conditions). Ensure allowance is built into the contract or find someone who is competent to complete the work once the circle is laid. Most contractors are wanting to move on to the next job as waiting around for cement to go off costs money and they will trowel it off to any finish if not carefully supervised.

3.2. Etching the Surface

A polished marble finish is obviously not suitable for throwing off as the friction coefficient is too low.

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NOTE :
The circle should be allowed to harden for 2 – 4 weeks before carrying out this procedure depending on drying conditions

Using brick and mortar cleaner (hydrochloric acid based), which can be purchased from most builders merchants the surface of the circle can be etched to give the desired traction surface for throwing.

Picture shows how the top surface is removed with acid to reveal finished throwing surface. Top section of the photo shows the small granite chips exposed following single acid

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Pour splashes (100 – 150mm in diameter) of acid across the surface of the circle and using an old rag evenly distribute the acid over the throwing surface.
The circle surface will fizz and emit rotten egg smell as the acid reacts with the lime in the cement.
Leave the surface fizzing for around 20 -30 seconds or until the fizzing has stopped rinse the circle with cold water. Any remaining acid is diluted or quickly neutralizes with the cement lime.
If in doubt of how much to use, have a practice in an area of the circle not used by the throwers or take advise from someone in the building trade, as they use this product on a regular basis and are familiar with the hazards and precautions.

Give the circle a good brushing and use for a couple of weeks. If the surface is too quick give it another quick acid wash until the desired surface is achieved. Once the dark gray granite chips start to show further acid washing is not normally required.

3.2.1. Safety Precautions for Using Acid

- Ensure the manufacturers safety guidelines are followed
- Wear protective overalls or old clothing
- Wear eye protection
- Wear rubber gloves – a pair of domestic rubber gloves sold in supermarkets are ok – rinse well or dispose of after use

Before starting this work position a bucket of water adjacent to the circle to be used in emergency to quickly remove any splashes to the skin or clothing.

4. Replacing Circle Surface

4.1. Removing old surface

If the circle structure is of solid construction and there is substantial support around the outside of the circle then the center concrete may be removed to a depth of 80mm and the surface replaced.
The inner concrete is likely to be very hard if it has been down for a few years.

The best method of removal is to hire a hydraulic concrete breaker similar to the one shown in the photograph.
Follow the tool hire companies recommended safety precautions including protective footwear, goggles and hearing protection.

Work from the middle and nibble away at the concrete – Do not drive the breaker deep into the concrete in one go as you run the risk of cracking the slab.

4.2. Surface Construction

Once the required depth has been achieved brush out the dust and debris from the removal operation. Take your time to remove as much as you can as this will provide a solid bond for the new surface.

Soak the surface of the base concrete with water and allow to soak in. Brush any remaining puddles around until there is no standing water. Coat the wetted surface with a proprietary bonding agent or diluted external PVA glue.
Mix sufficient C20 concrete mix to level the surface to 40mm below the top of the rim (See Table 3)
Once the C20 mix has stopped bleeding, mix and apply the granolithic top coat (see from Item_16 Appendix 4 Procedure for Laying Circle). The granolithic mix can be used to complete all this work in one go but will be more expensive.

4.3. Minor Repairs

Minor repairs can be carried out to the throwing surface using Granolithic concrete.

Using a hammer and cold chisel remove the damaged area to a depth of around 25mm. This will allow good bonding and provide a longer lasting repair.

Mix an amount of granolithic concrete mix enough to effect the repair see section 2.9. If the damage area is not large then remove the larger granite chips by hand from the Granodust to be used in the mix before adding the water.
Apply a coat of proprietary concrete bonding agent to the damaged surface, there should be no puddles of bonding agent left in the hole. Avoid getting bonding agent on the throwing surface as this will make the area slippery when wet.

Using a steel float apply the Grano mix to the damaged area. Leave until surface water has dispersed and then polish off the repair area with a steel float. If it is a hot day do not allow the mix to dry too quickly by covering the area with damp cardboard or cloth.

Allow a week to harden and then etch the surface of the repair with acid (see section 3.2).

Table 1

Equipment Required

Item Description	Nos	Use
Shovel	**1**	General removal of rubble
Spades	**2**	Excavation of the hole (as above). Excavator may be used for the removal of soil
Steel Float	**1**	Required for finishing the circle surface and leveling
Wheelbarrow	**1**	Required to hump stuff about. May require two if getting ready mix
Claw Hammer	**1**	Knocking nails in and removing them when you have knocked in the wrong place
Cross head Screw driver		Screw in the screws and used as a spike for marking out the sector
String line	**2**	One for aligning the sector and the other for aligning the perpendicular centre line across the centre of the circle
30m tape	**3**	3 tapes makes it easy for marking out the sector at 20 x 20 x 12 – you can manage with three people by pinning the two ends of two tapes at the proposed centre of the circle with the screw driver. Tapes run out to 20m. Use the third tape pulled out to 12m to form the base of the triangle. The person that uses the second shovel can order the people on the ends of the tapes about until the desired position of the sector is found
5m tape	**1**	General measuring during construction work
Hand saw	**1**	Used to adapt the bits of wood to fit
Pencil	**2**	One to use and the other spare because you always lose one
Knife	**1**	Sharpen pencil
Buckets	**2**	You always need water – one old bucket to be used for measuring the aggregate
3’ Spirit level	**1**	To check the level of the shuttering and circle rim when installing.
Cement mixer	**1**	For doing the hard work

Table 2

Materials Required

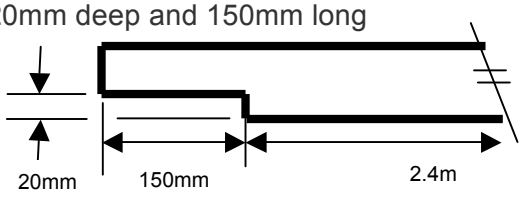
Item Description	Nos	Use
4" flat head nails	**16**	4 nails required to knock in the top of the stakes used to mark the centre lines of sector and centre line of circle 8 to be used for constructing the shuttering 4 to be used to maintain the alignment of the shuttering
2 1/2 " No 10 cross head wood screws	**20**	To secure the shuttering to the ground stakes
25 x 100mm x 2.4 m timber	**2**	Shuttering internal side panels
25 x 100mm x 2.6 m timber	**2**	Shuttering external side panels
25 x 20mm x 1m Wooden lathes	**3**	2 Used to maintain the shape of the shuttering + spare as it may not be right first time
50 x 50 x 600mm stakes	**8**	Used to secure the shuttering timber 1 in each corner and an extra one available for each side
50 x 50 x 300mm stakes	**4**	Centre line markers – to be placed 2 – 5m from the edge of the excavation
50 x 150mm x 3m Wooden Baton	**1**	Allow the centre of the circle to be reached during skimming
House Bricks	**5**	Two to rest the wooden baton on during skimming, Two extra bricks in case the builder is overweight and one brick is not high enough –
Plastic or Plywood sufficient for a 4m x 4m area	**1**	To be laid on the ground either to protect from the dumping of the ready mix or used to protect the mixing area
Throwing circle discus rim	**1**	
25mm plastic conduit	**1m**	To be used for drain holes if desired
Water supply	**1**	Used for mixing the cement and making juice on a hot day and a brew of tea if there is a kettle handy
Wacker Plate	**1**	Consolidate the sub base
Tamping plank	**1**	Plank of wood 2.7m for leveling circle Check fro straightness of the plank by lining up the eye along the length of the plank. The plank should have the appearance of a squashed T by cutting a piece off each end 20mm deep and 150mm long 

Table 3

Concrete Volumes and Ingredient Weights

Method One	**Volume**	
C20 Concrete	(2.7m x 2.7m x Depth 0.21m) – (Granolithic mix and rim depth) = 1.53 m^3 – $(2.5 / 2)^2$ π x 0.06m = 1.44m^3	1.44$m^3$1m^3 of concrete requires 2592 kg ballast 504 kg of cement
Method Two		
Hardcore		1500Kg chalk or crushed concrete
C20 Concrete	(2.7m x 2.7m x Depth 0.16m) – (Granolithic mix and rim depth) = 1.17 m^3 – $(2.5 / 2)^2$ π x 0.06m = 1.08m^3	1.08m^3 of concrete requires 1944 kg of ballast 378 kg of cement
Throwing Surface		
Granolithic Concrete 40mm thick	$(2.5 / 2)^2$ π x 0.04m = 0.2m^3	0.2 m^3 of Granolithic mix 286 kg of Granodust 48 kg of Sharp Sand 96 kg of cement
Circle Repair		
Following removal of 80mm depth of concrete from within the rim of the circle a 40mm base coat of C20 concrete will be laid before laying the Granolithic surface as above	$(2.5 / 2)^2$ π x 0.04m = 0.2m^3	0.2m^3 of concrete requires 360 kg of ballast 70 kg of cement

Appendix 4

Procedure For Laying The Circle

1. Set out the circle following details in section 2.1 of this procedure.
2. Construct the shuttering box as detailed in section 2.5 of this procedure.
3. Lay the box in the proposed circle position and align with the sting lines.
4. Mark the limits of the excavation.
5. Remove the string lines and the shuttering box.
6. Excavate the hole to the required depth.
7. Install shuttering as detailed in section 2.5 to desired finished level check the fall away from the circle to the surrounding ground.
8. Verify correct orientation with sector using string lines.
9. If ground is solid and method 2 (thinner concrete on sub base) is used tip hardcore into excavation and consolidate down using Wacker plate. Carry out this operation in two layers for best effect.
10. Place C20 concrete (either ready mix or as per hand mix see section 2.8) in the excavation to a level such that the rim of the circle is just above the finished shuttering level 6mm max.
11. Install the rim into the centre of the square shuttering check for level using a straight piece of wood and the spirit level – check in several orientations.
12. Continue to fill the perimeter between the shuttering and the circle rim.
13. Fill the centre area of the circle to within 60mm of the top of the rim of the circle.
14. Float off the area between the shuttering and the rim of the circle. If the rim is left a few mm proud of the shuttering this forms a fall away from the circle and reduces the damage to the perimeter concrete when leveling the centre.
15. Leave the centre of the circle a short while to stop bleeding water. Roughen the surface slightly to provide a better bond with the granolithic mix.
16. Lay the granolithic mix in the centre of the circle until the level is approximately 20mm ± 6mm from the top of the rim. Roughly level the mix with the steel float.
17. Using the notched tamping plank steadily work the mix with and up and down action to consolidate the surface and a rotational sawing action to set the correct level fill any low spots and gently re-tamp to get consistent level. Do not over tamp as you run the risk of forcing the rim further into the base mix.
18. When an even level has been achieved smooth over the surface to provide a flat finish. Do not work hard with the trowel at this time (see section 3.1). Working the surface at this time will lead to a loose dusty surface with poor wearing properties
19. Leave the centre circle until you can touch the surface with the palm of your hand and the surface fat does not stick to your hand. Using the wooden baton to allow access to the centre of the circle trowel the surface to a shiny finish using the steel float. If water comes to the surface leave the surface longer before retrying.
20. Cover the surface from rain or direct sunlight. Leave covered for a couple of days. Leave the surface a further three weeks to harden before etching with acid (see section 3.2) in preparation for use.