



Track and Field Facilities Manual

2019 EDITION

TRACK AND FIELD FACILITIES MANUAL

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CHAPTER 1

GENERAL ASPECTS OF PLANNING

1.1 Competition Rules

1.1.1 COMPETITION RULES PUBLICATION

Track and Field athletics and its events of running, walking, jumping and throwing are governed by the Rules of World Athletics (“Rules”). Track designers should consult the Rules, Technical Regulations of the competitions as well as this Track and Field Facilities Manual (“Manual”), and take into account the level of competitions intended to be staged at the venue.

The Rules ensure equal conditions for competition and form the basis for standardisation and acceptance of the competition facilities.

1.1.2 TRACK AND FIELD FACILITIES MANUAL

In order to comply with modern standards of construction, World Athletics decided to publish this Manual in addition to the Rules. The Manual contains detailed and more clearly defined specifications for the planning and construction of Track and Field facilities than those contained in the Rules. The aim is to pay greater attention to technical and performance requirements of Track and Field facilities.

1.1.3 SUITABILITY FOR COMPETITION

In order to establish the suitability of a sports facility for competition, proof is required of fulfilment of the requirements listed in this Manual by reports and certificates testifying to the Construction Category, the observance of the measurements and, when relevant, the suitability of the synthetic surface.

1.1.4 WORLD ATHLETICS CERTIFICATION SYSTEM

A certification programme was introduced in 1999 based upon the goal that all facilities, synthetic surfaces, implements and equipment built for use in international competitions conform to World Athletics specifications and therefore guarantees the validity of the performances and the quality of the products.

It is World Athletics’ duty as the sport’s world governing body for athletics to ensure that all athletics items used in international competitions are of the requisite standard, manufactured in accordance with the World Athletics technical requirements and, most importantly, guarantee the safety of the athletes.

There has been a rapid development in the manufacture of athletics equipment over recent years, including implements and synthetic track surfaces, resulting in an increased number of products on the market. It also recognises the growing trend towards international standardisation of product specifications, as well as the need to prevent unauthorised usage of the World Athletics name.

Products with a World Athletics Product Certificate are not all of the same quality, even though they meet the minimum required specifications. The purchaser must make his own assessment of the product quality.

The Certification System Procedures are available on the World Athletics website (www.worldathletics.org) and from the Office of World Athletics (“Office”) upon request.

1.2 Use of Facilities

1.2.1 GENERAL

Sports facilities for Track and Field athletics are generally used for daily training as well as for staging regional or local competitions. The staging of competitions at higher levels normally entails more extensive requirements for the sports facility, particularly in respect of the infrastructure.

1.2.2 UNIFORM SPORTS FACILITIES

In order to ensure equal conditions for all athletes, uniform facilities are necessary, particularly since competitions are held in many different venues. Furthermore, the athletes need similar conditions for training that they will find in competition. This Manual has subdivided facilities into different Competition Categories (1.3) and Construction Categories (1.5) on the basis of competition requirements.

For training in training centres, for example, it is possible to deviate from a particular Construction Category by providing additional opportunities for training such as a special throwing field, two sprint tracks, and a special landing mat for High Jump or more individual facilities.

1.2.3 ADDITIONAL USE FOR SPORTING ACTIVITIES

It is normal for an athletics track to be used for other sports. Generally, this involves using the interior of the 400m tracks as a pitch for soccer, American football or rugby. Obstacle-free sports areas in the segments at the same level as the playing field, without kerbs over which sportspeople could stumble, can be included in the safety zones.

	Type of 400m Oval Track			
	Standard Track	Double Bend Track		
Figure	1.2.3a	1.2.3b	1.2.3c	1.2.3d
Radius (R)	R = 36.500	R1 = 51.543 R2 = 34.000	R1 = 48.000 R2 = 24.000	R1 = 40.022 R2 = 27.082
Straights	84.390	79.997	98.527	97.265
Rectangular Interior				
Width	73.000	80.000	72.000	69.739
Length	84.390	79.997	98.527	97.265
Dimension of Segment				
Width	73.000	80.000	72.000	69.739
Length	36.500	35.058	27.215	29.688

Table 1.2.3a - Dimension of interior of 400m Oval Track (in m)

The dimensions of the area necessary for these additional sporting uses are given in Table 1.2.3b. The dimensions which are provided in the interiors of the 400m Standard Track (Figure 1.2.3a) and of double bend tracks (Figures 1.2.3b and 1.2.3c) are shown in Table 1.2.3a. Other double bend tracks may be accepted. As sprinters may not like the smaller radii, the Technical Regulations of major competitions may stipulate that the track facility must be of a single radius bend construction, or if of a double radius bend design, the smaller radius may not be less 30.00m. In the case of double bend tracks in Figure 1.2.3d, the dimensions apply to American football only.

Sport	Pitch Size				Safety Zone		Total Standard Size	
	Under Competition Rules		Standard Size		Long Sides	Short Sides		
	Width	Length	Width	Length			Width	Length
Football (Soccer)	45-90	90-120	68	105	1	2	70	109
FIFA Matches	64-75	100-110	68	105	5	5	80	115
American Football ¹	48.80	109.75	48.80	109.75	1	2	50.80	113.75
Rugby ²	68-70	97-100	70	100	3.50-5	10-22	77-80	120-144

¹ In this case, athletics use may be hampered in the segment areas
² A slight rounding of the corners of the "touch down" areas by bending the segment arcs will be necessary

Table 1.2.3b - Field dimension of interior of 400m Oval Track when used for other sports (in m)

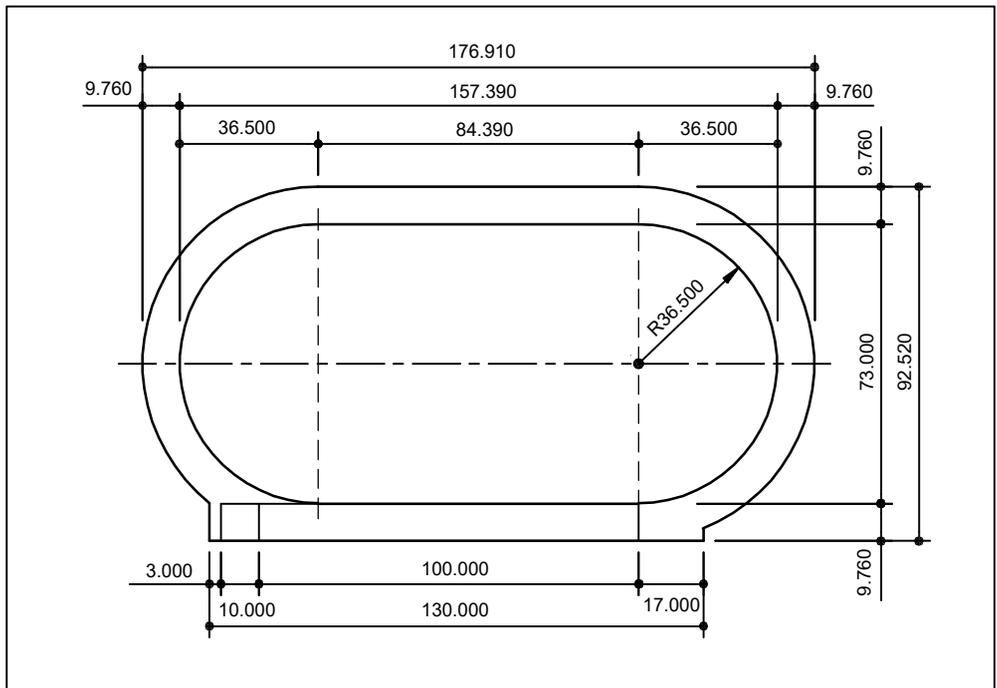


Figure 1.2.3a - Shape and dimensions of the 400m Standard Track (Radius 36.50m, planned length of circuit at running line 400.001m) (Dimensions in m)

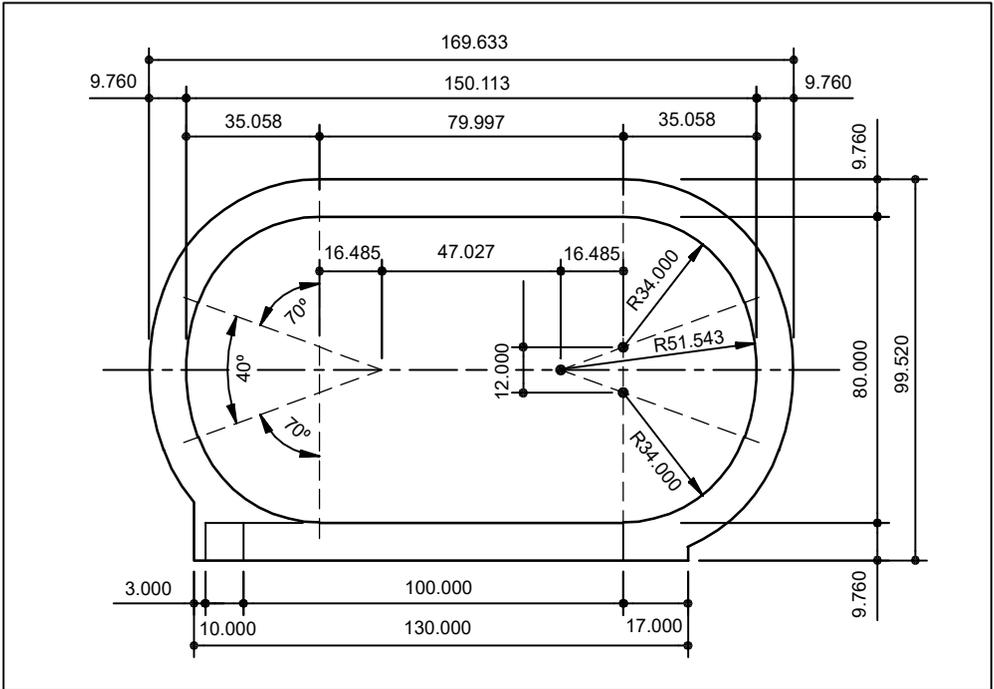


Figure 1.2.3b - Shape and dimensions of 400m Double Bend Track (Radii 51.543m and 34.00m, planned length of circuit at running line 400.002m)
(Dimensions in m)

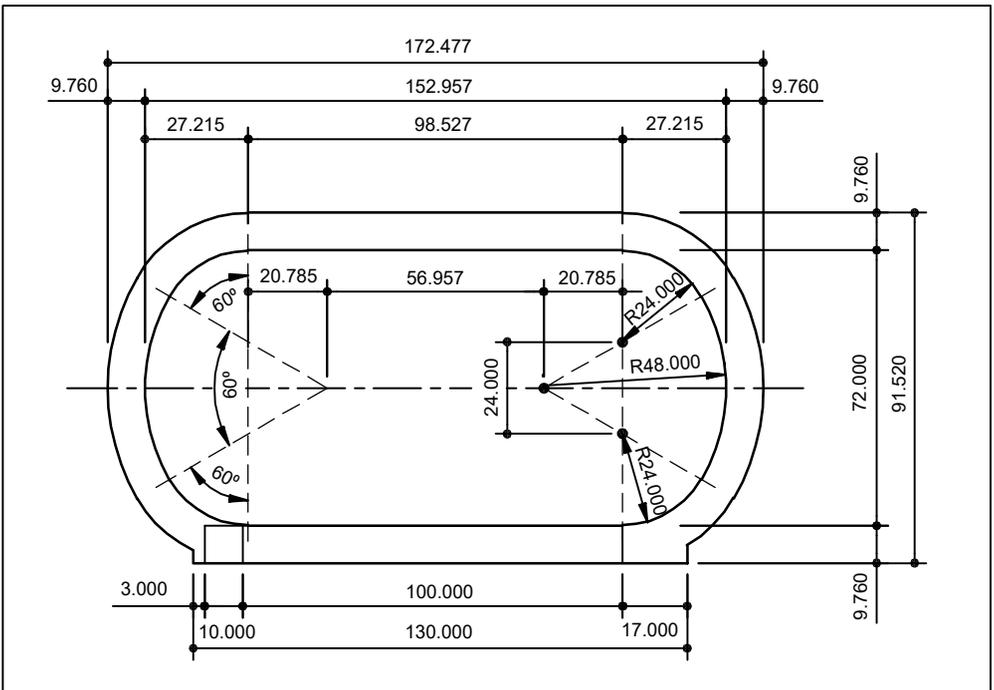


Figure 1.2.3c - Shape and dimensions of 400m Double Bend Track (Radii 48m and 24m, planned length of circuit at running line 400.001m)
(Dimensions in m) - NOT SUITABLE FOR MAJOR COMPETITIONS!

several days (for example, World Championships) or those which are concentrated within one or two days (for example, one-day meetings or international matches).

1.3.2 COMPETITION CATEGORIES

Table 1.3.2 provides an overview of the various Competition Categories. In the table, the approximate maximum number of athletes, competition officials and auxiliary personnel on the arena at any one time is given. (The “Event Management Guidelines – Infield” contains the recommended number of officials on the Field of Play for World Athletics competitions.) The total number of these type of people at a competition can be many times greater. The “Number of Days” column gives the approximate duration of an athletics meeting. For details of items I to V listed under "Recommended Construction Category", refer to Section 1.5. Finally, the last column states the authority responsible for allocation and technical control at the international, area, regional or national level, with the exception of the Olympic Games for which the IOC is responsible for allocation and various Group Games for which Group Associations have responsibility.

Competition Category	Event	Approximate Maximum Number of Participants at Any One Time			Duration of Competition Number of Days	Recommended Construction Category	Governing Body
		Athletes	Competition Officials	Auxiliary Personnel			
1	World Championships and Olympic Games	75	100	75	9	I	World Athletics, IOC
2	Area, Regional and Group Championships and Games	75	75	60	4 - 8	II	Area, Regional or Group Association
3	Continental / Regional / Area Cups	50	60	50	2	III ¹	World Athletics, Regional or Area Association
4	Matches	50	60	30	1 - 2	III	World Athletics, Area or National Federation
5	International Invitation Meetings specifically authorised by World Athletics	50	30	30	1	III	World Athletics
6	International Invitation Meetings specifically authorised by an Area Association	50	30	30	1	III	Area Association
7	Other Meetings specifically authorised by an Area or a Member and National Championships	75	60	30	2 - 4	IV	Area Association or National Federation
8	Combined Events	50	50	30	2	IV	As appropriate
9	Other National Competitions					V	National Federation

¹ Warm-up track must conform to Competition Category I

Table 1.3.2 - Competition Categories; number of athletes, officials and auxiliary personnel

1.3.3 OTHER COMPETITIONS

Each country may modify technical requirements in respect of domestic competitions.

1.4 Selection of the Venue

The venue is selected by the organisers. In addition to the Construction Category for the competition facility required for the respective competition, other factors of importance for the choice of venue are:

- The accessibility for international or national transport network
- The infrastructure
- Accommodation and care of participants (Also 1.7)
- Population catchment area so as to maximise spectators

1.5 Construction Categories

1.5.1 GENERAL

In addition to certification Classes, sports facilities for the staging of competitions at higher levels are subdivided into different Construction Categories. An early decision is needed on the appropriate Construction Category for the highest level of competition likely to be conducted on the facility. It may be possible to add additional warm-up facilities and Field Event facilities either temporarily or permanently at a later date, but sufficient space must be allowed for these in the early planning. The rating "Construction Category" is determined by the relevant governing body (Table 1.3.2). For this, confirmation of the suitability of the sports facility for competition is required which is documented by:

- A certificate confirming observance of the minimum requirements of the respective Construction Category (See 1.5)
- A certificate confirming observance of measurements for individual components of the sports facilities (See 2.1 to 2.5)
- A certificate confirming suitability of the synthetic surface
- In special cases, a certificate assuring quality in the manufacture of the synthetic surface (See Chapter 3)
- In some cases, a certificate for lighting may be necessary

1.5.2 CATEGORIES

In the light of the organisational requirements of the Competition Categories listed in Table 1.3.2, the following five Construction Categories for Track and Field facilities are recommended:

- Construction Category I for the Competition Category 1
- Construction Category II for the Competition Categories 2
- Construction Category III for the Competition Categories 3, 4, 5 and 6
- Construction Category IV for Competition Categories 7
- Construction Category V for Competition Category 9

1.5.3 REQUIREMENTS OF CONSTRUCTION CATEGORIES

The requirements of Table 1.5.3 are minimum requirements and the Technical Regulations of the specific competition should also be checked. For exceptions, see Section 1.5.4.

Item	Competition Facilities	Construction Category				
		I	II	III	IV	V
1	400m track as described under Chapter 2 with min. 8 oval lanes and 8 straight lanes for 100m and 110m Hurdles	1 ^{a)}	1 ^{a)}	1 ^{a)}	-	-
2	400m track as item 1, but with min. 6 oval lanes and 6 straight lanes for 100m and 110m Hurdles	-	-	-	1 ^{b)}	-
3	400m track as item 1, but with min. 4 oval lanes and 6 straight lanes for 100m and 110m Hurdles	-	-	-	-	1 ^{b)}
4	Water jump for the Steeplechase	1	1	1	-	-
5	Long and Triple Jump facility with landing area at each end	2 ^{c)}	2 ^{c)}	1	2	-
6	Long and Triple Jump facility with landing area at one end	-	-	-	-	1
7	High Jump facility	2	2	1	2	1
8	Pole Vault facility with provision for landing area at each end	2 ^{c)}	2 ^{c)}	1	2	-
9	Pole Vault facility with provision for landing area at one end	-	-	-	-	1
10	Discus and Hammer Throw combined facility (concentric or separate circles but concentric is preferred)	1 ^{d)}	1 ^{d)}	1 ^{d)}	1 ^{e)}	1
11	Javelin Throw facility	2 ^{f)}	2 ^{g)}	2 ^{g)}	1	1
12	Shot Put facility	2 ^{c)}	2 ^{c)}	2	2	1
	Warm-up Facilities#					
13	400m track with min. 4 oval lanes and 6 straight lanes (similar surface to the competition track); jumping events facilities; separate combined throwing field for Discus, Hammer, Javelin Throw; min. 2 Shot Put facilities	*	-	-	-	-
14	Min. a 200m oval track with min. 4 oval lanes and 4 straight lanes (min. 60m), (synthetic surface), or min. a 100m straight and a training bend; facilities for jumping events; combined throwing field for Discus, Hammer, Javelin Throw; Shot Put facility	-	*	-	-	-
15	Min. 4 straight lanes (min. 60m) but preferably also including a training bend with (synthetic surface); jumping events facilities; combined throwing field for Discus, Hammer, Javelin; Shot Put facility	-	-	*	-	-
16	Adjacent park or playing field preferably with min. 4 straight lanes (min. 60m)	-	-	-	*	-
17	No warm-up facility	-	-	-	-	*
	Others					
18	Ancillary rooms as described in Chapter 4 with area of min. m ²	250	200	150	200	-
19	Full facilities for spectators	*	*	*	*	_*
^{a)} As part of an IAAF Certified Facility (but preferably a 400m Standard Track) ^{b)} As part of an IAAF Certified Facility ^{c)} The two facilities must be in the same direction and should be adjacent to allow simultaneous competition by two groups of athletes with similar conditions (as per Figure 2.5a) ^{d)} An additional Discus only facility may also be provided ^{e)} For large events, a second facility outside the stadium but in the same throwing direction is desirable ^{f)} One at each end of the area and minimum runway length 33.5m ^{g)} Preferably, within the same sports complex, adjacent to the competition facility, however, there is no maximum limit in distance set. If a facility is being considered for a major international event, the location and standard of the warm-up facilities will be assessed by the relevant governing body. *Required						

Table 1.5.3 - Requirements of the Construction Categories

There is a trend towards some sports that normally use the infield of athletics arenas, preferring synthetic surfaces on which to play their sport. These synthetic surfaces are generally not suitable for the throwing of athletics implements because they are damaged by the implements and/or a satisfactory mark is not made on the synthetic surface so that the judges can determine the first mark made by the fall of the implement. A few synthetic surface materials have been developed for which it is claimed that the surfaces can be used for football as well as for all athletics throwing events. Anyone thinking of installing such a surface should consult with the local athletics and football federations and, if necessary, World Athletics before making a final decision. The highest Construction Category possible for an arena that does not have all the requisite throwing facilities on the main arena is Construction Category III, if complying throwing facilities are provided within the same sports complex.

The highest Construction Category possible for an arena with a double bend radius less than 30m, or if the radius to and from the inside water jump is less than 10m, shall be Construction Category V.

The requirement for Construction Category V for the 110m Hurdles starting area is 2.5m min., for other Construction Categories, 3m min.

The World Athletics markings and colour codes must be complied with for certification of Construction Category IV and above.

1.5.4 EXCEPTIONS

For specific competitions, the Technical Regulations shall determine the specific requirements for the competition including training and warm-up facilities. In agreement with the appropriate athletics authority, the organisers of a competition may make exceptions to the respective Construction Category.

1.6 Demand for Sports Facilities

1.6.1 GENERAL

The demand for sports facilities in a town or rural district depends on:

- The current sporting activities of the population
- The sporting interests of the population
- The appeal of opportunities for sporting activities and the way they are organised
- The existing sports facilities

1.6.2 SPORTING ACITVITES OF THE POPULATION

The individual's sporting activities depend on age, profession, financial situation and the local opportunities for sporting activity. The sporting activities of the population as a whole are thus dependent on the organisation structures (school sports, sports for all, competitive sports and leisure sports) and on access to the relevant sports facilities.

1.6.3 UTILISATION CAPACITY OF SPORTS FACILITIES

The degree of utilisation capacity of a sports facility depends on:

- The time available for use in hours per week in terms of the effects of the weather and periods of maintenance
- The time of day and day of the week of possible utilisation in relation to the user's age and profession
- The design of the sports facility with respect to varied sports use and the simultaneous practice of different sports
- The organisation of sports activities with respect to the persons supervising the sportspeople and sports facilities

1.6.4 DEMAND BASED ON REQUIREMENTS AND SUPPLY

The demand for sports facilities is derived from the balance of sporting activities of the population and for physical education on the one hand and the utilisation capacity of the existing sports facilities on the other. Demand does not have to be met alone in the form of additional sports facilities at new locations. It can also be covered by reconstructions, further developments, extensions, reallocation of use or intensification of use. This requires intensive checking and assessment of the existing sports facilities and their degree of utilisation as well as an investigation of the existing and future requirements for sports of the population. Here it is important not to forget that the respective sporting activities of the population are also subject to the publicity appeal of the local or regional sports federations and that the housing development structure with its population density may reduce or increase the demand on account of problems of distance (distance between home and sports facility) necessarily associated with this.

1.6.5 BASIC SPORTS FACILITIES

Track and Field athletics are counted among the basic disciplines of most sport and, in addition to spaces for ball games, constitute an obvious component of the sports facility structure. Facilities for running, jumping and throwing therefore are necessary on every sports ground of basic supply and on every school sports facility. However, the demand for them, subject to the utilisation structure and to the frequency of use, differs from country to country.

It is recognised that communities' health is improved by healthy exercise either in organised sport or individual physical activity. Running, jumping and throwing are natural activities for all people but particularly for younger people who have to develop their locomotion skills as well as hand and eye coordination.

1.6.6 KEY SPORTS FACILITIES

Track and Field facilities are usually designed as multi-purpose facilities (tracks with playing fields inside). They may be used for sports other than Track and Field events (See 1.2) and therefore constitute key sports facilities.

They should be located in areas with a larger population density and serviced by an effective transport network.

1.6.7 PLANNING SPORTS FACILITIES

A business plan should be developed in order to justify fully the construction of new sports facilities or improvement of existing facilities. The plan will be an important document for seeking funding.

The business plan might include the following components:

- A needs analysis identifying potential users from clubs, schools and higher education institutions etc. for Track and Field competition, and training with usage patterns and times of usage as well as for other sports users.
- A commitment to sustainable building design that recognises the need for reducing carbon emissions and more efficient use of resources.
- A sustainability plan which addresses energy and resource conservation in design and construction in line with the World Athletics Green Project.
- An operational plan that identifies the type of management structure that will be responsible for the day to day operation and maintenance of the facility. The manager could be a single club, a multiple user management committee or an external management authority such as a municipal, state or national body.
- Costing based on an outline brief would include:
 - Consultants' fees
 - Civil engineering work including the synthetic surface
 - Building costs
 - Athletics equipment
 - Operation and maintenance costs on a life cycle basis
- A funding analysis identifying possible capital sports funding sources such as federal, state and/or municipal authorities, philanthropic trusts, and private donations that may attract taxation concessions. Projected use charges will determine whether the cost of operation and maintenance can be funded by users or whether supplementary funding will be required from an external source.

It would be appropriate to have the business plan prepared by a consultant who would interview all the potential stakeholders.

1.7 Location of the Sports Facility

1.7.1 GENERAL

The location selected for a sports facility depends upon the demand as described under Sections 1.6.2 and 1.6.3, the population density within the catchment area and, above all, upon the availability of adequately large areas of land. It is precisely these relatively large spaces required for sports facilities which make the choice of location considerably more difficult in view of the overall shortage of available land in areas with high population densities. An early development of aims within the framework of area and regional planning and early securing of suitable space is therefore necessary. Only in this way will it be possible to supply sports facilities which both meet demand and are suitably located.

1.7.2 SIZE OF LAND

The size of the land shall be at least twice as large and, if possible, three times as large as the required net sports area in order to be able to accommodate suitably landscaped areas between the sports spaces. Only in this way can the desired integration of the sports facility into housing developments and the surrounding natural environment be guaranteed.

1.7.3 SOIL CONDITIONS

Prerequisites for economic construction, operating and maintenance costs are adequate load-bearing soil conditions with maximum possible permeability and a topography which is as level as possible because of the need for large horizontal areas for sport. Filled ground can be very expensive to excavate and recompact to meet the required foundation conditions for a facility. For the foregoing reasons, a geotechnical investigation of the site is recommended.

1.7.4 MICROCLIMATE

A favourable microclimate free of troublesome wind, fog and temperature extremes is particularly important for the optimal use of outdoor facilities for sports.

1.7.5 ENVIRONMENTAL CONDITIONS

The environmental conditions, which are of special importance for outdoor sports facilities, shall be balanced to ensure either that no troublesome smells, noises, vibrations or dust nuisances will occur, or that measures of protection can be implemented to prevent them. Neighbourhoods sensitive to the effects of lights and noise (vehicles, spectators, sports apparatus, floodlighting) should be avoided or only accepted if suitable measures for protection are implemented. The impairment to, or destruction of, natural or typical elements of the landscape (including biotypes) must be precluded or suitable measures must be implemented to compensate for this.

1.7.6 TRANSPORT NETWORK

An adequate and economically justifiable transport network, including necessary parking spaces, must be feasible. Consideration must be given to the parking requirements of both private and public transport, and sufficient spaces should be allocated to each.

The extent of the provision of public transport (e.g. buses, trains) will determine the area needed for parking for private vehicles (e.g. private buses, cars, motorcycles).

In addition to parking spaces for VIPs, press, athletes, competition officials, auxiliary personnel and attendants, there should be one car parking space, (approx. 25m²) for every four spectator spaces or, in the case of an optimal public transport network, 25 spectator spaces and one bus park (approx. 50m²) for every 500 spectator spaces.

1.7.7 SUPPLY AND WASTE DISPOSAL

Adequate and economically justifiable systems of supply for water, energy, telecommunications and waste disposal must be feasible.

1.8 Safety of Spectators and Athletes

1.8.1 CIRCULATION

A strict division of the circulation systems for spectators and for athletes is of particular importance to the safety of the athletes. For facilities with larger spectator capacities, a separation system between the spectator and the sports areas is essential. (Figures 1.8.1a and 1.8.1b)

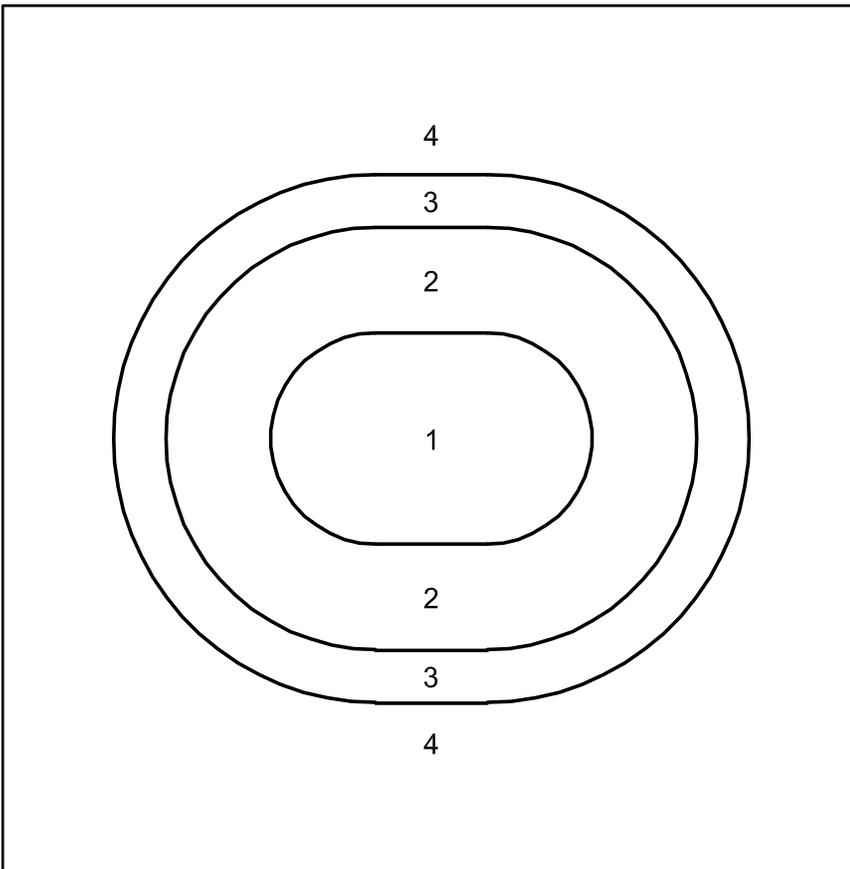


Figure 1.8.1a - Subdivision into zones

- 1 Central sports / events area
- 2 Spectator area
- 3 Perimeter zone
- 4 Approach / public area

Source: *Planning Principles for Sportsgrounds / Stadia, IAKS Series Sports and Leisure Facilities No. 33*

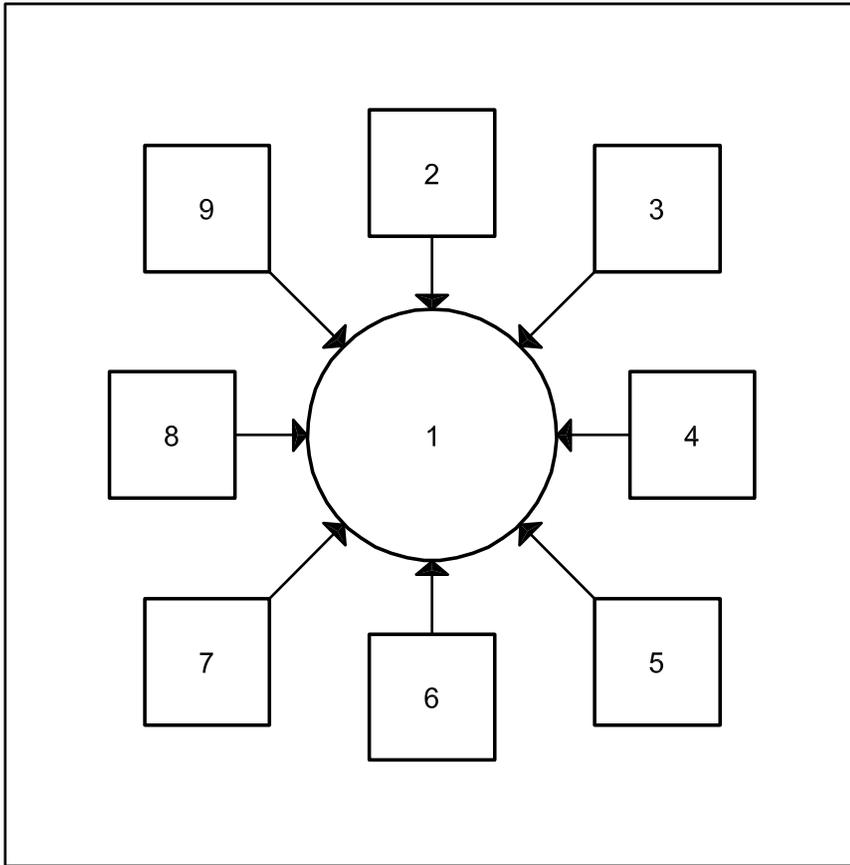


Figure 1.8.1b - Subdivision into individual sections

- 1 Sports / event area
- 2 Sports participants
- 3 Leisure-orientated users
- 4 Persons involved in non-sporting events
- 5 Spectators
- 6 Media
- 7 Event organisation
- 8 Stewards and security services
- 9 Administration maintenance

Source: Planning Principles for Sportsgrounds / Stadia, IAKS Series Sports and Leisure Facilities No. 33

1.8.2 SAFETY MARGINS

Due to the integration of various facilities for sports into one large complex, which is common today and necessary for economic reasons, the provision of certain safety margins between areas for individual disciplines of sports to preclude any dangerous activities, has become particularly important. The same also applies to the keeping of safety areas free from obstructions of all types. Organisers as well as officials, judges and athletes must pay very special attention to these aspects.

The safe conduct of Track and Field events is addressed in Chapters 2 and 3.

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CHAPTER 2

COMPETITION ARENA

2.1 General Remarks

Track and Field athletics include competition areas for running, walking, jumping and throwing events. These are normally integrated into an arena, the design of which is dictated by the 400m oval track. The competition areas are first dealt with individually and then regarding their integration into the arena.

The dimensions given are to be adhered to. Permissible deviations are given as tolerances (+ or ± or –) after each figure. All linear measurements and levels shall be made to the nearest whole mm.

This Manual stipulates dimensions and equipment for international and other high- class competition by elite athletes. For club and school competitions, the dimensions of Horizontal Jumps landing areas, distance to take-off boards, the lengths of runways, dimensions of landing areas etc. may be reduced. The safety of athletes must be paramount in making such decisions. If you are in doubt as to what is appropriate, consult your national athletics federation.

The additional requirements / facilities that may be required for para-athletics (competitions for athletes with a disability) are not covered specifically in this Manual and may be obtained from the International Paralympic Committee (IPC) or those national federations which have para-athletics programmes.

The design principles hereunder should also apply to temporary facilities constructed for one-off competitions for one or more Track and/or Field Events. See also 8.3.1.3 for additional information for portable indoor tracks.

It is expected that the facility owner will engage a professional engineering consultant to design and supervise the new construction. It is the responsibility of the consultant to ensure that all phases of the construction will meet the final surface tolerances specified hereunder. In particular, the supervising consultant will ensure that the tolerances of thicknesses and evenness of the various layers of construction are met. The evenness achieved in the synthetic surface will also be checked by the surveyor undertaking the Measurement Report.

2.1.1 TYPES OF COMPETITION FACILITIES

Construction details for demountable facilities used outdoors are as detailed in Chapter 8.

2.1.1.1 Track Events

The Competition area for Track Events includes:

- Oval track with at least 4 lanes ($400\text{m} + 0.04\text{m} \times 1.22\text{m} \pm 0.01\text{m}$) and safety zones measuring not less than 1.00m on the inside and preferably at least 1.00m on the outside.

- Straight with at least 6 lanes ($100\text{m} + 0.02\text{m} \times 1.22\text{m} \pm 0.01\text{m}$ for sprints and $110\text{m} + 0.02\text{m} \times 1.22\text{m} \pm 0.01\text{m}$ for hurdles).
Starting area: 3m min. (for 110m Hurdles, Construction Category V: 2.5m min.).
Run-out: 17m min.
- Steeplechase track as for oval track with a permanent water jump ($3.66\text{m} \times 3.66\text{m} \times 0.50\text{m} \pm 0.05\text{m}$) placed inside or outside the second bend.

2.1.1.2 Jumping Events

The competition area for Jumping Events includes:

- Long Jump facility with runway ($40\text{m min.} \times 1.22\text{m} \pm 0.01\text{m}$ except for major international competitions where the minimum length shall be 45m), take-off board ($1.22\text{m} \pm 0.01\text{m} \times 0.20\text{m} \pm 0.002\text{m} \times 0.10\text{m max.}$), placed between 1m and 3m from the nearer end of the landing area, and the landing area 2.75m min. wide with the far end at least 10m from the take-off line, but at least 11m if the facility is used for major international competitions.
- Triple Jump facility as for Long Jump except for a take-off board placed 13m min. for men or 11m min. for women from the nearer end of the landing area for international competitions. For any other competition, this distance shall be appropriate for the level of competition. The far end of the landing area shall be at least 21m from the take-off line for men.
- High Jump facility with a 16m minimum width runway (radius 15m min. except for major international competitions where the minimum length shall be 25m but preferably longer) and landing area ($6\text{m} \times 4\text{m min.}$).
- Pole Vault facility with a runway ($40\text{m min.} \times 1.22\text{m} \pm 0.01\text{m}$ except for major international competitions where the minimum length shall be 45m), a box for inserting the pole ("planting box") and landing area ($6\text{m} \times 6\text{m min.}$) with an additional forward extension (2m min.).

2.1.1.3 Throwing Events

The competition area for Throwing Events includes:

- Discus Throw facility with throwing circle ($2.50\text{m} \pm 0.005\text{m}$ diameter), protective cage and landing sector (80m radius, 48m chord)
- Hammer Throw facility with throwing circle ($2.135\text{m} \pm 0.005\text{m}$ diameter), protective cage and landing sector (90m radius, 54m chord)
- Javelin Throw facility with runway (30m min. $\times 4\text{m}$), arc with a radius of 8m and landing sector (100m radius, 50.00m chord)
- Shot Put facility with throwing circle ($2.135\text{m} \pm 0.005\text{m}$ diameter) stop board ($1.21\text{m} \pm 0.01\text{m} \times 0.112\text{m} \times 0.10\text{m} \pm 0.02\text{m}$) and landing sector (25m radius, 15m chord)

2.1.2 POSITIONING FOR COMPETITION

2.1.2.1 Standard Positions

When installing all Track and Field facilities, careful consideration must be given to the position of the sun at critical times of day and the prevailing wind conditions.

To avoid the dazzling effect of the sun when it is low, the longitudinal axis of arenas should lie along the north-south axis, although it is possible to deviate to the

north-north-east and north-north-west. That said, there are very successful stadia which are oriented east-west because of topography and the prevailing breeze being from the west.

The strength and direction of local winds should also be taken into consideration. This may result in the main straight being on the eastern side of the arena and, consequently, will require consideration of the effects of a western setting sun on the spectators in the main stand. However, the most important aspect of design is to ensure that the best possible competition conditions are provided for the athletes.

2.1.2.2 Exceptions to Standard Positions

Departures from the standard positions for specific facilities (e.g. High Jump, Pole Vault) are permissible, if the stadium is situated in a location where the sun's rays do not reach those facilities, or the facility is fully enclosed.

Where deviations from the standard positions are necessitated by the local conditions (e.g. steep hill position, unfavourable layout of the land, existing developments), any possible disadvantages this may cause the athletes must be carefully considered.

Particularly serious disadvantages may necessitate the selection of an alternative site.

2.1.2.3 Positioning of Spectator Facilities

Spectator facilities should, if possible, be positioned to face east but also see above. Where there are two stands opposite each other, or all-round spectator facilities, this shall apply to the main stand.

2.1.3 GRADIENTS FOR TRACK, JUMPING AND THROWING EVENTS COMPETITION AREAS

2.1.3.1 Track Events

For the competition area for Track Events the following maximum overall gradients shall apply:

- 1:1000 (0.1%) downward, in the direction of running. Should the gradient of the sprint track as part of a Standard Track vary, the inclination is measured in a straight line between start and finish line for each event.
- 1:100 (1.0%) across the width of the track towards the inside lane, unless special circumstances exist which justify World Athletics providing an exemption. The transverse gradient (lateral inclination) is primarily to ensure quick drainage of rainwater from the track surface. In very dry desert climates, it might be appropriate for the track to be flat. To ensure that, because of construction inaccuracies, the gradient does not exceed the maximum allowable, it is strongly advised that the design gradient be made slightly less than 1.0%.

2.1.3.2 Jumping Events

For the competition area for Jumping Events, the following maximum overall gradients shall apply:

- In the last 40m of the runway, 1:1000 (0.1%) downward in the running direction

for Long Jump, Triple Jump and Pole Vault. Should the gradient of the competition area as part of a Standard Track vary, the inclination is measured in a straight line for 40m from the take-off line or the back end of the box.

- In the last 15m of the runway, 1:167 (0.6%) downward in the running direction for High Jump along a 15m radius of the 16m wide runway area centred midway between the uprights. (The Rules state that an athlete's approach to the High Jump should be up the inclination.)
- 1:100 (1.0%) across the width of the runway for Long Jump, Triple Jump and Pole Vault unless special circumstances exist which justify World Athletics providing an exemption.

2.1.3.3 Throwing Events

For the competition area for Throwing Events, the following maximum overall gradients shall apply:

- In the last 20m of the runway, 1:1000 (0.1%) downward in the running direction for Javelin Throw.
- 1:100 (1.0%) across the width of the runway for Javelin Throw.
- 1:1000 (0.1%) downward in the throwing direction for Shot Put, Discus Throw, Javelin Throw and Hammer Throw landing sectors calculated along a straight line through the centre of the circle / javelin throwing arc to the lowest point in the landing sector at any particular distance.
- Circles for Shot Put, Discus Throw and Hammer Throw shall be approximately level.

2.1.4 ARRANGEMENT OF THE FACILITIES

When deciding upon the arrangement of facilities, consideration must be given to the necessary movement of athletes during competition. The routes between ancillary rooms and competition areas should be as short as possible and not interfere with events in progress. Since optimum arrangement is almost impossible for competition, the use of facilities must be well planned to ensure the most practical and safe conduct of the competition.

In the same manner, entrances to and exits from the arena must be planned. One exit must be located immediately after the finish line in order to bring the athletes out of the arena to the Mixed Zone and Post Event Area. Entrances should be placed in the other corners of the arena and, preferably, at the starts of sprint events to facilitate the entry of the athletes to the arena and to accommodate the preparation of the sites for competition.

Provision must also be made for transport of competition equipment and implements, and athletes' gear from start areas to the Post Event Area.

For the Marathon and other events taking place mainly outside the stadium, a suitable connecting passage linking the track with the road course must be provided. The slope of the passage should not be too steep as this will affect the athletes, particularly walkers. The passage should be wide enough to take the mass of athletes at the start of the Marathon and road Race Walk.

2.2 Facilities for Track Events

Track Events include sprint, middle and long distance, hurdle, steeplechase and Race Walking events. The direction of running and walking is anticlockwise. The 400m oval track usually forms the basis of a multi-sports arena. Its dimensions are, therefore, dependent on the requirements of other sports. When integrating the straight and the steeplechase into the oval track, deviations from Section 2.1.3 will arise in the longitudinal slopes in some areas.

Although there are a number of different layouts for the 400m oval track, it is World Athletics' objective to create uniform criteria, not only with a view to improving the performance parameters necessary for equal opportunities for all athletes and for the suitability for competition but also to simplify the principles of construction, surveying and certification of facilities.

Experience has shown that the most suitable 400m oval tracks are constructed with bend radii of between 35m and 38m, with an optimum of 36.50m. It is recommended that all future tracks are constructed to the latter specification and this will be referred to as the "400m Standard Track". A track with a single bend radius less than 33.50m and where the running line radius of the outer lane exceeds 50m (except where the bend is formed with two different radii, in which case the longer of the two arcs should not account for more than 60° of the 180° turn) will not be certified.

For further details, see 2.2.1 to 2.2.3. For details of other layouts for the 400m track, see 2.2.1.8.

2.2.1 THE 400M STANDARD TRACK

2.2.1.1 Layout (Figures 1.2.3a and 2.2.1.1a)

The 400m Standard Track has the advantages of a simple construction, straight and curved sections and uniform bends which are most suitable to the running rhythm of athletes. Furthermore, the area inside the track is large enough to accommodate all Throwing Events and also a standard football pitch (68m × 105m).

The 400m Standard Track comprises 2 semicircles, each with a radius of 36.50m, which are joined by two straights, each 84.39m in length (Figure 1.2.3a). The inside edge of the track must have a kerb around the bends and optionally on the straights, that should be coloured white, with a height of 0.05m to 0.065m and a width of 0.05m to 0.25m. The kerb on the two straights may be omitted and a white line 0.05m wide substituted. Under no circumstances may the entire kerb be omitted from the bends. Minimise the length(s) of temporarily removed kerb for Javelin Throw and High Jump competitions by having short lengths of kerb. Any kerb temporarily removed shall be limited to that required to conduct a particular Field Event and the kerb shall be replaced at the completion of the Field Event.

The inner edge of the track is 398.116m in length ($36.50\text{m} \times 2 \times \pi + 84.39\text{m} \times 2$). This length for the inner edge gives a length of 400.001m ($36.80\text{m} \times 2 \times \pi + 84.39\text{m} \times 2$) for the theoretical running line (measurement line) at a distance of 0.30m outward from the kerb or the painted white line if the kerb is omitted from the straights only. The inside lane (lane 1) will, therefore, have a length of 400.001m along its theoretical running line. The length of each of the other lanes is measured along a theoretical running line 0.20m from the outer edge of the adjacent inside lane (Figure 2.2.1.1b).

All lanes have a width of $1.22\text{m} \pm 0.01\text{m}$, including the 0.05m line on the outside (For tracks constructed before 1 January 2004, the lane may have a width of maximum 1.25m but when the track is resurfaced, the track shall be remarked with lanes 1.22m wide.) All lanes shall be of the same nominal width. The 400m Standard Track has 8, 6 or occasionally 4 lanes but the last is not used for international running competition. Nine is the maximum number of oval lanes that should be provided at a facility as otherwise there is too much advantage gained by the athlete in the outside lane in a

Length of parallel straights	84.390
Construction radius of semicircle bend (including the raised kerb on inside edge of track)	36.500
Radius of measurement line (running line) in lane 1 (0.30m outside raised kerb)	36.800
Length of each bend on construction line (kerb line)	114.6681
Length of each bend along running line (nominal measuring length)	115.6106
Length of oval track on construction line (kerb line)	398.1163
Length of oval track along of running line (nominal measuring length)	400.0012

Table 2.2.1.1 - 400m Standard Track set out measurement (Dimensions in m)

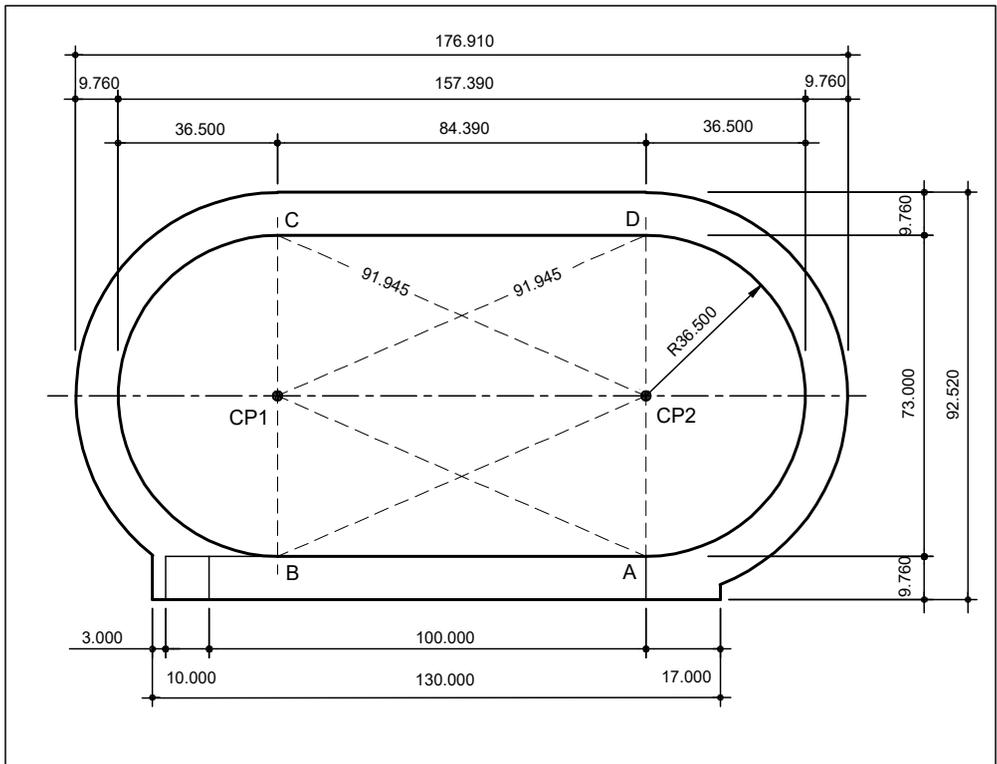


Figure 2.2.1.1a - Setting out plan and dimensions of the 400m Standard Track (Dimensions in m)

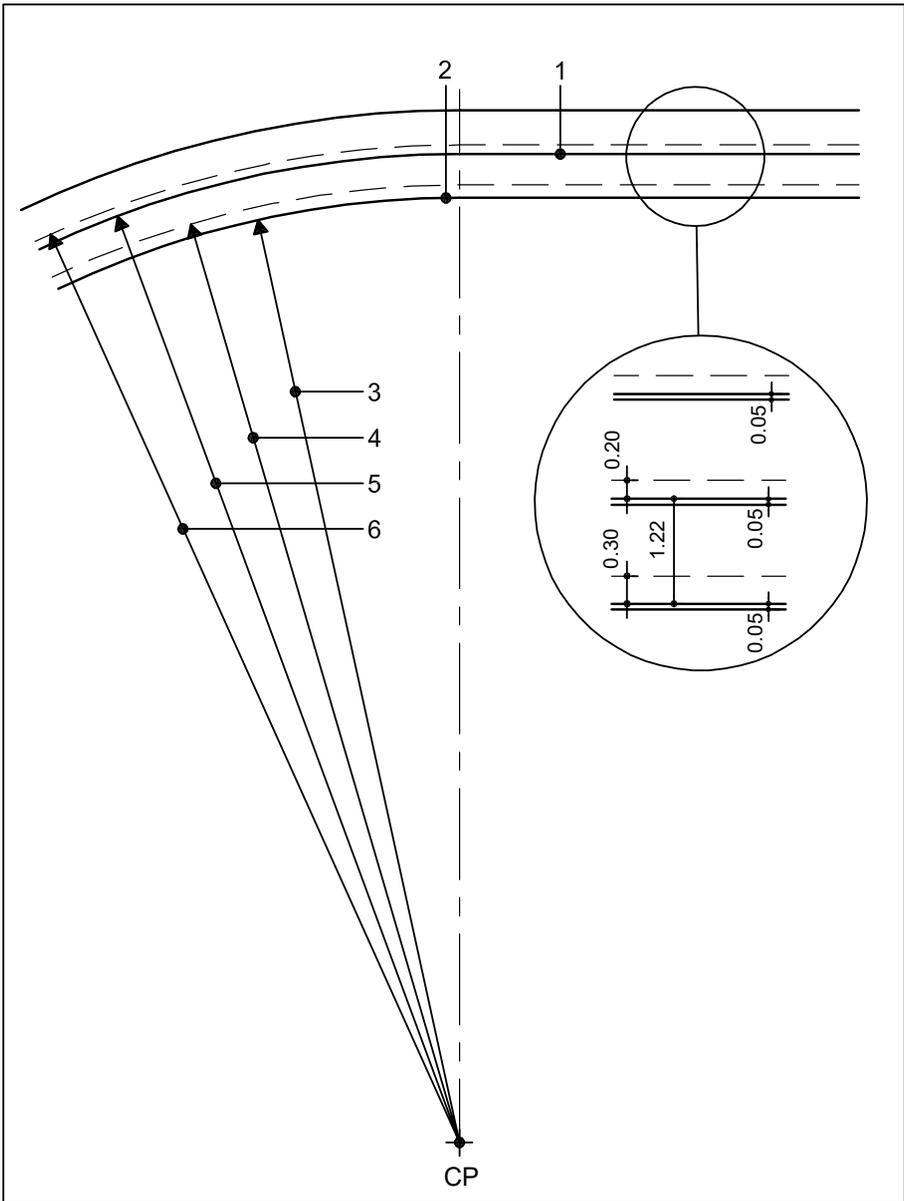


Figure 2.2.1.1b - Calculation of the track length of the 400m Standard Track (Dimensions in m)

- 1 Lane marking
- 2 Kerb
- 3 36.50m outside edge of kerb
- 4 36.80m running line lane 1
- 5 37.72m outside edge of lane marking
- 6 37.92m running line lane 2

Length of the 400m Standard Track	
2 straights of 84.3900m each	= 168.7800m
2 semicircle bends (running line) of 36.80m x π = 115.6106m each	= 231.2212m
	<hr/>
Total	= 400.0012m

200m race over the athlete in the inside lane. Further, the outside lane could infringe the World Record Rule that states “the Record for an oval Track Event shall be made in a track lane where the running line radius does not exceed 50m, except where the bend is formed with two different radii, in which case the longer of the two arcs should not account for more than 60° of the 180° turn” (see also 2.2). It is permissible to have any number of sprint lanes on the straights.

Normally, there should be one finish line for all Track Events which is the prolongation of diameter D-A (see Figure 2.2.1.4 a). However, if site limitations dictate, a separate finish line for the 110m may be marked not more than 10m past the normal finish line with a minimum 17m run-out past the added finish line.

A second sprint track may be provided, and it shall meet the same requirements for measurement and levels as the main sprint track.

Setting out the 400m Standard Track. Figure 2.2.1.1a

SETTING OUT PLAN AND DIMENSIONS OF THE 400M STANDARD TRACK (RADIUS 36.50M) (dimensions in m)

When determining the basic rectangle (A, B, C, D) with a currently calibrated measuring tape and a currently calibrated electronic distance measuring (EDM) instrument:

1. Distance between CP1 - CP2 (the centre points of the semicircles) using measuring tape: $84.390\text{m} \pm 0.002\text{m}$
2. Place one EDM on each of CP1 and CP2: angle $a = 25.9881$ gon;
CP1 - A or D and CP2 - B or C = 91.945m
3. A, B, C, D are in line with the inner track border.

When using tapes, the following points must be observed:

1. Standard steel measuring tapes only, with temperature equalisation table.
2. Immediately before and after measuring (position measuring tape with 50N tensile load for 30m tapes and 100N for 50m and 100m tapes), read temperature of measuring tape using a contact or infrared thermometer.*
3. Correct reading based on the temperature of the measuring tape and the temperature equalisation table.
4. In the absence of a temperature equalisation table: Calculate the change in length of the measuring tape caused by temperature using a reference temperature of 20°C as follows:
Temperature of the measuring tape in degrees Celsius of the deviation from 20°C \times length of the measuring distance in m \times 0.0115mm.
5. If the temperature of the measuring tape is more than 20°C, subtract the change in length of the measuring tape calculated from the reading or alternatively add it on, if the temperature is under 20°C.
6. Example:
Temperature of measuring tape 15°C and measuring distance 36.50m;
Change in measuring tape: $5 \times 36.50 \times 0.0115\text{mm} = 2.09\text{mm}$;
Increase reading of 36.500mm to 36.502mm.

*If an invar measuring tape (36% nickel content) is used, the temperature control may be dispensed with.

2.2.1.2 Gradients

The kerb of the 400m Standard Track must be laid horizontally throughout. For gradients, see 2.1.3.1. Local variations in inclinations are permitted on parts of the track.

2.2.1.3 Drainage

For drainage of the 400m Standard Track, see 3.3.

2.2.1.4 Dimensional Accuracy

The dimensional accuracy of the 400m Standard Track, required for all categories of competition, is deemed fulfilled if the following set values are attained in the "28-point control measurement" (Figure 2.2.1.4a) on the outside edge of the inner track border:

- 84.390m \pm 0.005m for each of the two straights (2 readings)
- 36.500m \pm 0.005m for 12 points per semicircle (including kerb) on the arc of the circle approximately 10.42m apart (24 readings)
- Alignment of the kerb in the area of the two straights: no deviations greater than 0.010m (2 readings). Ideally, the length of the kerb in the straight and the length of the outer lane measured along the outside edge of the lane should be equal.

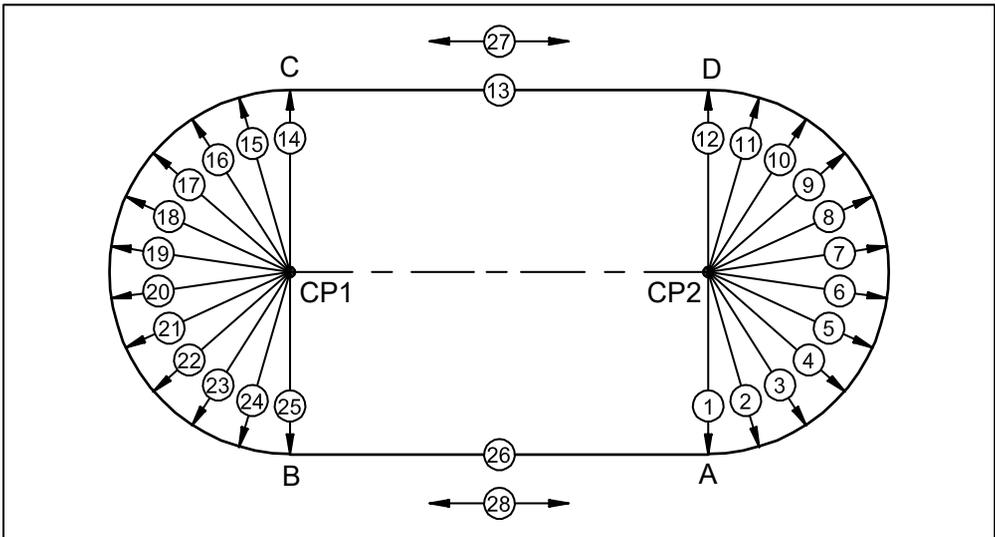


Figure 2.2.1.4a - 28-point control measurement of 400m Standard Track

Prerequisite: Distance from the centres of the semicircles (CP): 84.39m \pm 0.005m

Measurement 1-12 and 14-25: 36.50m resp. \pm 0.005m

Measurement 13 and 26: 84.39m resp. \pm 0.005m

Measurement 27 and 28: alignment of the straights (permitted deviation of 0.010m)

The readings ascertained for 1-12 and 14-25 must be equalised in the light of the record of 28 point control measurement.

The track length calculated after equalisation may not be less than 400.000m or more than 400.040m.

Example of readings see in Table 2.2.1.4.

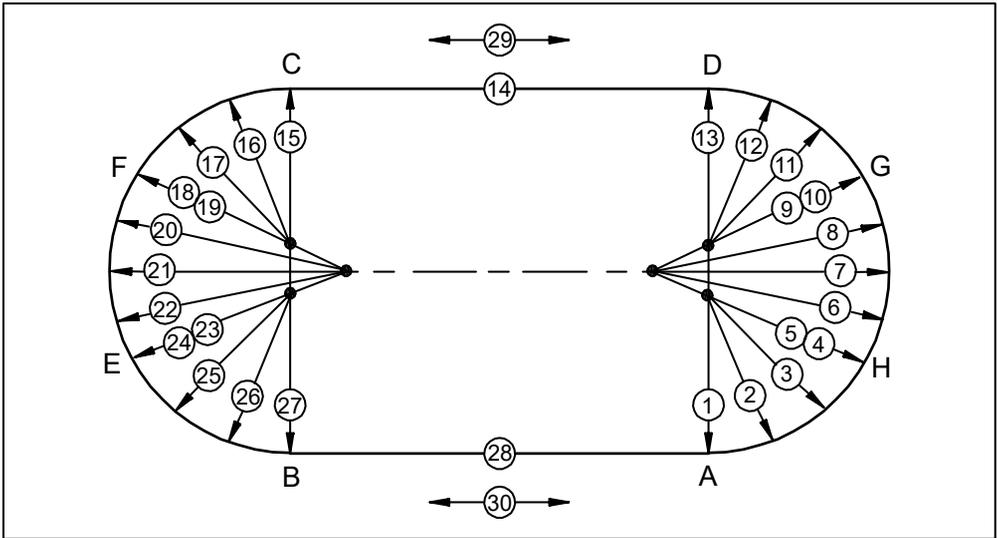


Figure 2.2.1.4b - Example for the control measurement of 400m Double Bend Track

The number of radial readings on each of the arc segments may be varied depending on the type of double bend so that the arcs between readings are approximately equal in length.

Tolerance on radial measurements and 14 and 28: $\pm 0.005\text{m}$

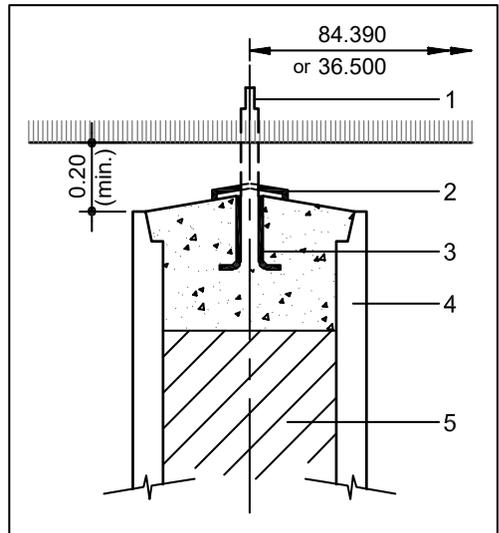
Measurement 29 and 30: alignment of the straights (permitted deviation of 0.010m)

The readings ascertained for 1-13 and 15-27 must be equalised in the light of the record of the control measurement.

The track length calculated after equalisation may not be less than 400.000m or more than 400.040m.

Figure 2.2.1.4c - Marking of centre of semicircle
(Proposal for construction)
(Dimensions in m)

- 1 Stainless steel bolt appr. 12mm in diameter
- 2 Socket covered with stainless steel lid
- 3 Stainless steel socket inserted into mortar in exact vertical position
- 4 Steel tube in concrete foundation min. 1.0m depth and constructed to prevent frost heave
- 5 Gravel sand



Measurement in Accordance with Fig 2.2.1.4a Number	Measuring Result m	Deviation from the Desired Value ¹ ± mm	Calculation of the Running Length Based on Average Deviation m	
1	36.502	+2		
2	36.503	+3		
3	36.502	+2		
4	36.501	+1		
5	36.499	-1		
6	36.497	-3		
7	36.500	±0		
8	36.501	+1		
9	36.505	+5		
10	36.502	+2		
11	36.500	±0		
12	36.500	±0		
Average of Measurements 1 to 12=		_____	1. Semicircle $0.001 \times \pi =$ $+0.0031$	
14	36.498	-2		
15	36.497	-3		
16	36.500	±0		
17	36.502	+2		
18	36.503	+3		
19	36.505	+5		
20	36.505	+5		
21	36.504	+4		
22	36.501	+1		
23	36.503	+3		
24	36.504	+4		
25	36.502	+2		
Average of Measurements 14 to 25 =		_____	2. Semicircle $0.002 \times \pi =$ $+0.0063$	Deviation from the running length (in m)
13	84.393	+3		1. Semicircle +0.0031
26	84.393	+3		2. Semicircle +0.0063
27	0.005	-		2 Straights +0.0060
28	0.008	-		
Total Deviation of Measurements 13 and 26 =		_____	2 Straights $+0.006$	Total +0.0154 Permitted max. +0.040
¹ Desired value for 1 to 12 and 14 to 25: 36.500 ±0.005 Desired value for 13 and 26: 84.390 ±0.005 Desired value for 27 and 28: Alignment Permitted deviation from desired value for 1 to 26: ± 0.005 Permitted deviation from alignment for 27 and 28: 0.01 Permitted tolerance of the running length: + 0.040 max. (in m)				

Table 2.2.1.4 - Record of 28 point control measurement (Example with readings)

The 28-point control measurement should be carried out and the readings recorded. The average of the deviations must not exceed + 0.040m nor be less than 0.000m (Table 2.2.1.4).

These control readings also form the basis of the layout of the kerb on whose dimensional accuracy the dimensional accuracy of all markings for the 400m Standard Track depends.

These control readings can also be used for other 400m oval tracks if the relevant measurements for the straights and radii are included (See 2.2.1.8).

For the construction of the arcs and for the 28-point control readings, the centres of the two semicircles must be marked by permanent non-corrodible metal markers placed 84.390m apart - see Figure 2.2.1.4c for one possibility.

In addition, permanent marks should be installed on the inner and outer border on the segment lines A – D and B – C to allow the centre point markers to be quickly located.

Please note that the “control measurements” will be different for double bend tracks (See Figure 2.2.1.4b).

2.2.1.5 Safety Zones

The 400m track must have an obstacle-free zone (safety zone) on the inside at least 1.00m wide and should have on the outside an obstacle-free zone at least 1.00m wide. Any drainage system positioned under the kerb must be flush with the surface and level with the track.

The obstacle-free safety zones must be level with the surface of the track.

2.2.1.6 Track Marking

General

All track markings shall be in accordance with the World Athletics 400m Standard Track Marking Plan (“Marking Plan” - Figure 2.2.1.6a attached to this Manual). Additional markings may be provided for national events provided they do not conflict with international markings. Such additional markings should not be installed until after the conduct of an international event if one is scheduled. The markings and colour codes must be complied with for certification of Construction Category IV and above. If the colour of the track surface makes it difficult to distinguish any coloured marking, World Athletics’ approval should be obtained for an alternate colour.

All markings are 0.05m wide (except where otherwise specified).

All lanes shall be marked by white lines. The line on the right hand of each lane, in the direction of running, is included in the measurement of the width of each lane.

All start lines (except for curved start lines) and the finish line shall be marked at right angles to the lane lines.

All lanes and start lines shall be measured as indicated in 2.2.1.4. The deviation from the running length of all start lines must not exceed $+0.0001 \times L$ nor be less than 0.000m where L is the length of the race in metres.

Marking of start, relay and hurdle positions:

- with measuring tape on straights only; with theodolite on the bends according to the centre angles of the nominal arc segments

Marking with measuring tape on bends only as a backup method:

- e.g. checking, correcting and supplementing
- in each lane, always measure from the start (A,C) or end (B,D) of the arc

All measurements shall be undertaken with surveying instruments with current certificates of instrument accuracy not more than 12 months old at the date of the survey provided by an appropriate measurement organisation so that the measurements can be traced back to national measurement standards.

Finish Line

The finish line shall be marked by a white line (see also 2.2.1.1).

Immediately before the finish line, the lanes may be marked with numbers with a minimum height of 0.50m.

In each lane, a white line, 0.03m wide and 0.80m long, may be marked 1m before the finish line.

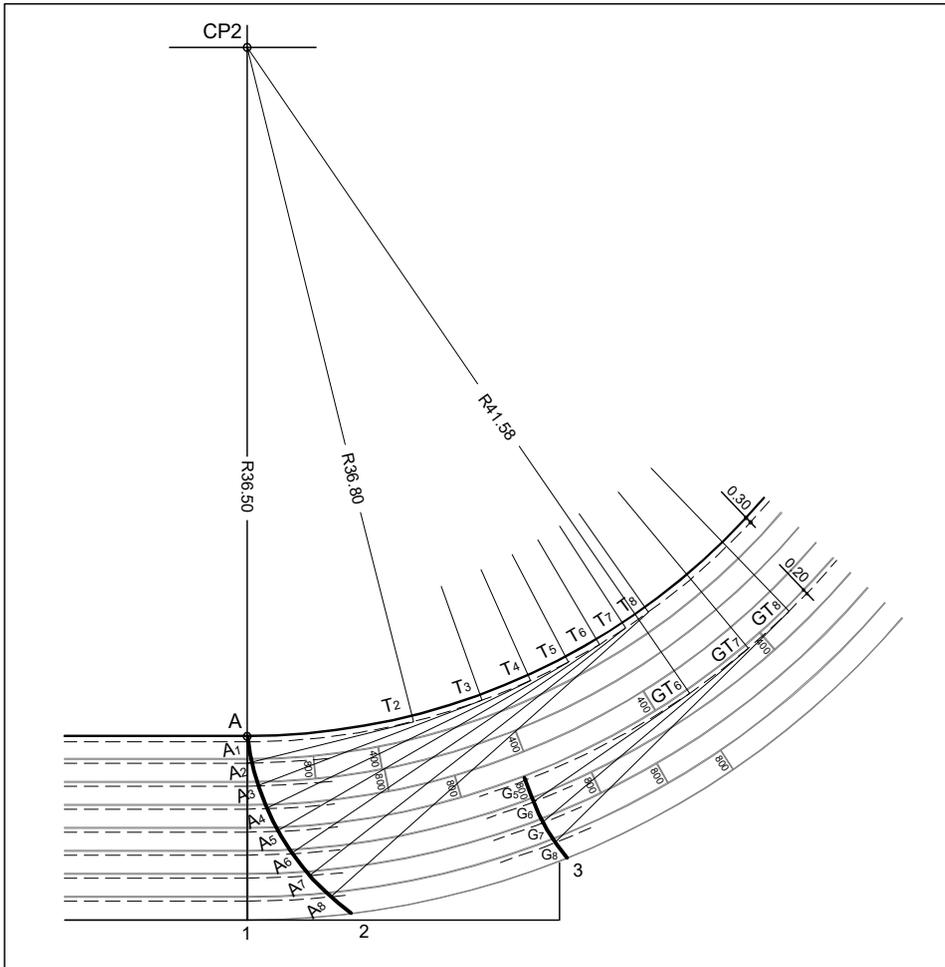


Figure 2.2.1.6b - Start and group start marking for 2000m and 10,000m in the first bend
(Dimensions in m)

CP2 to A: kerb line radius (36.50m)

CP2 to A1: lane 1 running line radius (36.80m)

CP2 to A2: lane 2 running line radius (36.80m + 1.12m)

CP2 to A3 ... A8: lanes 3-8 running line radii (37.92m + 1.22m each)

T2 to T8: tangent points for curved start

GT6 to GT8: tangent points for outer curved start (group starts)

1 Finish line

2 Start line 2000m and 10,000m

3 Start line group starts 800m, 2000m and 10,000m

Note: Curved start line 2 and 3 may be extended to the extent of available synthetic surface.

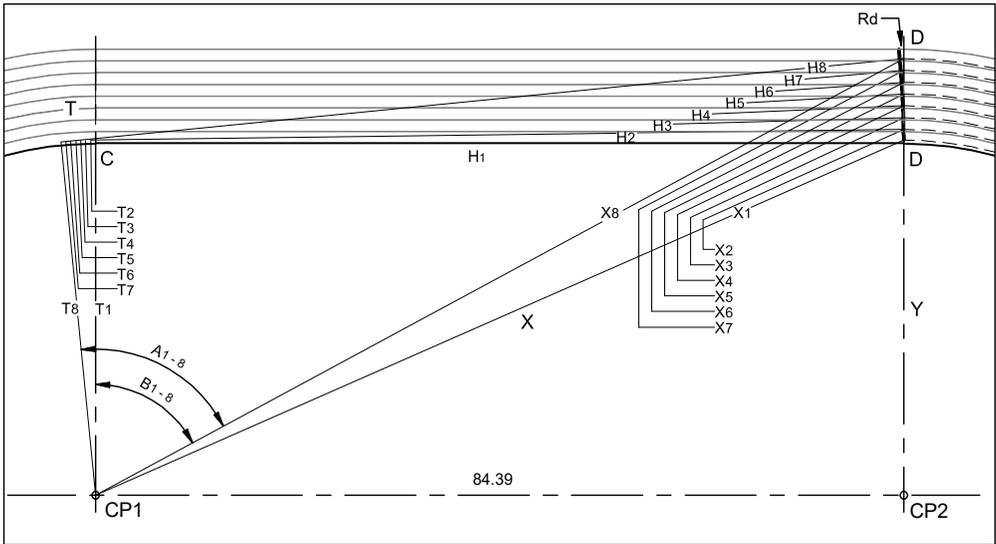


Figure 2.2.1.6c - Breakline marking for 800m races (Dimensions in m) (see also Table 2.2.1.6b)

- X distance CP1 to D1/D8
- Y distance CP2 to D1/D8
- H distance H2/H8 to T2/T8
- T tangent points T2/T8
- Rd deviation of breakline from D/D line
- C and D points on the kerb of the track

In order to confirm that the camera is correctly aligned and to facilitate the reading of the photo finish image, the intersection of the lane lines and the finish line shall be coloured black in a suitable design. Any such design must be solely confined to the intersection, for no more than 0.02m beyond, and not be extended before, the leading edge of the finish line. Similar black marks may be placed on each side of an appropriate lane line and the finish line to further facilitate reading.

Start Lines

The essential requirement for all start lines, straight, staggered or curved, is that the distance for every athlete, when taking the shortest permitted route, shall be the same and not less than the stipulated distance, i.e. no negative tolerance.

All race distances are measured along the measurement line (0.30m outward from the inside of the track for lane 1 or 0.20m from the inside lane of an outer start) in a clockwise direction (back from the finish line), from the edge of the finish line nearer to the start to the edge of the start line farther from the finish.

Distance on Running Line	Marking Plan Area	Bends Run in Lanes	Lane 2	Lane 3	Lane 4	Lane 5	Lane 6	Lane 7	Lane 8
200	C	1	3.519	7.351	11.184	15.017	18.850	22.682	26.515
400	A	2	7.037	14.703	22.368	30.034	37.699	45.365	53.030
800	A	1	3.526	7.384	11.259	15.151	19.060	22.987	26.930
4x400	A	3	10.563	22.086	33.627	45.185	56.760	68.352	79.960

Table 2.2.1.6a - Staggered start data for the 400m Standard Track
(in m, measured on the running line)

For races of 800m or less, each athlete shall have a separate lane at the start. Races of up to and including 400m shall be run entirely in lanes. The data for staggered starts for 400m Standard Track (constant lane width of 1.22m) are listed in Table 2.2.1.6a.

Races of 800m shall start and continue in lanes until the end of the first bend. (Figure 2.2.1.6c and Table 2.2.1.6b). By the Rules, a curved start line for the 800m is an allowable option for international matches when the countries agree not to use lanes and it coincides with the 2000m and 10,000m start line(s).

The exit from the first bend shall be marked distinctively with a 0.05m wide line (breakline) across all lanes other than lane 1 to indicate where the athletes can break from their lanes. (Figure 2.2.1.6c). To assist athletes identify the breakline, small cones or prisms (0.05m × 0.05m) and no more than 0.15m high preferably of a different colour from the breakline and the lane lines shall be placed on the lane lines immediately before the intersection of each lane and the breakline.

Lane	X CP2 to D	Y CP1 to D	Angle A	Angle B	A - B = Arc Angle	Arc Length	84.39 + Arc Length	Hypote- nuse H	Reduc- tion ¹
1	92.065	36.80	73.822	73.822	0.000	0.000	84.390	84.390	0.000
2	92.518	37.92	73.958	73.115	0.842	0.487	84.877	84.884	0.007
3	93.025	39.14	74.108	72.354	1.754	1.014	85.404	85.436	0.032
4	93.545	40.36	74.260	71.600	2.660	1.538	85.927	86.002	0.075
5	94.077	41.58	74.414	70.856	3.559	2.057	86.447	86.581	0.134
6	94.623	42.80	74.570	70.119	4.451	2.573	86.963	87.174	0.211
7	95.181	44.02	74.728	69.391	5.336	3.085	87.474	87.779	0.305
8	95.751	45.24	74.887	68.672	6.214	3.592	87.982	88.397	0.415

¹ Not measured on the theoretical running line but on the H line!

Table 2.2.1.6b - Calculation figures for breakline marking for 800m races for the 400m Standard Track only (in m, angles in gon)

Marking for the 800m Breakline

- The breakline in lane 1 is on the prolongation of the track diameter A-D. Mark this point X1 with a pin on the measurement line. This is the point where the measurement of the rear edge of the 800 m breakline will begin.
- Securely fix a pin on the lane 1 measurement line on the prolongation of the track diameter B-C.
- Securely fix further pins along the 0.30m measurement line around the curve before the point C in lane 1. The pins should be not more than 0.30m apart. The pin furthest from C should be far enough around the curve so that it is beyond the tangent point on the measurement line for the tangent line from the outside extremity of the breakline.
- Secure the end of a length of steel wire to the surface of the track on the measurement line just beyond this last pin.
- Laying the wire along the surface of the track against the pins, pull it tight and mark the position on the wire at point X1. Using this position on the wire and

keeping the wire tight, mark the rear of the breakline in a continuous curve from the lane 2 inner line to the outside of the outer lane.

Referring to Figure 2.2.1.6c:

$$84.39 + \text{arc}(T1-T8) = H2 + \text{arc}(T2-T8) = \dots = H8$$

The reductions shown in Table 2.2.1.6b are measured along the hypotenuse H line, and for lanes 7 and 8 are not equal to the required reduction along the running line. These reductions must be measured from the marked breakline to the D-D line.

Marking for Curved Start Lines for Races over 800m

- Measure the race distance and mark the rear edge of the start line in the inside lane with a pin on the measurement line.
- Securely fix further pins along a 0.30m measurement line (0.20m for a lane without kerb) around the curve before the starting point in the inside lane. The pins should be not more than 0.30m apart. The pin furthest from the starting point should be far enough around the curve so that it is beyond the tangent point on the measurement line for the tangent line from the outside extremity of the start line.
- Secure the end of a length of wire to the surface of the track on the measurement line just beyond this last pin.
- Laying the wire along the surface of the track against the pins, pull it tight and mark the position on the wire of the rear edge of the start line in the inside lane. Using this position on the wire and keeping the wire tight, mark the rear of the start line arc across the track.

Races over 800m shall be run without lanes, using a curved start line.

For the 1000m, 2000m, 3000m, (optional 3000m Steeplechase with inside water jump), 5000m and 10,000m, when there are more than 12 athletes in a race, they may be divided into two groups with one group of approximately two thirds of the athletes on the regular arced start line and the other group on a separate arced start line marked across the track from lane 5 for an 8 or 9-lane track and lane 4 for a 6-lane track. The other group shall run as far as the end of the first bend of the race on the outer half of the track (Figures 2.2.1.6b and 2.2.1.6d). The inside line marking for the outer group shall have cones or flags at intervals not exceeding 4m or temporary kerbing placed on the white line from the start to the breakpoint.

The outer group start for 1000m, 3000m and 5000m on the inside lane is 0.134m forward of the 200m start line (8-lane track) and the outer group start for 2000m and 10,000m on the inside lane coincides with the 800m start line. The outer group start for the 3000m steeplechase (inside water jump, standard 8-lane track) in lane 5 is 15.151m forward of the 3000m steeplechase lane 1 start point.

The track shall be marked with a 0.05m x 0.05m distinctive mark on the inner line of the outer half of the track just after the beginning of the finish straight to indicate to the athletes of the outer group where they are permitted to join the athletes using the regular start line. To assist athletes identify this point, a cone or flag shall be placed immediately before the mark. For 2000m and 10,000m, this point is at the intersection of the 800m breakline and the inner line of lane 5 (8-lane track).

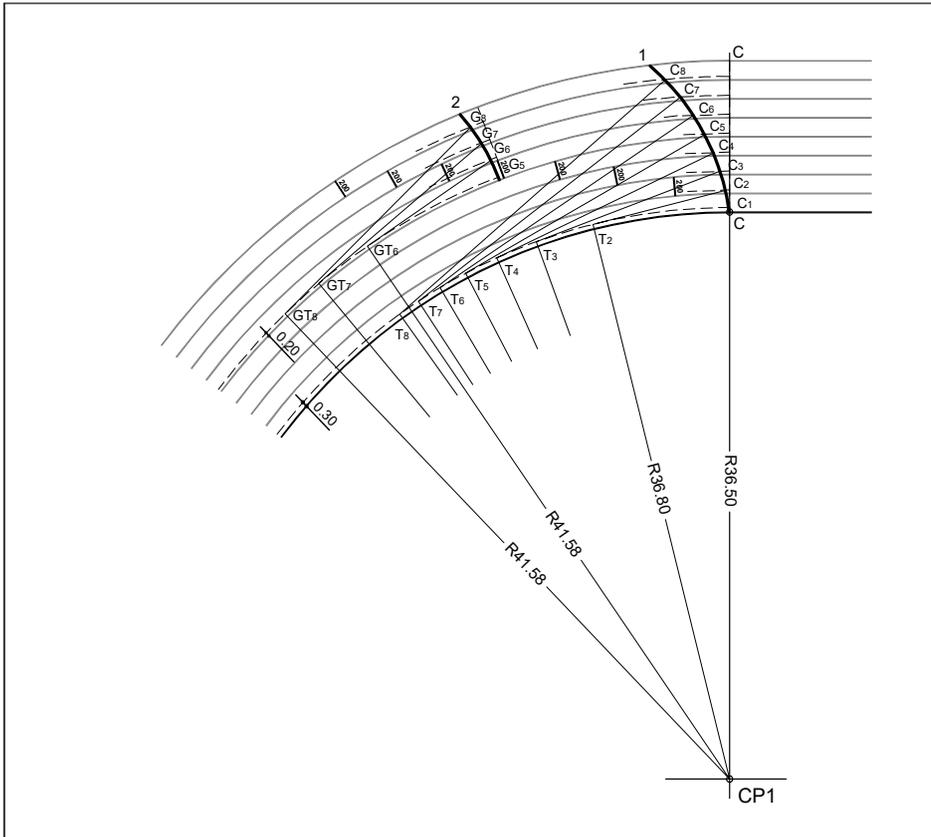


Figure 2.2.1.6d - Start and group start marking for 1000m, 3000m and 5000m in the second bend
(Dimensions in m)

CP1 to C: kerb line radius (36.50m)
 CP1 to C1: lane 1 running line 36.80m
 CP1 to C2: lane 2 running line 36.80m + 1.12m (37.92m)
 CP1 to C3...C8: lanes 3-8 running line 37.92m + 1.22m each
 T2 to T8: tangent points
 GT6 to GT8: tangent points for outer curved start (group starts)

1 Start line 1000m, 3000m, 5000m,
 2 Start line group starts 1000m, 3000m, 5000m

The 1500m start line, or where applicable, any other curved start line, may be extended out from the outside bend lane to the extent that synthetic surface is available.

Relay Races

For the 4 × 100m Relay races, the echelon starting positions for the first athletes in each lane are the same as for the 400m. The scratch lines at the first and second changes in each lane are the same as the start lines for the 300m and 200m respectively.

The marking of the 4 × 200m and Medley Relays is not recommended for tracks to be used for international competitions unless these events are on the programme. Where the 4 × 200m Relay race is marked, the start positions for the first athletes and

each change will depend on whether the race is run entirely in lanes. The different options for the conduct of these Relay races are given in the Rules. It is not recommended that specific scratch lines be permanently marked for these events. However, permanent marks may be located by the surveyor on each lane line and/or the line marking under the track kerb, for each start position so as to allow technical officials to temporarily mark each start accurately before each relay competition. Note that the start marks of the Medley Relay are the first change scratch marks of the 4 × 200m relay run in lanes for the first two legs and part of the third.

In the 4 × 100m and the 4 × 200m relays, and for the first and second changes in the Medley Relay, each takeover zone shall be 30m ± 0.020m long, of which the scratch line is 20m from the start of the zone.

For the 4 × 400m Relay races, the echelon starting positions for the first athletes in each lane shall be marked as shown in the Marking Plan. The arc across the track, from lane 2 at the entry to the back straight showing the positions at which the second stage athletes are permitted to leave their respective lanes shall be identical to the breakline arc for the 800m event. The scratch lines of the first takeover zones are the same as the start lines for the 800m. Each takeover zone shall be 20m ± 0.020m long of which the scratch line is the centre. The zones shall start and finish at the edges of the zone lines nearest the start line in the running direction. The takeover zones for the second and last takeovers shall be marked 10m either side of the finish line.

Other Marks

All points on lane 1 at which the track changes from a curve to a straight or a straight to a curve shall be marked, in a distinctive colour 0.05m x 0.05m on the white line, by the surveyor and a cone placed at such points during a race. In addition, similar marks should be provided where one curve changes to another curve for a double bend track or an inside steeplechase bend to assist in re-establishing the original design when the track is resurfaced. The measurement to the mark shall be to the edge nearer to the start.

2.2.1.7 Official Acceptance

All tracks to be used for World Athletics competitions must have a current Certificate. Such certificates will only be issued upon submission of full details including actual measurements. Standard forms of Facility Certification Application and Facility Measurement Report are available from the Office or may be downloaded from the website.

2.2.1.8 400m Oval Track Other Layouts (Figure 1.2.3b to d and Table 1.2.3a)

Radii less than 33.50m or not complying with the World Record Rule should not be used for tracks for international competition, except for double bend tracks the dimensions of which ensure an infield size adequate for rugby. In this case, the minimum radius must not be less than 24.00m, but any double bend track with the smaller radius less than 30m can only be Construction Category V.

2.2.2 THE STRAIGHT AS A COMPONENT OF THE 400M STANDARD TRACK

2.2.2.1 Layout (Figure 2.2.2.1).

The straight with a minimum of 6 lanes is integrated into the 400m oval track. As

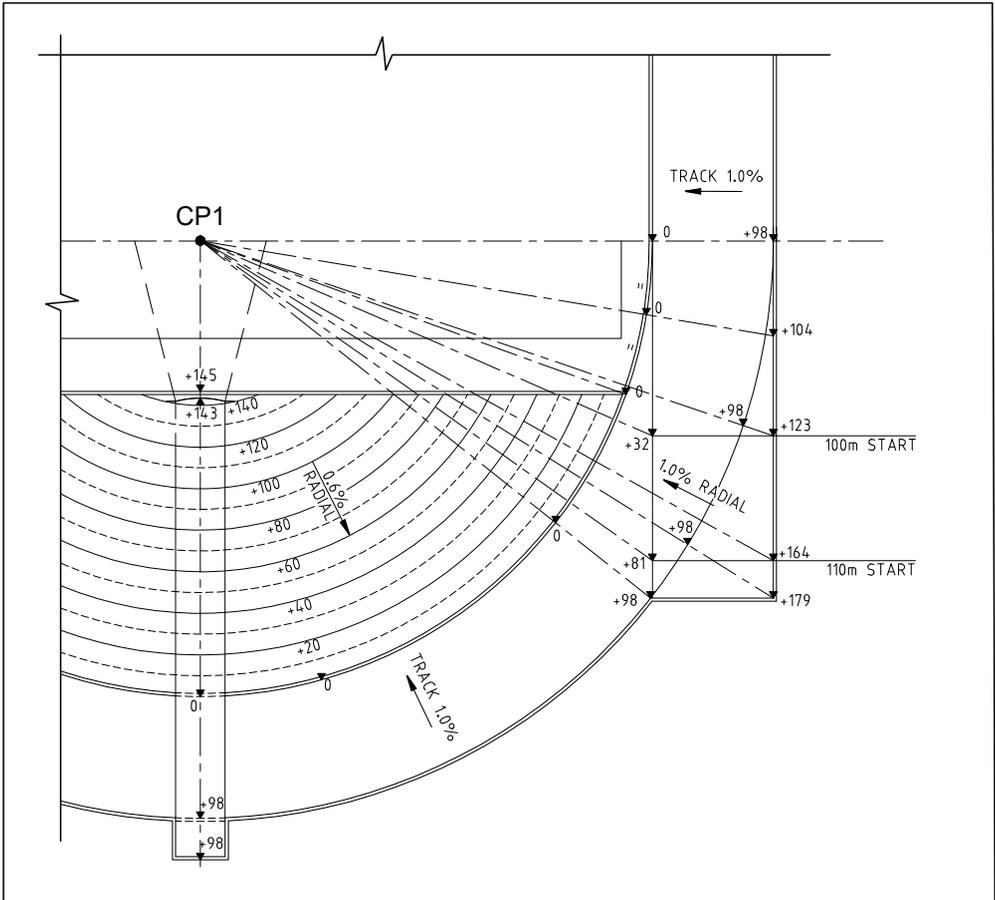


Figure 2.2.2.2 - Segment of 400m Standard Track at the 100m / 110m start area with track radial slope of 1.0% (Dimensions of distance in m, dimensions of heights in mm)

2.2.3 THE HURDLE RACE TRACK INTEGRATED WITHIN THE 400M STANDARD TRACK

2.2.3.1 Layout and Marking

The standard 400m track (2.2.1) and the sprint track(s) with 100m and 110m (2.2.2) can be used for hurdle races. The hurdle positions for 100m, 110m and 400m shall be marked on the track by lines 0.10m × 0.05m so that the distances measured from the start to the edge of the line nearest the approaching athlete are in accordance with Table 2.2.3.1 (tolerance: ± 0.01m for 100m and 110m; ± 0.03m for 400m).

It is not recommended that full hurdle position marks for other hurdle races be permanently marked for these events when the track is used for international competitions. However, permanent marks may be located by the surveyor on each lane line in appropriate colours and/or on the line marking under the track kerb for each hurdle position so as to allow technical officials to temporarily mark each hurdle position accurately before each relay competition.

Event	Height of Hurdles ²	Distance from Start Line to First Hurdles ³	Distance between Hurdles ³	Distance from Last Hurdles to Finish Line ³	Number of Hurdles
110m Men	1.067	13.72	9.14	14.02	10
110m U20 Men	0.991	13.72	9.14	14.02	10
110m U18 Men	0.914	13.72	9.14	14.02	10
100m Women / U20	0.838	13.00	8.50	10.50	10
100m U18 Women	0.762	13.00	8.50	10.50	10
400m Men / U20	0.914	45.00	35.00	40.00	10
400m U18 Men	0.838	45.00	35.00	40.00	10
400m Women / U20 / U18	0.762	45.00	35.00	40.00	10

¹ The staggering of the hurdle positions in the outer lanes of the 400m Standard Track for 400m Hurdle races can be seen in Figure 2.2.1.6a
² ± 0.003
³ ± 0.01 for 100m and 110m; ± 0.03 for 400m

Table 2.2.3.1 - Hurdle number, height and position¹ (in m)

The hurdles shall be placed so that the vertical plane of the side of the bar nearest the approaching athlete coincides with the edge of the track marking nearest the athlete.

2.2.4 THE STEEPLECHASE TRACK INTEGRATED WITHIN THE 400M STANDARD TRACK

2.2.4.1 Layout

The steeplechase track is integrated into the 400m Standard Track.

For the steeplechase track, a total of five hurdles are required, if possible, at equal distances apart. One of the hurdles forms part of the water jump.

The water jump (3.66m × 3.66m × 0.50 - Figure 2.2.4.1c) is permanently installed inside the Standard Track in the 2nd segment (Figures 2.2.4.1a and 2.2.4.1d) or outside the Standard Track outside the 2nd bend (Figures 2.2.4.1b and 2.2.4.1e). The water jump track inside the segment is connected to the main track by a transitional arc (radius 16.00m), and the water jump outside the segment by a transitional straight (9.86m) followed by a transitional arc (radius 36.50m). If the water jump bend is located inside the track, the kerb of the Standard Track must be removable at the beginning and end of the water jump bend. The uniform slope of the bottom of the water jump pit ($12.4^\circ \pm 1^\circ$) shall be maintained as shown in Figure 2.2.4.1 c.

Water jump pits that were installed as per the Figure in previous editions of the Manual are still accepted.

If the steeplechase track inside the bend is not bordered by a fixed kerb, it must be marked by a white line. Measurement of the track must be taken from a theoretical distance of 0.20m outward from this line. The same applies to the running line for water jumps outside the segment. The theoretical running line for the steeplechase track is 3.916m shorter in the segment containing the water jump than along the adjacent Standard Track (Figure 2.2.4.1a), for example, the length of the steeplechase lap with the water jump inside the segment is 396.085m. If the water jump is placed closer to

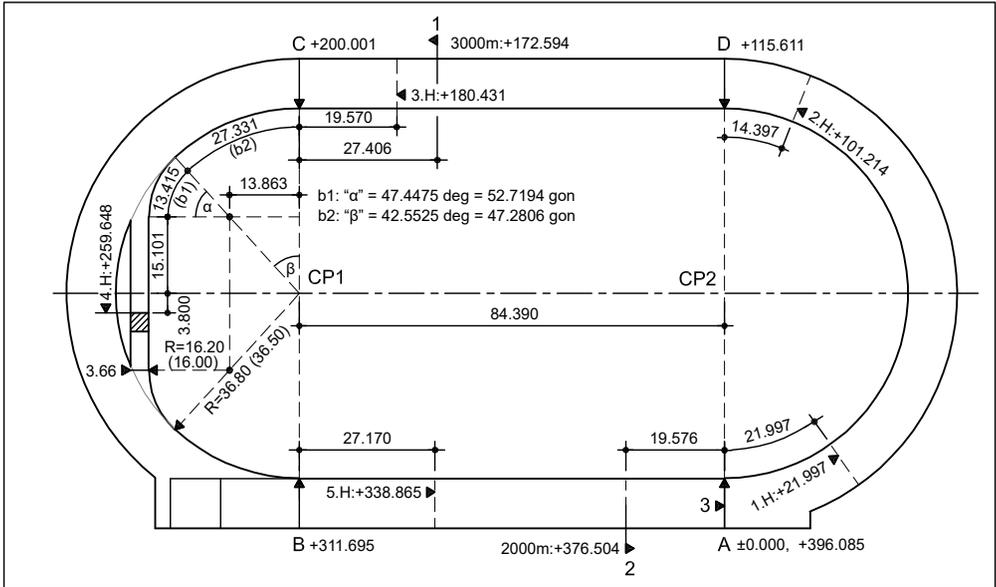


Figure 2.2.4.1a - Steeplechase track with water jump inside the bend of the 400m Standard Track
 (Without fixed kerb, dimensions in m, determined by calculations to four decimal places)

- 1 Start for 3000m: +172.594
- 2 Start for 2000m: +376.504
- 3 Finish line, also start and finish of steeplechase lap A ±0.000 and + 396.085

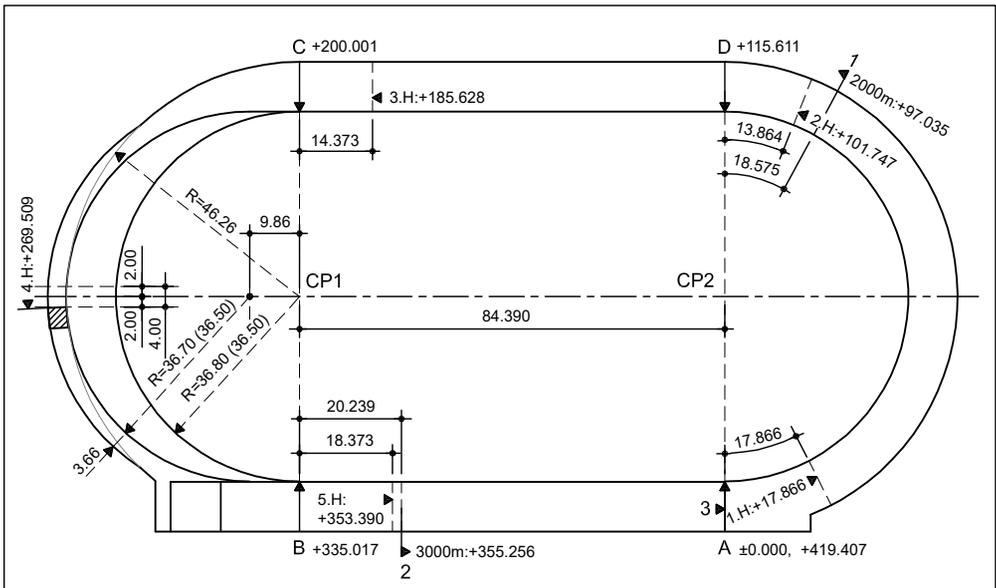


Figure 2.2.4.1b - Steeplechase track with water jump outside the bend of the 400m Standard Track
 (Without fixed kerb, dimensions in m, determined by calculations to four decimal places)

- 1 Start for 2000m: +97.035m
- 2 Start for 3000m: +355.256m
- 3 Finish line, also start and finish of steeplechase lap A ±0.000 and +419.407

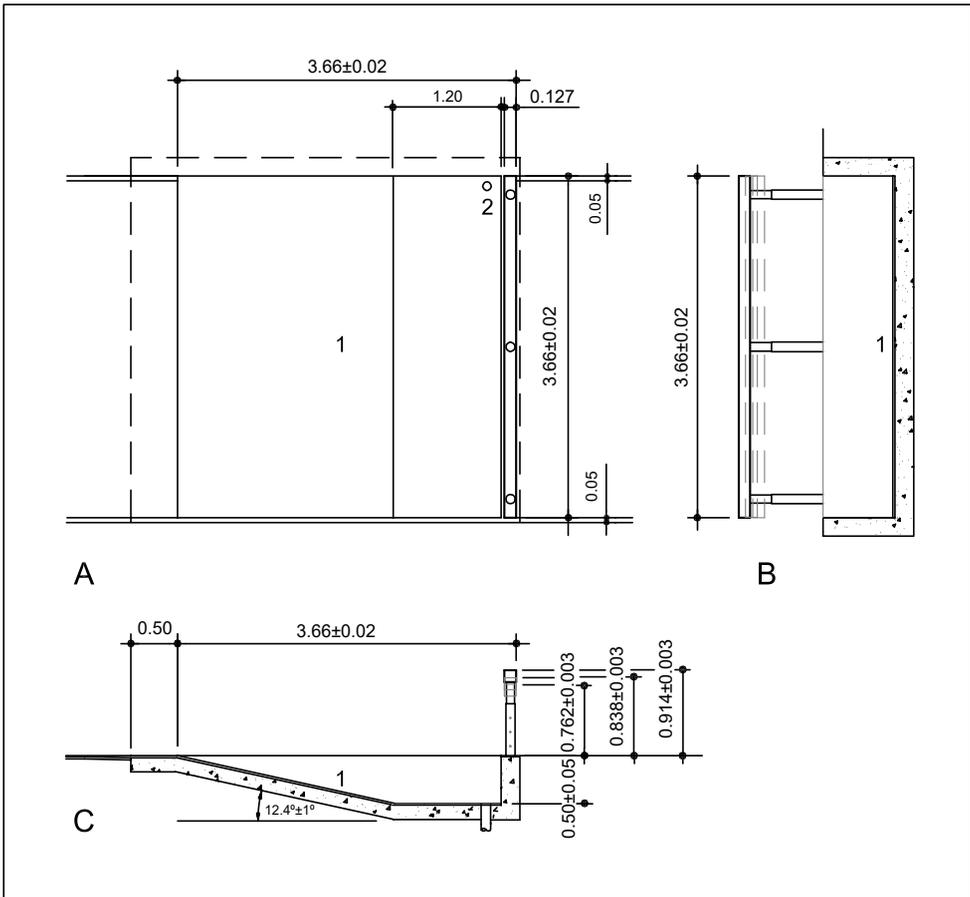


Figure 2.2.4.1c - Water jump for steeplechase track (Dimensions in m)

- A Layout plan
- B Cross section
- C Longitudinal section

- 1 Synthetic surface, 25mm
- 2 Discharge pipe

tangent point C, the location of hurdle 1 should not be closer than 12m past the finish line. It may be necessary to increase the spacings between hurdles 3, 5 and 1. The water jump shall be located so that the end of the water jump hurdle is not closer than 0.7m from the oval track kerb.

The theoretical running line for the steeplechase track outside the segment is 19.406m longer than along the adjacent Standard Track (Figure 2.2.4.1b), giving a steeplechase lap with the water jump outside the segment of 419.407m.

When the water jump pit is on a curved line, it is possible to set out the edge of the pit closer to the curve centre as a chord of the curve. The inside lane markings to and from the pit would then be part of the curve. The theoretical difference between the chord and the circumferential measure at the pit is insignificant and does not have to be taken into account. The water jump shall be located so that the end of the water jump hurdle is at least 0.1m from the oval track but preferably further away.

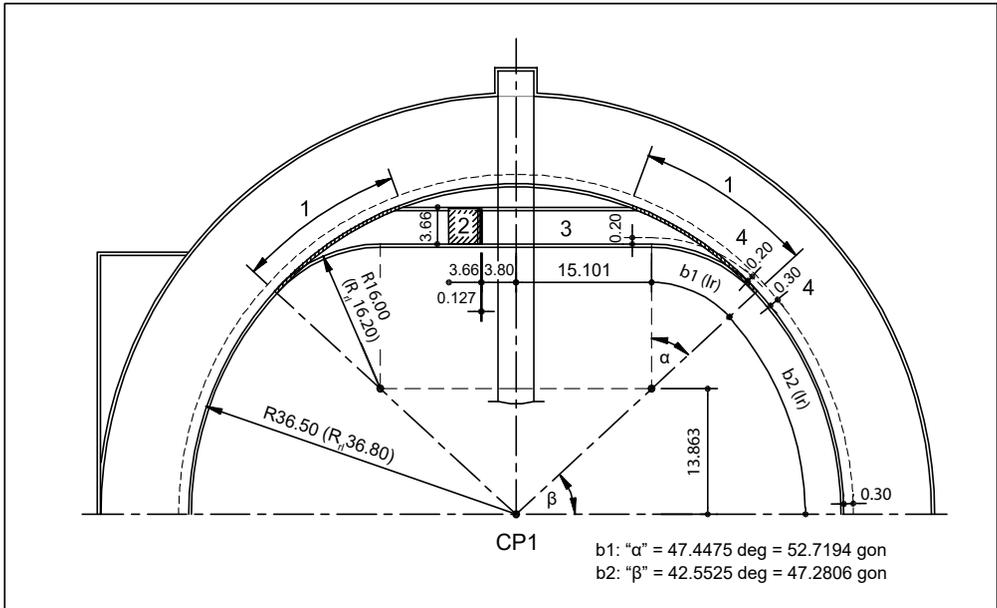


Figure 2.2.4.1d - Water jump on inside bend (Dimensions in m)

For the calculation of the length of running (lr) of the steeplechase track: Distance of running line (rl) and the marking: 0.20m

$$b = r \times \pi \times \frac{\alpha^\circ}{180^\circ}$$

$$b1 \text{ lr} = 16.20 \times \pi \times \frac{47.4475}{180} = 13.4155\text{m}$$

$$b2 \text{ lr} = 36.80 \times \pi \times \frac{42.5525}{180} = 27.3307\text{m}$$

Length of running of water jump bend: $2 \times 13.41545 + 2 \times 27.3307 + 2 \times 15.101 = 111.6943\text{m}$
 Length of running of the water jump bend is 3.916m shorter than the semicircle bend of the Standard Track ($36.80 \times \pi = 115.6106\text{m}$)

- 1 Removable track border
- 2 Water jump
- 3 Straight
- 4 Distance between running line and track inside edge

For a 9-lane oval track, an inside water jump is preferred, however if the water jump is outside, much greater care is needed in the design so that the distance from the finish line to the first hurdle is not less than 12m, the distance from the 5th hurdle to the finish line is not less than 40m and the distance from the start line to the 1st hurdle to be jumped is not less than 70m.

The top of the water jump pit shall be level with a concrete and/or synthetic surface finish but without any cut-outs or niches so that a painted white line can define the left hand inside edge of the pit. The crossfall of the adjoining synthetic shall be warped so as to provide a smooth transition.

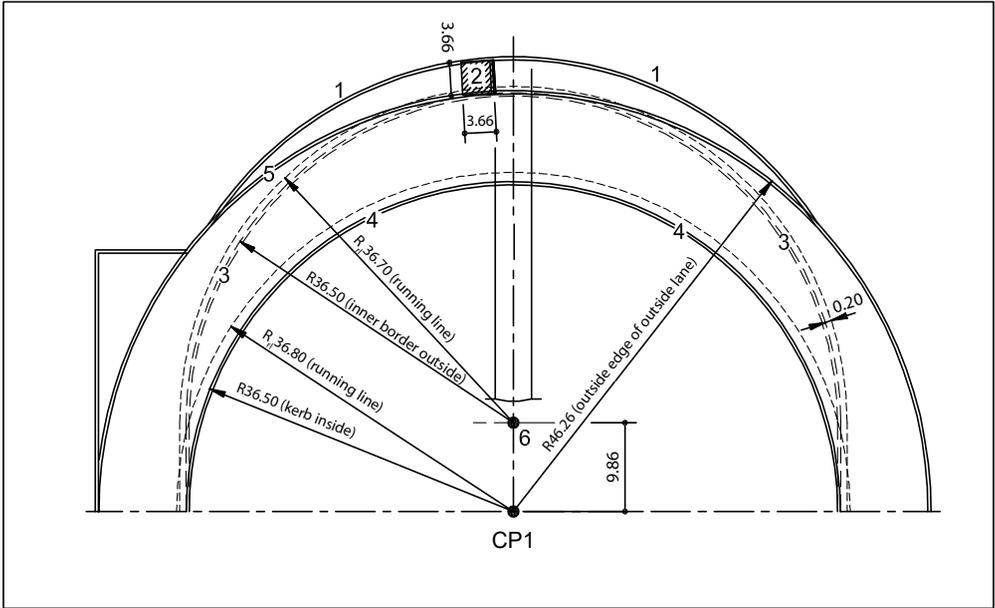


Figure 2.2.4.1e - Water jump outside the bend (Dimensions in m)

For the calculation of the length of running of the steeplechase track: Distance of running line (rl) and the marking: 0.20m
 Length of running of water jump bend: $9.86 \times 2 + 36.70 \times \pi = 135.0165\text{m}$
 Length of running of the water jump bend 19.406m longer than the semicircle bend of the Standard Track ($36.80 \times \pi = 115.6106\text{m}$)

- 1 Outer track border (flush mounted)
- 2 Water jump
- 3 R=36.50 (Inner border outside edge of steeplechase track)
- 4 Inner track border (0.05m high)
- 5 Outer track border (flush mounted)
- 6 Centre point of additional circle

A single radius steeplechase curve is recommended for a double bend track with an outside water jump.

Comments on Figure 2.2.4.1a

STEEPLECHASE TRACK WITH WATER JUMP INSIDE THE BEND INTEGRATED INTO THE 400M STANDARD TRACK (dimensions in m)

1. Length of steeplechase lap measured along the running line (from A to A) over the water jump on the inside bend:	
Semicircle bend (R = 36.80m)	115.6106m
2 straights of 84.3900m each	168.7800m
Water jump bend:	111.6943m
Middle straight	(30.2020m
2 transition bends b1 of 13.41545m each	26.8309m
2 semicircle bend sections b2 of 27.3307m each	54.6614m)
	396.0849m

2. Number of jumps per full steeplechase lap:
5 (4 hurdles + 1 water jump)
For 1st full lap of the 2000m, only 3 jumps (the first hurdle to be jumped is the 3rd hurdle of the steeplechase lap.)
3. Number of hurdles per steeplechase race:
For 3000m: 35 (28 × hurdle + 7 × water jump)
For 2000m: 23 (18 × hurdle + 5 × water jump)
4. Number of steeplechase laps (396.0848m each) per steeplechase race:
For 3000m: 7 laps with a total length of running of 2772.5936m and prior to the start of the first full lap an additional stretch without hurdles of 227.4064m
For 2000m: 5 laps with a total length of running of 1980.4240m and prior to the start of the first full lap an additional stretch without hurdles of 19.5760m
5. Spacing of the hurdles along the running line of the steeplechase lap
 - 5.1 Assumptions:
Ideally, five equal spacings. Alternatively, four equal spacings to whole metres such that the fifth spacing is not more than 2.5m different from the other spacings.
 - 5.2 Spacing calculated:
 $396.085\text{m} : 5 = 79.217\text{m}$
 - 5.3 Spacing selected:
 $4 \times 79.217\text{m} (=316.868\text{m}) + 79.217\text{m} = 396.085\text{m}$
6. Position of the start lines for 3000m and 2000m Steeplechase race along the steeplechase lap:
 - 6.1 Assumptions:
Length of the steeplechase lap in compliance with No. 1 above; normal finish line; additional stretches in compliance with No. 4 above: 227.4064m or 19.5760m respectively.
 - 6.2 Position for 3000m:
227.4064m before the finish line, measured against the direction of running from the finish line along the normal track without water jump bend (84.3900 + 115.6106 + 27.4058)
 - 6.3 Position for 2000m:
19.5760m before the finish line, measured against the direction of running from the finish line
7. Position of the hurdles along the steeplechase lap in the direction of running:
 - 7.1 Assumptions:
Length of the steeplechase lap in compliance with No. 1 above; spacing of the hurdles in compliance with No. 5.3; fixed points: finish line and water jump
 - 7.2 Position of the 4th hurdle (water jump):
259.648m after the finish line
(115.6106m + 84.390m + 27.3307m + 13.4155m + 15.101m + 3.800m)
 - 7.3 Position of the 5th hurdle:
338.865m after the finish line (259.648m + 79.217m)

- 7.4 Position of the 1st hurdle:
21.997m after the finish line ($338.865\text{m} + 79.217\text{m} - 396.085\text{m}$)
- 7.5 Position of the 2nd hurdle:
101.214m after the finish line ($21.997\text{m} + 79.217\text{m}$)
- 7.6 Position of the 3rd hurdle:
180.431m after the finish line ($101.214\text{m} + 79.217\text{m}$)
- 7.7 Position of the 4th hurdle (water jump) check:
259.648m after the finish line ($180.431\text{m} + 79.217\text{m}$)
8. The positions of the hurdles are calculated along the running line of the steeplechase lap and are each marked with their distance from the finish line in the direction of running. They are the same for both the 3000m and 2000m Steeplechase race. The hurdle positions must be marked on lane 1 and 3 in accordance with the Marking Plan. The distance from the finish line to the first hurdle should not be less than 12m. To achieve this distance for some designs where the water jump is placed closer to tangent point C, it may be necessary to increase the spacings between the water jump hurdle, hurdle 5 and hurdle 1 by up to 10 metres more than the other hurdle spacings. (c.f. 2.2.4.1)

Comments on Figure 2.2.4.1b

STEEPLECHASE TRACK WITH WATER JUMP OUTSIDE THE BEND INTEGRATED INTO THE 400M STANDARD TRACK (dimensions in m)

- Length of steeplechase lap measured along the running line (from A to A) over the water jump on the outside bend:

Semicircle bend ($R = 36.80\text{m}$)	115.6106m
2 straights of 84.3900m each	168.7800m
Water jump bend:	135.0165m
2 transition straights of 9.8600m each	(19.7200m)
Curved section ($R = 36.70\text{m}$)	115.2965m)
	419.4071m
- Number of jumps per full steeplechase lap:
5 (4 hurdles + 1 water jump)
For 1st lap of the 2000m, only 3 jumps (the first hurdle to be jumped is the 3rd hurdle of the steeplechase lap.)
- Number of hurdles per steeplechase race:
For 3000m: 35 ($28 \times \text{hurdle} + 7 \times \text{water jump}$)
For 2000m: 23 ($18 \times \text{hurdle} + 5 \times \text{water jump}$)
- Number of steeplechase laps (419.4070m each) per steeplechase race:
For 3000m: 7 laps with a total length of running of 2935.8490m and prior to the start of the first full lap an additional stretch without hurdles of 64.1510m
For 2000m: 4 laps with a total length of running of 1677.6280m and before the start of the first full lap an additional stretch without hurdles 1 and 2 of 322.3720m

5. Spacing of the hurdles along the running line of the steeplechase lap
 - 5.1 Assumptions:
Ideally, five equal spacings. Alternatively, four equal spacings to whole metres such that the fifth spacing is not more than 2.5m different from the other spacings.
 - 5.2 Spacing calculated:
 $419.407\text{m} : 5 = 83.8814\text{m}$
 - 5.3 Spacing selected:
 $4 \times 83.881\text{m} (= 335.524\text{m}) + 1 \times 83.883\text{m} (= \text{total } 419.407\text{m})$
6. Position of the start lines for 3000m and 2000m Steeplechase race along the steeplechase lap
 - 6.1 Assumptions:
Length of the steeplechase lap in compliance with No. 1 above; fixed point: finish line; additional stretch in compliance with No. 4 above: 64.1510m for 3000m (or first lap shortened by 97.0350m for 2000m)
 - 6.2 Position for 3000m:
64.1510m before to the finish line, measured against the direction of running from the finish line along the running line or 355.2560m after the finish line in the direction of running over the water jump.
 - 6.3 Position for 2000m:
97.0350m after the finish line, measured in the direction of running from the finish line along the running line over the water jump.
7. Position of the hurdles along the steeplechase lap
 - 7.1 Assumptions:
Length of the steeplechase lap in compliance with No. 1 above; spacing of the hurdles in compliance with No. 5.3; fixed points: finish line and water jump.
 - 7.2 Position of the 4th hurdle (water jump):
269.509m after the finish line in the direction of running
($200.001\text{m} + 9.860\text{m} + 57.648\text{m} + 2.000\text{m}$)
 - 7.3 Position of the 5th hurdle:
353.390m after the finish line in the direction of running
($269.509\text{m} + 83.881\text{m}$)
 - 7.4 Position of the 1st hurdle:
17.866m after the finish line in the direction of running
($353.390\text{m} + 83.883\text{m} - 419.407\text{m}$)
 - 7.5 Position of the 2nd hurdle:
101.747m after the finish line in the direction of running
($17.866\text{m} + 83.881\text{m}$)
 - 7.6 Position of the 3rd hurdle:
185.628m after the finish line in the direction of running
($101.747\text{m} + 83.881\text{m}$)
 - 7.7 Position of the 4th hurdle (water jump) check:
269.509m after the finish line in the direction of running
($185.628\text{m} + 83.881\text{m}$)

8. The positions of the hurdles are calculated along the running line of the steeplechase lap and are each marked with their distance from the finish line in the direction of running. They are the same for both the 3000m and 2000m steeplechase race. The hurdle positions must be marked on lane 1 and 3 in accordance with the Marking Plan.
9. To achieve the safety distances according to Section 2.2.4.1, it may be necessary to make one or more of the following design decisions:
 - make the spacings between the water jump hurdle, hurdle 5 and hurdle 1 up to 10m greater than the other hurdle spacings;
 - delete the drainage channel on the main track side of the water pit;
 - move the pit to within 0.10m of the outside of the outside lane of the main track as illustrated in Figure 2.2.4.1 b;
 - move the pit anticlockwise towards the finish line.
 - Alternatively, the hurdle spacing may be kept more or less equal but before the start of the 3000m steeplechase event, officials must move the 1st hurdle anticlockwise so that the distance from the start to the 1st hurdle is not less than 70m. After the athletes have passed, the 1st hurdle must then be moved back to its normal position.

These design decisions above may apply particularly to a 9-lane oval track.

2.2.4.2. Safety

When not in use, the water jump pit should be completely covered level with the surrounding surface.

2.2.4.3 Marking

For the marking of the steeplechase track, apply Section 2.2.1.6 analogously. The position of the starting lines and the hurdles depends on the position of the water jump. This is shown in Figures 2.2.4.1a, 2.2.4.1b, 2.2.4.1d and 2.2.4.1e. The dimensions given apply to the running line of the respective steeplechase laps. The positions of the hurdles should be marked as shown on the Marking Plan in lanes 1 and 3.

2.2.4.4 Suitability for Competition and Official Acceptance

The suitability for competition and official acceptance of the steeplechase track are established within the inspection of the 400m Standard Track. If the radius of the steeplechase track to and/or from the inside water jump is less than 10m, then the facility will only be granted a Construction Category V certificate.

2.3 Facilities for Jumping Events

The Jumping Events are Long Jump, Triple Jump, High Jump and Pole Vault. The facilities required for these are described in Section 2.1.1.2. Further details are given in Sections 2.3.1 to 2.3.4. These facilities preferably should not be on the infield because of the potential safety and event scheduling problems.

2.3.1 LONG JUMP FACILITY (See 2.1.1.2)

2.3.1.1 Layout (Figures 2.3.1.1a and b)

The Long Jump facility includes a runway, a take-off board and a landing area. Usually, it is placed outside the track along one of the straights with two adjacent runways with the landing areas offset at each end as shown in Figure 2.5a, thus allowing competition in either direction by two groups of athletes simultaneously. This is mandatory for Construction Categories I and II.

2.3.1.2 Runway (Figures 2.3.1.1a and b)

The length provided for the Long Jump runway shall be 40m min. but at least 45m for major international competitions and is measured from the beginning of the runway to the take-off line. The runway shall be $1.22\text{m} \pm 0.01\text{m}$ wide. It shall be marked by white lines 0.05m wide or broken lines 0.05m wide, 0.10m long and 0.50m apart. The runway is usually covered with the same surface as the track.

The maximum allowance for the overall downward inclination of the runway in the last 40m in the running direction shall not exceed 1:1000 (0.1%) when measured to the level of the lowest part of the take-off board.

2.3.1.3 Take-off Board (Figure 2.3.1.1a and Chapter 6)

The Long Jump take-off board shall be rectangular and shall measure $1.22\text{m} \pm 0.01\text{m}$ long, $0.20\text{m} \pm 0.002\text{m}$ wide and not more than 0.10m deep. It shall be coloured white. The surface of the take-off board, and any blanking board, must be flush with the surface of the runway.

In the case of a runway with a permanent surface, this requires a built-in installation tray made of corrosion-protected metal in which the take-off board can be correctly positioned. During sport-free periods, the take-off board can be removed. If it has a track surface on its reverse side, it can be turned over and used as part of the runway. Alternatively, a separate non-corrosive metal blanking board with a synthetic surface may be used. This makes it possible to combine Long and Triple Jump with two or three take-off boards (which can be used on both sides) on a Triple Jump runway.

The take-off boards and the blanking boards shall not have any exposed metal at the runway surface level.

(For the take-off board itself, see also Chapter 6.)

2.3.1.4 Landing Area (Figure 2.3.1.1a and b)

The Long Jump landing area must be 8m to 10m long depending on the distance between its nearer end and the take-off line and shall be 2.75m min. wide. Generally, a landing area length of 8m placed 2m (3m, if the facility is used for major international competitions) from the take-off line is recommended. The landing area shall, if possible, be so placed that the middle of the runway coincides with the middle of the landing area. If two landing areas are situated parallel side by side, the distance between them must be at least 0.30m. Staggering the two landing areas is preferred, with the separation between the two areas being at least 0.30m (Figure 2.3.1.1b).

If there are two or three parallel runways using a common landing area, the width

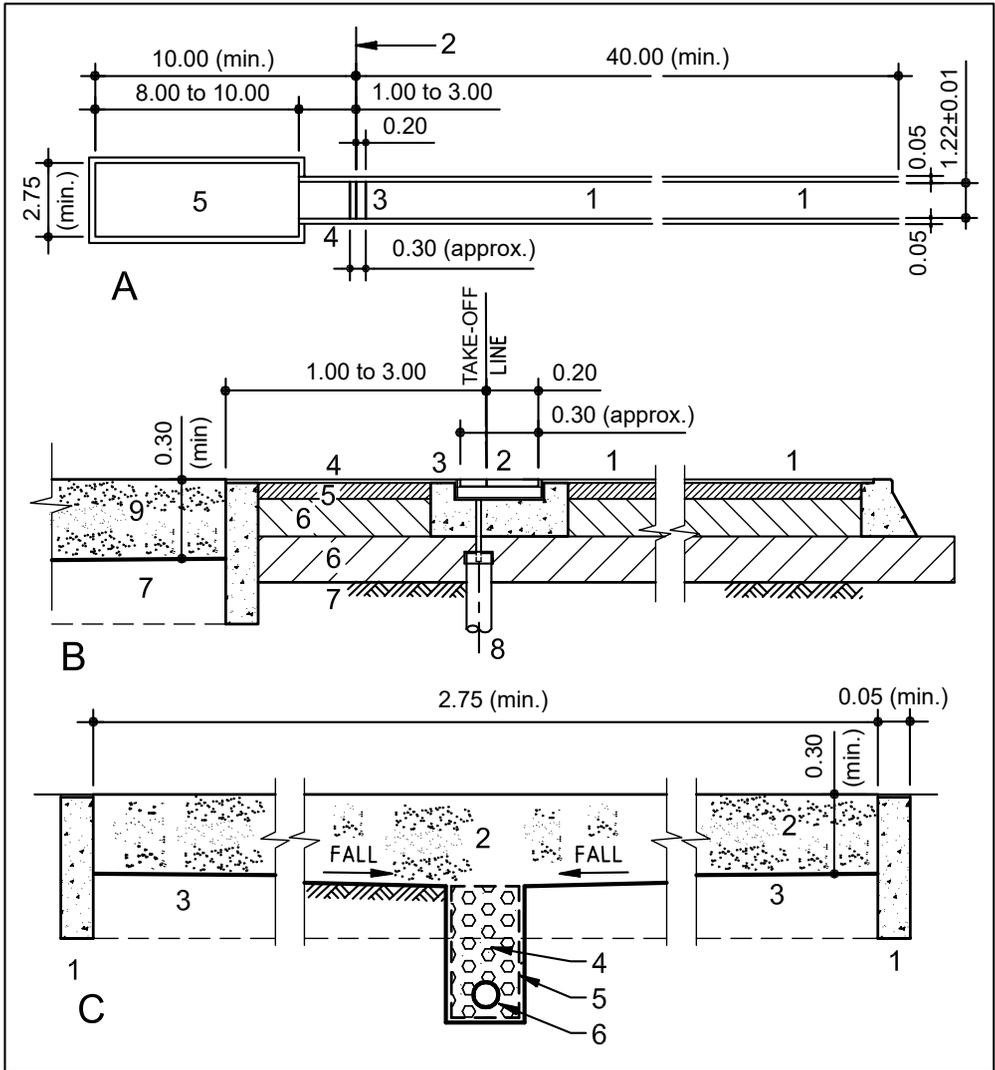


Figure 2.3.1.1a - Long Jump facility (Dimensions in m)

- A Layout plan
 1 Runway 40m (min.)
 2 Take-off line
 3 Take-off board
 4 Built-in tray
 5 Landing area

- B Longitudinal section of built-in tray for take-off board
 1 Runway
 2 Removable take-off board with adjustable legs
 3 Built-in tray
 4 Synthetic surface
 5 Asphaltic concrete layer
 6 Gravel base layer
 7 Subgrade
 8 Tray drainage
 9 Landing area

- C Cross section of landing area
 1 Pit edge with flexible material on the top
 2 Washed river sand 0 to 2mm granules, no organic components, max. 5% of weight up to 0.20mm
 3 Subgrade
 4 Drainage gravel
 5 Geo fabric material
 6 Subsoil drainage pipe

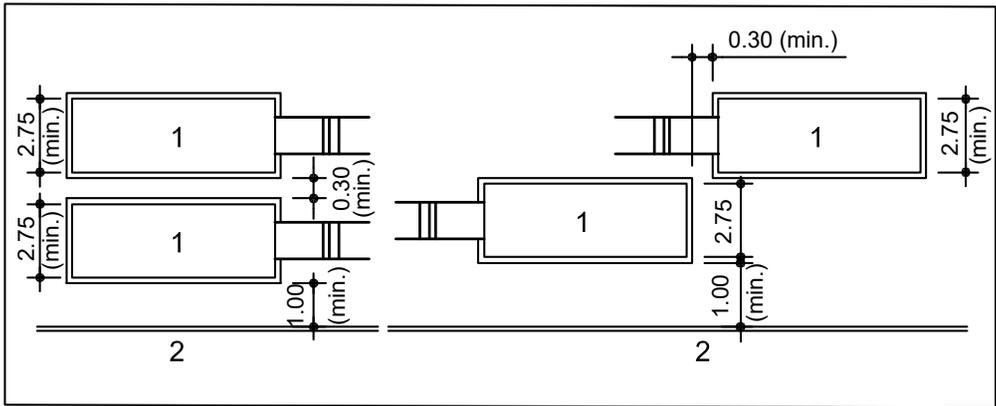


Figure 2.3.1.1b - Minimum distance of parallel situated Long and Triple Jump facility
(Dimensions in m)

- 1 Landing area
2 Outer lane

of the landing area should be as shown in Figure 2.3.1.4a and Figure 2.3.1.4b so that, with the centreline of the part of the landing area corresponding with the centreline of the runway, the width of the relevant part of the landing area is between 2.75m and 3.00m. The tolerance on any difference between the centreline of the landing area and the centreline of the runway is 0.05m.

Where new facilities are developed at which it is envisaged that visually impaired athletes will compete, at least one landing area should be built with an increased width (3.50m instead of 3.00m maximum as in the Rules) as recommended by IPC. When used for World Athletics competitions, such a landing area will need to be taped temporarily so as to limit the width of the landing area to 3.00m maximum.

The landing area should have a border not less than 0.05m wide and 0.30m high, rounded off towards the inside (e.g. wooden plank or concrete border with soft covering) and level with the ground. The border should be white coloured.

The landing area must have a water permeable substructure or a suitable drainage system (draining well or canal connection) and be filled with sand to a depth of not less than 0.30m at the edges and slightly deeper at the centre. If the base of the landing area is concrete, it is recommended to increase the depth up to 0.40m.

The top edge of the border of the landing area, which generally also dictates the level of the sand, must be level with the take-off board. The landing area border level may not be more than 0.02m lower than the highest part of the highest take-off board. Landing areas wider than 3.00m used for multiple runways can be a particular problem in this regard. It may be necessary to warp the runway from the Triple Jump board to the nearer edge of the landing area and/or make the landing area level.

2.3.1.5 Safety

For the safety of the athletes, the sand must (to avoid hardening as a result of moisture) consist of washed river sand or pure quartz sand, without organic components, maximum 2mm granules, of which not more than 5% in weight is less than 0.2mm.

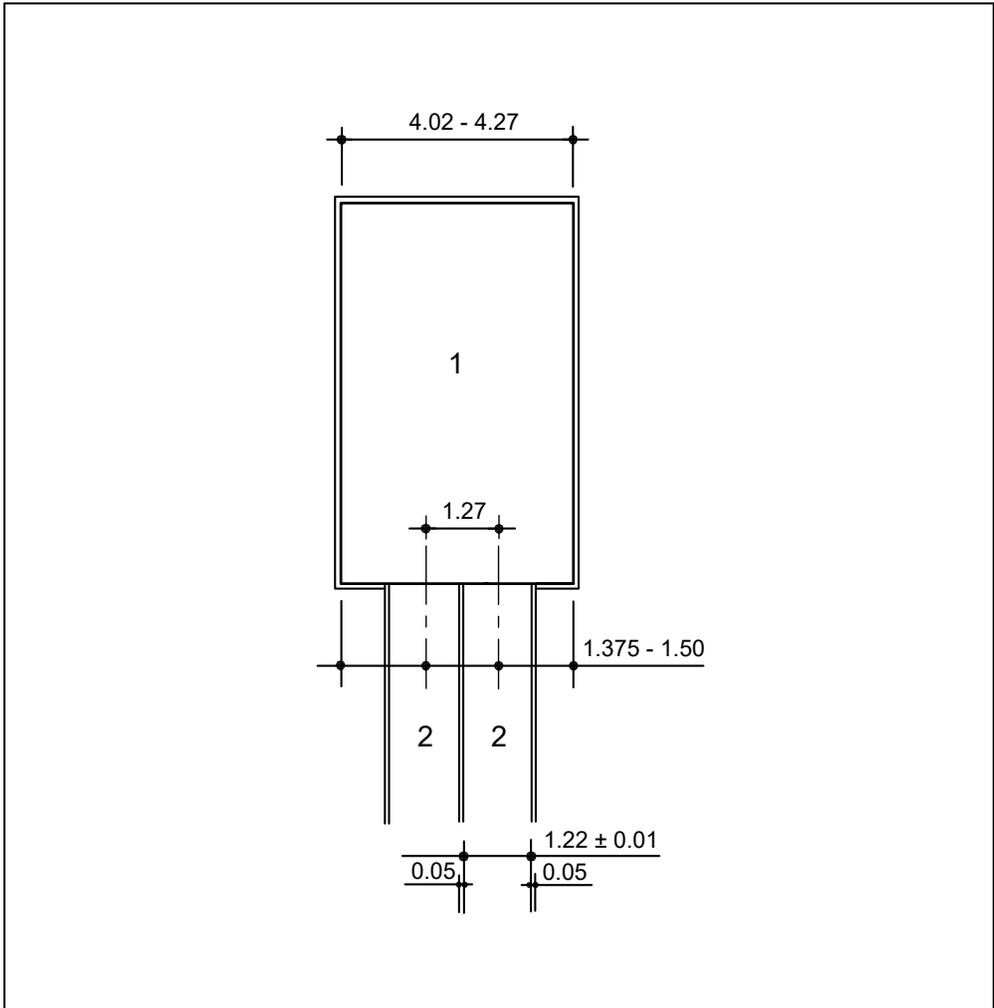


Figure 2.3.1.4a - Two-runway Long and Triple Jump landing area (Dimensions in m)

- 1 Landing area
- 2 Runway

It is also important to ensure that the top edge of the border of the landing area is designed using flexible material and rounded off.

Take-off boards installed permanently in synthetic runways are often the cause of accidents because the unevenness which necessarily occurs in the surface between them and the runway cannot be levelled out. This can be alleviated by using adjustable take-off boards placed in metal trays.

On all occasions, the overall minimum distances between the take-off board and the far end of the landing area must be complied with.

The area beyond the end of the landing area should be level and obstacle-free to allow athletes to run through the landing area.

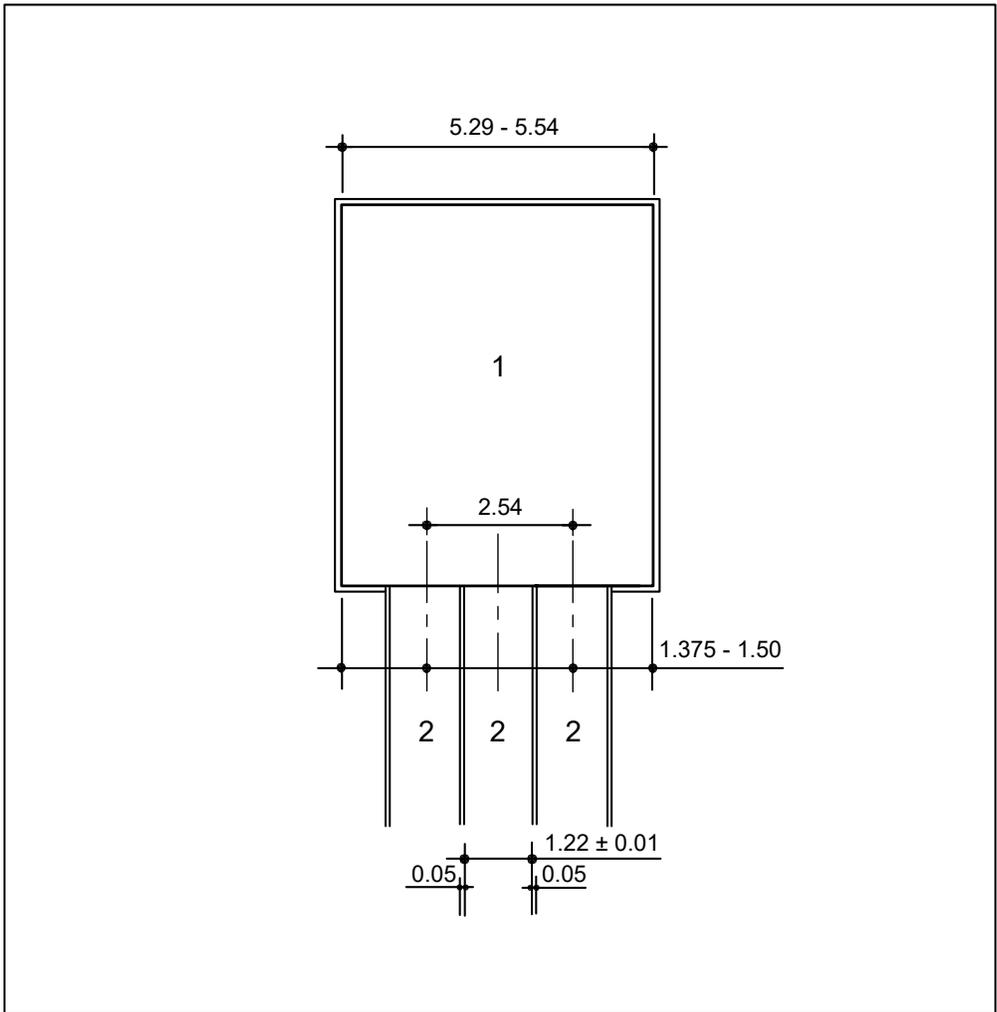


Figure 2.3.1.4b - Three-runway Long and Triple Jump landing area (Dimensions in m)

- 1 Landing area
- 2 Runway

If the Horizontal Jumps facilities are on the infield area, Long Throws should be scheduled so as not to clash with the use of the jump facilities for warm up and competition.

2.3.1.6 Suitability for Competition and Official Acceptance

Long Jump facilities must conform to the specifications. This can be established when inspecting the 400m Standard Track.

2.3.2 TRIPLE JUMP FACILITY (See 2.1.1.2)

2.3.2.1 Layout (Figure 2.3.2.1)

Except for the placement of the take-off board, the same facilities are used for Triple Jump as for Long Jump. For international competition, the take-off line shall be

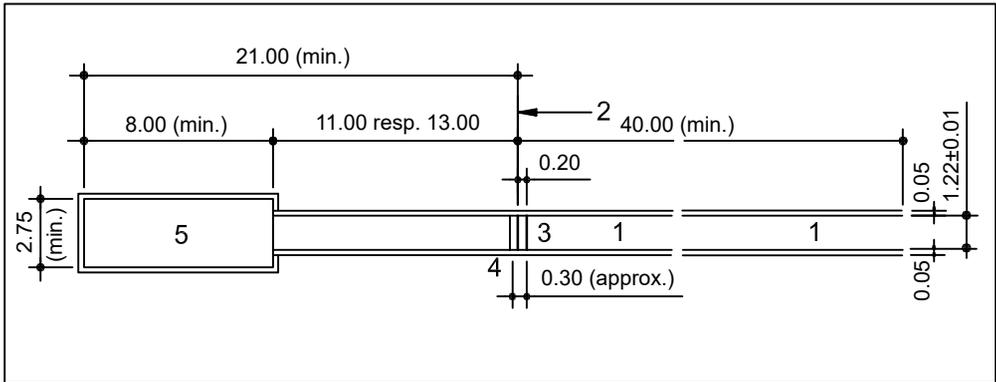


Figure 2.3.2.1 - Triple Jump facility (Dimensions in m)

- 1 Runway 40m (min.)
- 2 Take-off line
- 3 Take-off board
- 4 Built-in tray
- 5 Landing area

not less than 13m for men and 11m for women from the nearer end of the landing area. For other competitions, this distance shall be appropriate for the level of competition. For schools and other younger age competitions, additional “take-off boards” may be painted on the runway.

A Triple Jump facility on a segment inside the curve (“D”) is not recommended, as it is extremely difficult to construct the landing area so that the level of the border is not more than 20mm below the level of the highest part of any take-off board.

2.3.2.2 Runway (Figure 2.3.2.1)

Section 2.3.1.2 also applies to the Triple Jump runway with the exception of the position of the take-off line.

For international competitions, some jumpers request a run-up longer than 45m. Therefore, if space is available designers should consider making the runway at least 50m long to the 13m take-off board.

2.3.2.3 Take-off Board (Figures 2.3.1.1a and Chapter 6)

Section 2.3.1.3 also applies to the Triple Jump take-off board. The integration of the Triple Jump into the Long Jump facility requires a removable take-off board as described under Section 2.3.1.3. For Triple Jump, Sections 2.3.1.4 to 2.3.1.6 also apply.

2.3.3 HIGH JUMP FACILITY (See 2.1.1.2)

2.3.3.1 Layout (Figure 2.3.3.1)

The High Jump facility includes a runway, a take-off area, two uprights with crossbar and a landing area. By temporarily removing sections of the kerb, it is possible to use the oval track as part of the runway. For major championships, the High Jump facility must be large enough so that two High Jumps can be conducted simultaneously.

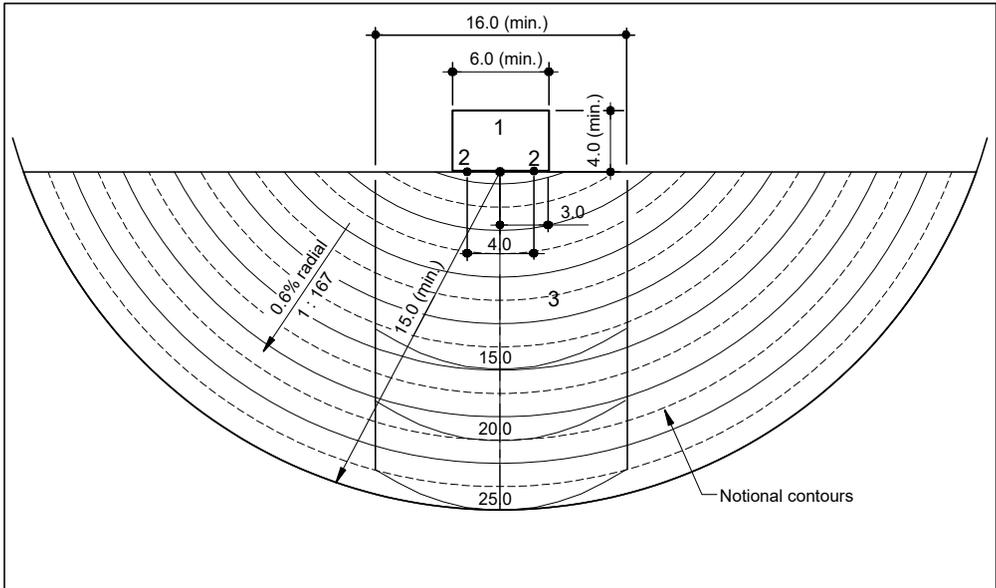


Figure 2.3.3.1 - High Jump facility (Dimensions in m, not to scale)

- 1 Landing mat
- 2 Uprights
- 3 Runway area

2.3.3.2 Runway (Figure 2.3.3.1)

The minimum width of High Jump runway shall be 16m and the minimum length of the runway shall be 15m except for major international competitions where the minimum length shall be 25m but preferably longer, centred midway between the uprights.

The maximum allowance for the overall downward inclination of the runway in the running direction shall not exceed 1:167 (0.6%) when measured along a 15m radius of the 16m wide runway area centred midway between the uprights. The take-off area shall be level or inclined not more than 1:167 (0.6%).

If it is necessary to remove the kerb temporarily in order to be able to use the oval track as a runway, care must be taken to ensure that the heights of the surfaces of the oval track and the segment are the same along the track border. The runway and take-off areas are usually covered with the same surface as the track.

For many competitions, it is necessary to conduct two High Jumps simultaneously under similar conditions. This can best be achieved by having two High Jump runways on the “D” symmetrically placed about a central Javelin Throw runway with the spacing between the two sets of High Jump uprights being between 12m and 15m. This is illustrated on Figure 2.5a.

2.3.3.3 Uprights (See Chapter 6)

The High Jump uprights must be installed $4.02\text{m} \pm 0.02\text{m}$ apart.

2.3.3.4 Landing Mats (Figure 2.3.3.1 and Chapter 6)

The High Jump landing mats shall measure not less than 6.00m × 4.00m and shall be covered by a spike proof protective mat. The overall height shall be minimum 0.70m. It may be placed on a 0.10m high grid which, on all sides, should be boarded to the ground with its front edge 0.10m behind that of the mat.

The landing mats should be placed so that the athlete's approach is up the inclination of the runway.

2.3.3.5 Safety

Of particular importance for the safety of the High Jump is a suitable landing mat, which will allow both sufficient absorption of the impact energy from the fall of the athletes and gives adequate resilience when compressed. The condition of the landing mat must be regularly monitored.

If the oval track is included in the runway, a removable kerb is essential.

2.3.3.6 Suitability for Competition and Official Acceptance

High Jump facilities must conform to the specifications. This can be established when inspecting the 400m Standard Track.

2.3.4 POLE VAULT FACILITY (See 2.1.1.2)

2.3.4.1 Layout (Figure 2.3.4.1)

The Pole Vault facility includes a runway, a box for inserting the pole ("planter box"), two uprights with crossbar and a landing area. It can be located either outside the track, parallel to one of the straights or within one of the segments. When located outside the track, it is usually constructed as a "symmetrical facility" with one landing area in the middle of two runways. When located within a segment, it is usually constructed with two parallel runways with positions for landing areas at each end.

For major championships (Construction Categories I and II), the Pole Vault facility must provide for two Pole Vaults to be conducted simultaneously in the same direction, preferably side by side and with same length of runway for each.

2.3.4.2 Runway with Box (Figure 2.3.4.1)

The length provided for the Pole Vault runway shall be 40m min. and where possible at least 45m. The runway is measured from beginning of the runway to the back end of the box ("0-line"). The runway shall be 1.22m ± 0.01m wide. It shall be marked by white lines 0.05m wide or broken lines 0.05m wide with a length of 0.1m and a distance of 0.5m. The Rules require markers to be placed beside the runway at each 0.5m between the points 2.5m and 5m from the 0-line and at each 1.0m from the 5m to the 18m point. The marks to help placing these markers may be temporary or permanent. At the end of the runway, the box must be mounted flush with the runway and installed such that the top inside edge of its end board lies on the 0-line and at the same height. The 0-line shall be marked by a white line, 0.01m wide which extends beyond the outside edges of the uprights.

The maximum allowance for the overall downward inclination of the runway in the last 40m to the planter box in the running direction shall not exceed 1:1000 (0.1%).

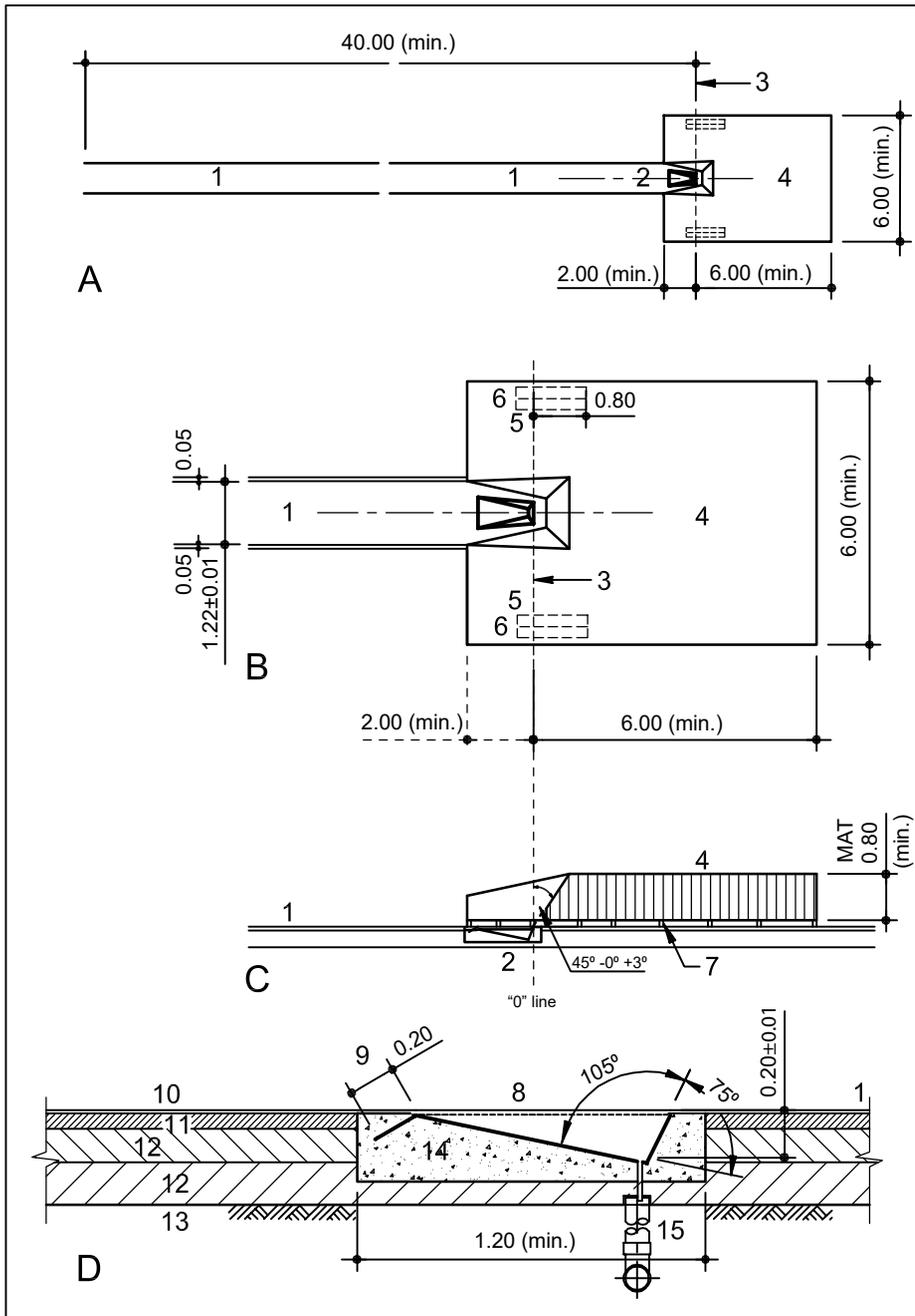


Figure 2.3.4.1 - Pole Vault facility (tolerances: - 0° / +1°, dimensions in m)

- A Layout plan
- B Detailed layout plan
- C Longitudinal section
- D Longitudinal section of the take-off box

- 1 Runway
- 2 Planter box
- 3 0-line
- 4 Landing mat
- 5 Installation zone or ground sockets for uprights
- 6 Protective pad
- 7 Grid

- 8 Cover plate
- 9 Flange
- 10 Synthetic surface
- 11 Asphaltic concrete
- 12 Gravel base layer
- 13 Subgrade
- 14 Concrete
- 15 Drainage pipe

The synthetic surface of the runway should be flush with the top of the planter box.

The dimensions of the box must comply with Figure 2.3.4.1. For convenience, it should be fitted with a drainage pipe and a cover which is level with the runway (see also 6.2.4).

The runway is usually covered with the same synthetic as the track.

2.3.4.3 Uprights (See Chapter 6)

The two movable Pole Vault uprights may be installed on metal bases horizontal in the longitudinal direction. It may be necessary to shim under the base to achieve this. The bases shall be located such that the crossbar on the crossbar supports can be moved from the 0-line not less than 0.80m towards the landing area on a fixed double rail base. Alternatively, the uprights may be installed in fixed ground sockets with movable crossbar supports.

The uprights must be not less than 5.20m apart with approximately 0.10m between each upright and the landing mat. Please note that at some venues the landing mats may be larger than the minimum dimensions specified in the Rules.

The metallic part of any base and the lower part of the uprights shall be covered with appropriate padding to protect the athletes and their poles. The landing mats shall be recessed to take the uprights and any bases. Separate protective pads shall be installed as necessary. The padding must not interfere with the movement of the uprights or transmit movement in the landing mat to the uprights.

Any upright base should be bolted to a substantial concrete strip footing to the upright manufacturer's specification to provide stability. The top surface of the footing should be directly underneath the synthetic surface when a Pole Vault facility is installed on a "D" synthetic surface. Thus, the top surface of the footing should be flush with the level of the asphalt under the synthetic. Using expanding anchors fixings into the asphalt is not acceptable.

Ideally, the level of the two upright bases should be the same but this is rarely possible because the "D" or other location has a crossfall to facilitate drainage. Each individual upright base may be tilted in the lateral direction.

2.3.4.4 Landing Mats (See Chapter 6)

With the exception of the dimensions, Section 2.3.3.4 shall apply for the Pole Vault landing mats. For major international competitions, the landing area shall not be smaller than 6.00m long (excluding the front pieces) × 6.00m wide × 0.80m high. It may be placed on a 0.10m high grid. The front pieces must be at least 2m long. The sides of the landing area nearest to the box shall be placed 0.10m - 0.15m from the box and shall slope away from the box at an angle of 45° - 00 + 30 from the vertical. For other competitions, the landing area should measure not less than 5.00m long (excluding the front pieces) × 5.00m wide.

2.3.4.5 Safety

For the safety of the Pole Vault, Sections 2.3.3.4 and 2.3.3.5 relating to the landing mat shall apply. The uprights must be mounted such that they are not easily

tilted. The Pole Vault box, when not in use, should have a cover which has the same synthetic surface as the runway, does not move when run on and is level with the ground. The minimum clearance from the centre of the runway to the edge of an adjoining Field Event facility, running track or a spectator fence should be 6m.

2.3.4.6 Suitability for Competition and Official Acceptance

Pole Vault facilities must conform to the specifications. This can be established when inspecting the 400m Standard Track.

2.4 Facilities for Throwing Events

The throwing events are the Discus Throw, the Hammer Throw, the Javelin Throw and the Shot Put. The facilities required for these are described under Section 2.1.1.3. Further details are listed in the Sections 2.4.1 to 2.4.5.

The landing sector shall consist of cinders or grass or other suitable material with an even surface soft enough to ensure that the place of the initial fall of the implement can be clearly established by the judges. The landing surface may not allow the implement to bounce backwards, thus creating a risk that the measuring point is obliterated.

The maximum allowance for the overall downward inclination of the landing sector, in the throwing direction at any point, shall not exceed 1:1000 (0.1%) when measured from the level of the centre of the circle or the level of the centre of the throwing arc.

Normally, the infield grass should be cut to a height of 0.03m to 0.04m. However, prior to competition, in order to facilitate judging, the grass height in the landing area should be reduced to not more than 0.025m. The grass has to allow the implement to travel through the grass sward before embedding in the ground beneath or leaving a visible mark when the implement bounces after contact.

A few synthetic surface materials have been developed for which it is claimed that the surfaces can be used for football as well as for all athletics throwing events. Anyone thinking of installing such a surface should consult with the local athletics and football federations and, if necessary, World Athletics before making a final decision. (See also 1.5.3)

Throwing circle metal rims are supplied with bracing to maintain the circularity of the rim but the diameters should be checked before installing the rim to ensure that the circle has not warped during handling. Additional bracing may be required before any concrete is carefully vibrated around the rim.

The "ground" around the circle may be constructed of concrete, synthetic, asphalt, wood or any other suitable material or a combination of these materials. However, the top of the ground must be flush with the top of the circle rim. Where possible, the surround, which should slope outwards so as to shed water away from the circle, shall be at least 0.75m wide to allow the 0.75m long white lines defining the rear portion of the circle to be marked on the surround.

For major events, the surface of a throwing circle at the warm-up area should be similar to that type of circle at the competition site.

2.4.1 DISCUS THROW FACILITY (See 2.1.1.3)

2.4.1.1 Layout (Figure 2.4.1.1)

The Discus Throw facility includes a throwing circle, a protective cage and a landing sector. Generally, the discus facility is combined with the hammer facility within a common cage designed specifically for hammer throwing located in the segment near the 1500m start. The hammer cage gates may be used to reduce the danger zone for discus throwing. A second discus facility may be located in the segment near the 200m start to take advantage of wind conditions. In each case, the landing sector is located in the grass area inside the track.

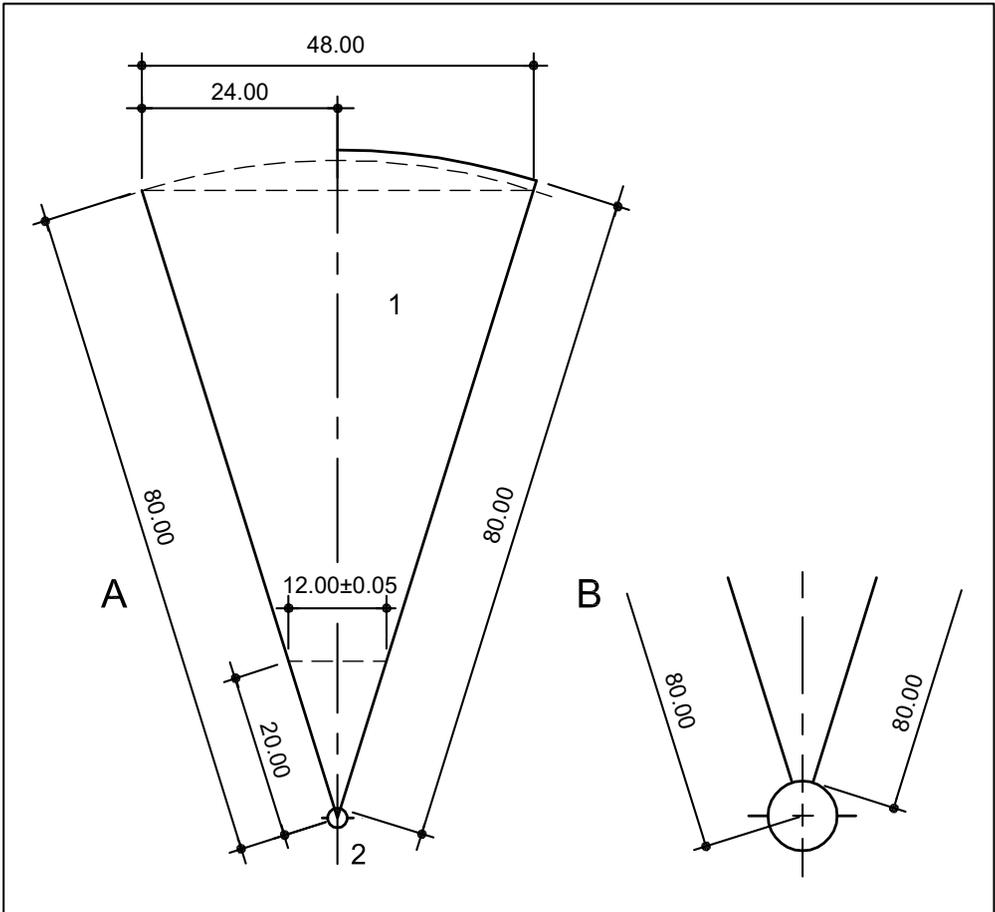


Figure 2.4.1.1 - Discus Throw facility (Dimensions in m)

A Setting out plan

B Marking plan

1 Landing sector

2 Throwing circle

The Discus Throw facility near the 1500m start is usually combined with a Hammer Throw facility, the only difference being the diameter of the throwing circle which is 2.50m for Discus Throw and 2.135m for Hammer Throw and the protective cage must meet the more stringent requirements for hammer throwing. If two separate discus and hammer circles are placed within the hammer protective cage, then the Discus Throw circle should be the circle closer to the landing sector.

2.4.1.2 Throwing Circle (Figure 2.4.1.2)

The Discus Throw circle shall be made of band iron, steel or other suitable material, the top of which shall be flush with the ground around the circle. (See also 2.4.) The interior of the circle shall be constructed of concrete, asphalt or some other firm but not slippery material.

The surface of the interior shall be level and $0.02\text{m} \pm 0.006\text{m}$ lower than the upper edge of the rim of the circle. The inside diameter of the circle shall be $2.50\text{m} \pm 0.005\text{m}$. The rim of the circle shall be at least 6mm thick, 70mm to 80mm deep and painted white. The centre of the circle through which all performances are measured shall be marked. (This is best done using a brass tube with a 4mm inside diameter laid flush with the surface of the circle). In addition, at the edge of the throwing circle, four or more evenly distributed, non-corrodible drainage pipes (e.g. brass pipe with a 20mm diameter) should be laid flush with the surface of the circle and in such a way that they reach down to the water permeable substructure or can be connected to a drainage system.

The throwing circle can be made of a minimum 0.15m thick welded wire mesh reinforced slab of 25MPa compressive strength concrete which lies on a frost-proof supporting layer. The throwing circle should be fixed when the concrete slab is laid. The circle rim must be radially braced so that the rim will not distort when the concrete is vibrated against it. The top surface of the concrete slab (= throwing area) must be finished with a smooth wood float for sufficient traction. For 1m³ of 25MPa compressive strength concrete, the following quantities are required: 300kg of cement, 135l of water and 1865kg of 0mm-20mm natural coarse aggregate. This yields a raw concrete weight of 2300kg/m³. If a material other than concrete is used for the slab, its surface properties must be similar to those of concrete. A white line 0.05m wide and 0.75m min. long shall be marked on either side of the circle. The rear edge of the white line shall form a prolongation of a theoretical line through the centre of the circle at right angles to the centreline of the landing sector.

2.4.1.3 Safety Cage (Figure 2.4.1.2 and Chapter 6)

Frequently, discus and hammer are thrown from a combined facility. Therefore in those instances, the higher standards required for hammer throwing apply to the protective cage design. The cage gates shall be positioned so that the end of the cage sides in discus throwing mode are not less 7m from the centre of the circle and 6m apart at the opening. The end points of the 6m wide mouth shall be the inner edge of the cage netting. The height of the netting panels or draped netting at their lowest point should be at least 4m and it should be at least 6m for the 3m nearest the front of the cage on each side. To provide greater safety for a stand-alone discus cage, it may be desirable to extend the netting on the side of the cage nearer to the track further than 7m from the centre of the circle and/or increase the height of the netting above 6m for the extension.

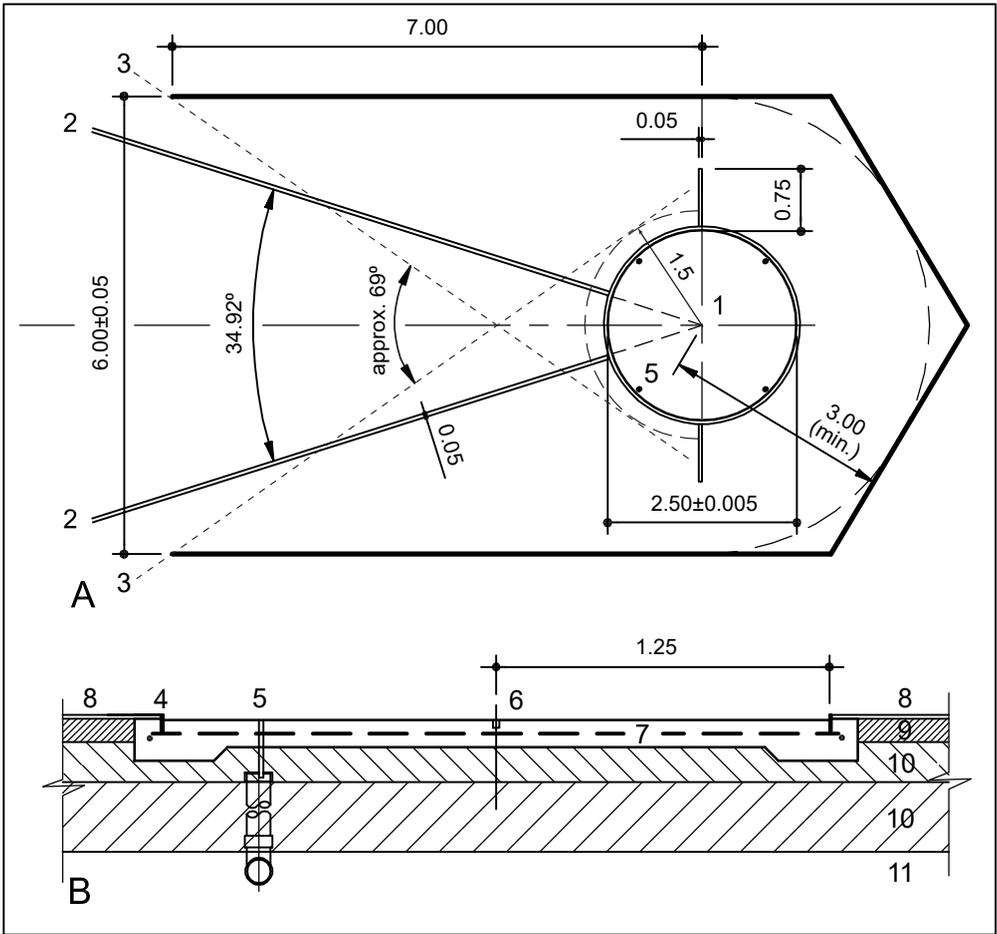


Figure 2.4.1.2 - Detail plan of Discus Throw circle and cage siting
(Dimensions in m)

A Layout plan
B Section through throwing circle

- 1 Centre point (intersection point of setting out plan)
- 2 Marking for the landing sector
- 3 Danger zone
- 4 Circular metal rim
- 5 Drainage pipe
- 6 Centring hole 4mm diameter (brass tube)
- 7 Concrete base with reinforcing mesh
- 8 Synthetic surface
- 9 Asphaltic concrete
- 10 Gravel base layer
- 11 Subgrade

2.4.1.4 Landing Sector (Figure 2.4.1.1)

For the Discus Throw landing sector, Section 2.4 shall apply in general with the following exceptions:

The landing sector must be laid from the middle of the circle with an angle of 34.92 degrees and shall be marked by 0.05m wide white lines, the inside edges of which form the boundary of the sector. The centreline of the sector should correspond with the centre of the cage opening. The length of the sector for international competitions shall be 80m. Its angle of 34.92 degrees will be attained if the two sector lines, at a distance of 80m, are spaced 48m apart. The marking of the sector lines shall extend to a distance appropriate to the competition.

2.4.1.5 Safety

The layout and erection of the protective cage are especially important for the safety of the Discus Throw facility. It is important to ensure the correct position of the axis of the landing sector in relation to the opening of the cage. For the safety of the Discus Throw facility, care must be taken to ensure that nobody enters the danger zone during the throw. Therefore, additional fencing at least 1.00m outside the sector lines is recommended. This fence also arrests skidding implements. The protective cage must be checked before each competition to ensure correct assembly and condition.

A location near the 1500m start is preferred for both discus and hammer throwing as most throwers are right-handed and therefore the fall of most of the implements is away from the oval track.

The cage must be correctly operated throughout training, warm up and competition.

2.4.1.6 Suitability for Competition and Official Acceptance

Discus Throw facilities must conform to the specifications. This can be established when inspecting the 400m Standard Track.

2.4.2 HAMMER THROW FACILITY (See 2.1.1.3)

2.4.2.1 Layout (Figure 2.4.2.1)

The Hammer Throw facility includes a throwing circle, a protective cage and a landing sector. It is usually combined with the Discus Throw facility. Section 2.4.1 applies.

2.4.2.2 Throwing Circle (Figure 2.4.2.2)

For the Hammer Throw circle, Sections 2.4 and 2.4.1.2 shall apply in general with the following exceptions:

The diameter of the throwing circle is $2.135\text{m} \pm 0.005\text{m}$. For a combined Discus and Hammer Throw facility, the diameter of the throwing circle is $2.50\text{m} \pm 0.005\text{m}$. It is reduced in size to $2.135\text{m} \pm 0.005\text{m}$ for Hammer Throw by inserting a 0.1825m wide and 0.02m high ring of suitable construction. The inserted ring must be fixed into the throwing circle such that it is level with the outer ring and constitutes no risk to the athletes. The inside rim of the insert shall be painted white. The top of the insert should be coloured other than white and have a non-slip finish. If the top of the insert is coloured white it is necessary to extend the 0.05m wide white lines defining the rear portion of the circles in a distinctive colour across the insert. For the throwing circle for Hammer Throw, a Shot Put circle (without stop board) may also be used if it is furnished with a suitable protective cage in accordance with Section 2.4.2.3.

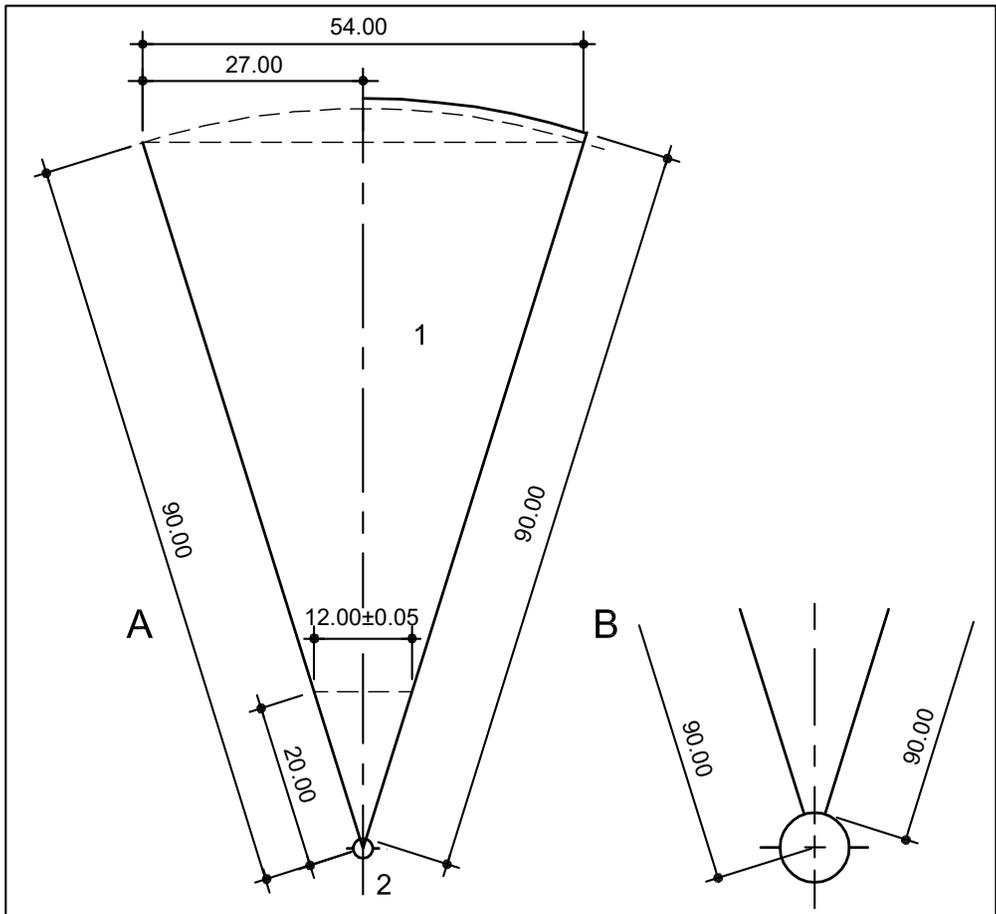


Figure 2.4.2.1 - Hammer Throw facility (Dimensions in m)

A Setting out plan
B Marking plan

1 Landing sector
2 Throwing circle

The surface finish to the concrete circle should be slightly smoother for hammer throwing than for discus throwing. When a circle is used for both discus and hammer throwing a compromise finish is required. The advice of an experienced throws coach and/or an elite hammer thrower might be sought in obtaining an appropriate surface finish.

2.4.2.3 Safety Cage (Figure 2.4.2.2 and Chapter 6)

It is essential that the Hammer Throw protection cage installed conforms to the requirements of Chapter 6 and is properly erected and operated. The necessary equipment for erecting and anchoring the protective enclosure should be installed together with the throwing circle.

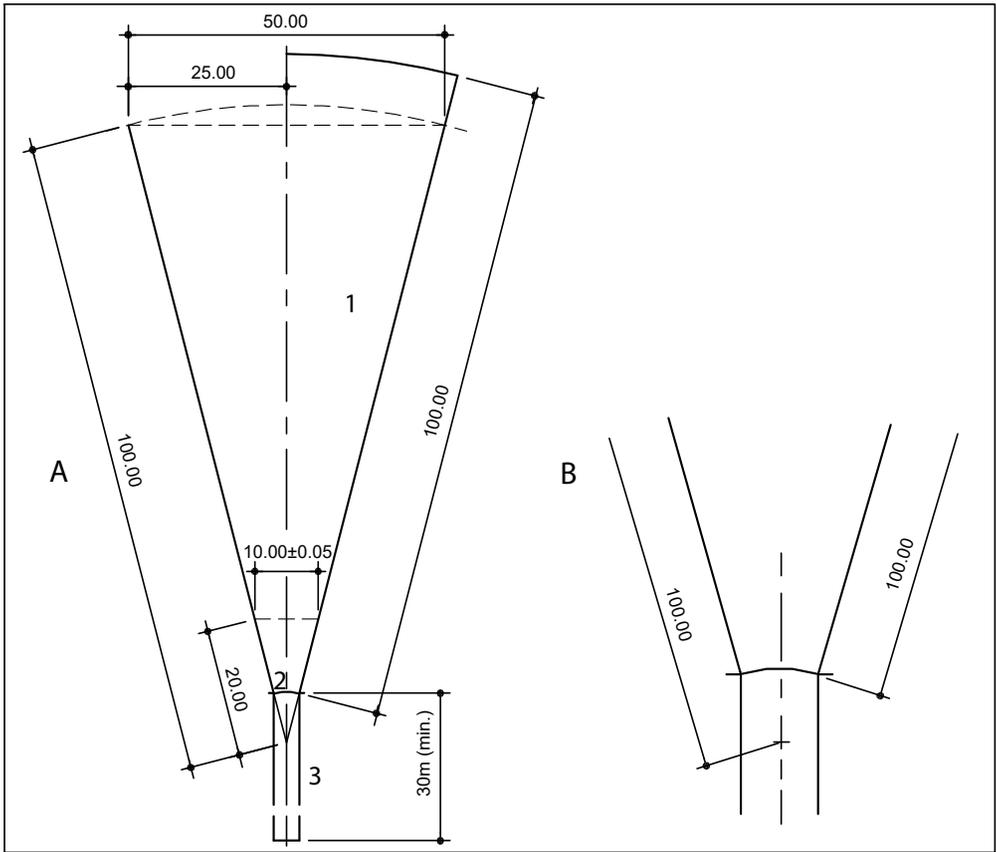


Figure 2.4.3.1 - Javelin Throw facility (Dimensions in m)

A Setting out plan
B Marking plan

1 Landing sector
2 Throwing arc
3 Runway

2.4.2.4 Landing Sector (Figure 2.4.2.1)

For the Hammer Throw landing sector, Section 2.4 shall apply in general with the following exceptions:

The length of the landing sector for international competitions shall be 90m. Its angle of 34.92 degrees will be attained if the two boundary lines at a distance of 90m are spaced 54m apart. The marking of the sector lines shall extend to a distance appropriate to the competition.

2.4.2.5 Safety

Section 2.4.1.5 shall also apply to the safety of the Hammer Throw facility.

A hammer cage should not be located near the 200m start or the finish line as some hammers are likely to land on the track.

2.4.2.6 Suitability for Competition and Official Acceptance

Hammer Throw facilities must conform to the specifications. This can be established when inspecting the 400m Standard Track.

2.4.3 JAVELIN THROW FACILITY (See 2.1.1.3)

2.4.3.1 Layout (Figure 2.4.3.1)

The Javelin Throw facility includes a runway, a throwing arc and a landing sector. Usually, two facilities are constructed with a runway parallel to the straights located through the centre of each of the segments. Since the length of the runway exceeds the space available in the segment, it is usually extended across the track and track border. In such cases, it is necessary to have a removable kerb and the height of the surfaces of the oval track and the segment must be the same along the track border. For a runway in either segment, the landing sector is located in the grass area inside the track.

2.4.3.2 Runway (Figure 2.4.3.2)

The length of the Javelin Throw runway shall be 30.00m minimum, which is measured from the beginning of the runway to the rear edge of the side markings outside the runway at the same level as the throwing arc and should extend at least 0.5m past the throwing arc (“over-run”). For Construction Categories I, II and III, the runways shall be at least 33.5m long. However, for major competitions, a runway at least 36.5m long should be provided. The runway is usually covered with the same surface as the track. It shall be marked by two parallel white lines 0.05m wide and 4.00m ± 0.01m apart. Two white square marks 0.05m × 0.05m beside the runway four metres back from the end points of the throwing arcs assist the officials in determining the leaving of the runway and in speeding up measuring the throw.

The maximum allowance for the overall downward inclination of the runway in the last 20m to the throwing arc in the running direction shall not exceed 1:1000 (0.1%).

2.4.3.3 Throwing Arc (Figure 2.4.3.2 and Chapter 6)

The Javelin Throw arc is situated at the end of the runway. It may be painted or made of other suitable material. If not marked with paint, it must be installed flush with the surface of the runway.

The throwing arc shall be at least 0.07m wide, coloured white and curved with a radius of 8.00m from the centre point in the middle of the runway, in the throwing direction. It is advisable that the centre point is marked with a synthetic plug of a different colour to the surface, with a diameter and surface thickness of 20mm to 30mm. Lines shall be drawn from the extremities of the arc at right angles to the parallel lines marking the runway. These lines shall be white, at least 0.75m in length and at least 0.07m wide.

2.4.3.4 Landing Sector (Figure 2.4.3.1)

For the Javelin Throw landing sector, Section 2.4 shall apply in general with the following exceptions:

The sector lines shall be laid from the centre point on the runway through the cross-points of the throwing arc and the lines of the runway. The length of the sector

for international competitions shall be 100m. At this distance, the inner edges of the sector lines shall be 50.00m apart. The marking of the sector lines shall extend to a distance appropriate to the competition.

2.4.3.5 Safety

For the safety of the Javelin Throw facility, an even-surfaced transition must be guaranteed between the segment and the oval track in the area around the removable kerb.

2.4.3.6 Suitability for Competition and Official Acceptance

Javelin Throw facilities must conform to the specifications. This can be established when inspecting the 400m Standard Track.

2.4.4 SHOT PUT FACILITY (See 2.1.1.3)

2.4.4.1 Layout (Figure 2.4.4.1)

The Shot Put facility includes a throwing circle, a stop board and a landing sector.

At least two facilities are usually constructed at one end of the arena to allow simultaneous competition by two groups of athletes under similar conditions. The circles are located within the segments dependent upon the location of other Field Event facilities. If the facilities are installed adjoining the 100m start area, then sufficient clearance must be allowed from the Shot Put circle so that the starter's stand can be installed. The landing sector is usually located in the grass area inside the track.

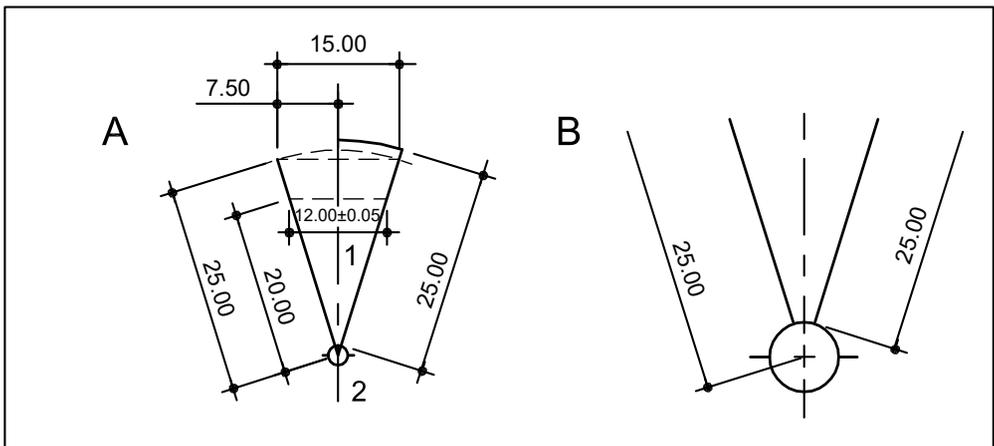


Figure 2.4.4.1 - Shot Put facility (Dimensions in m)

A Setting out plan

B Marking plan

1 Landing sector

2 Throwing circle

2.4.4.2 Throwing Circle (Figure 2.4.4.2)

For the Shot Put circle, Sections 2.4 and 2.4.1.2 shall apply in general with the following exception:

The inside diameter of the throwing circle is $2.135\text{m} \pm 0.005\text{m}$.

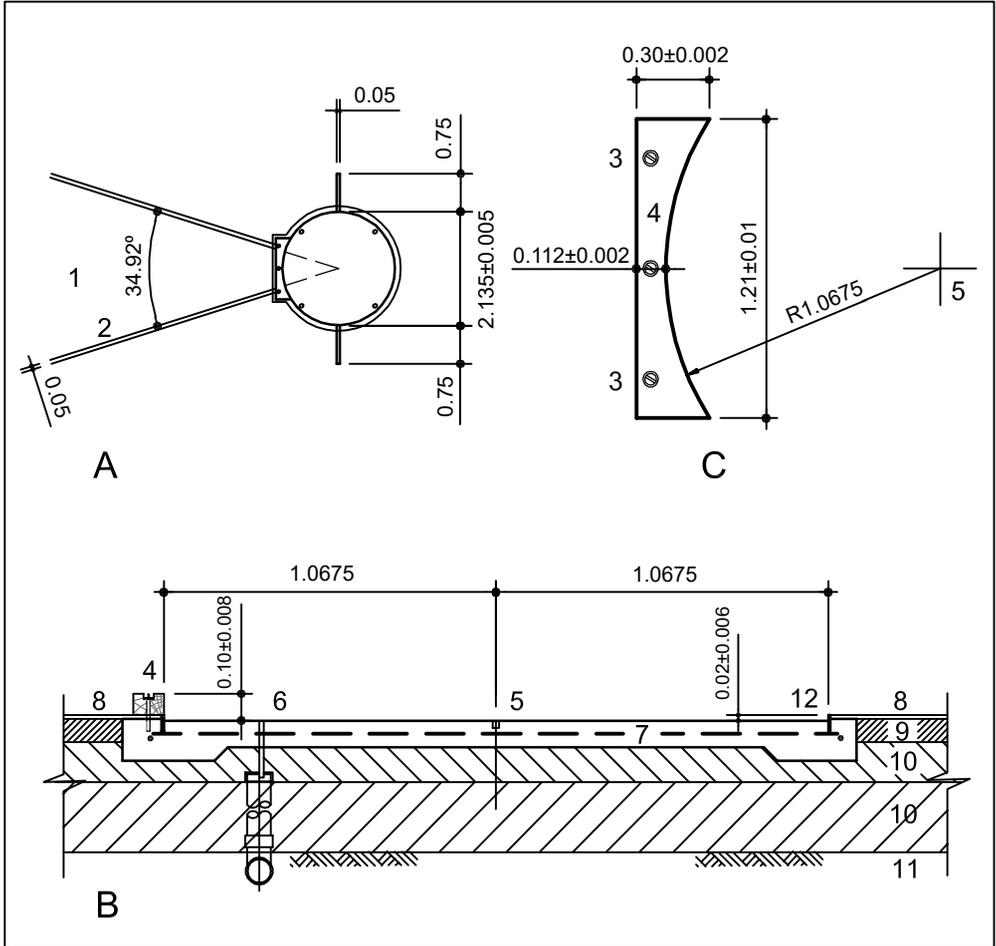


Figure 2.4.4.2 - Shot Put circle (Dimensions in m)

- A Layout plan
- B Detail section
- C Stop board

- | | |
|--|--|
| <ul style="list-style-type: none"> 1 Landing sector 2 Marking for the landing sector 3 Fastening attachment 4 Stop board 5 Centring hole 4mm diameter (brass tube) 6 Drainage pipe | <ul style="list-style-type: none"> 7 Concrete base with reinforcing mesh 8 Synthetic surface 9 Asphaltic concrete 10 Gravel base layer 11 Subgrade 12 Circular metal rim |
|--|--|

2.4.4.3 Stop Board (Figure 2.4.4.2 and Chapter 6)

The Shot Put stop board shall be white and made of wood or other suitable material in the shape of an arc so that the inner surface aligns with the inner edge of the rim of the circle and is perpendicular to the surface of the circle. It shall be placed so that its centre coincides with the centreline of the landing sector and shall be firmly fixed to the ground outside the circle. It shall be $1.21\text{m} \pm 0.01\text{m}$ long on the inside. The width at the narrowest point is $0.112\text{m} \pm 0.002\text{m}$ and the height is $0.10\text{m} \pm 0.008\text{m}$ measured above the adjoining surface of the circle when the stop board is firmly in position. (See also 6.3.1)

A stop board complying with the 1983/84 specification remains acceptable. (Figure available on the website.)

2.4.4.4 Landing Sector (Figure 2.4.4.1)

For the Shot Put landing sector, Section 2.4 shall apply in general with the following exceptions:

The length of the sector for international competitions shall be 25.00m. The angle of 34.92 degrees will be attained if the two sector lines, at a distance of 25.00m, are spaced 15m apart. The marking of the sector lines shall extend to a distance appropriate to the competition.

2.4.4.5 Safety

For the safety of the Shot Put facility, care must be taken to ensure that nobody enters the landing sector during the throw.

2.4.4.6 Suitability for Competition and Official

Shot Put facilities must conform to the specifications. This can be established when inspecting the 400m Standard Track.

2.5 Layout of the "Standard Competition Arena"

This arena corresponds to the categories given in Table 1.5.3, Chapter 1, Construction Category I, and is recommended as the Standard Competition Arena.

The Field Events are evenly distributed over the arena to avoid congestion and to satisfy the needs of the spectators. This layout avoids undue disruption of events by ceremonies and counterbalances the concentration of interest in the finish area.

The layout is, of course, flexible. Local climatic conditions particularly wind conditions and the effects of the rays of the sun on jumpers / vaulters must be considered.

Figures 2.5b and 2.5c show the slope of the northern segment (radial and lean-to slopes), Figures 2.5d and 2.5e the slope of the southern segment (radial and lean-to slopes).

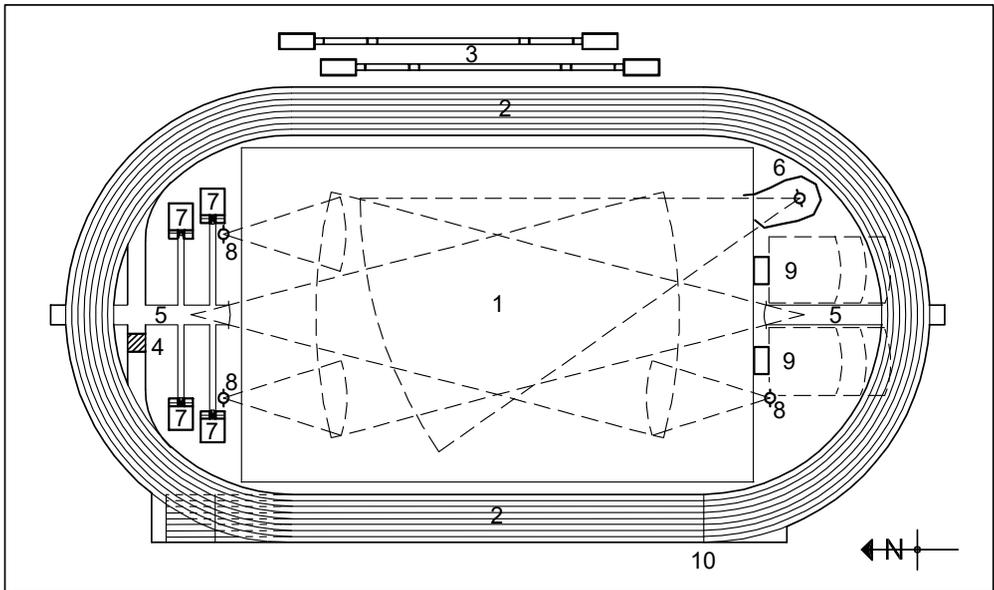


Figure 2.5a - Standard layout of competition facility

- 1 Football pitch
- 2 Standard Track
- 3 Long and Triple Jump facility
- 4 Water jump
- 5 Javelin Throw facility
- 6 Combined Discus and Hammer Throw facility
- 7 Pole Vault facility
- 8 Shot Put facility
- 9 High Jump facility
- 10 Finish line

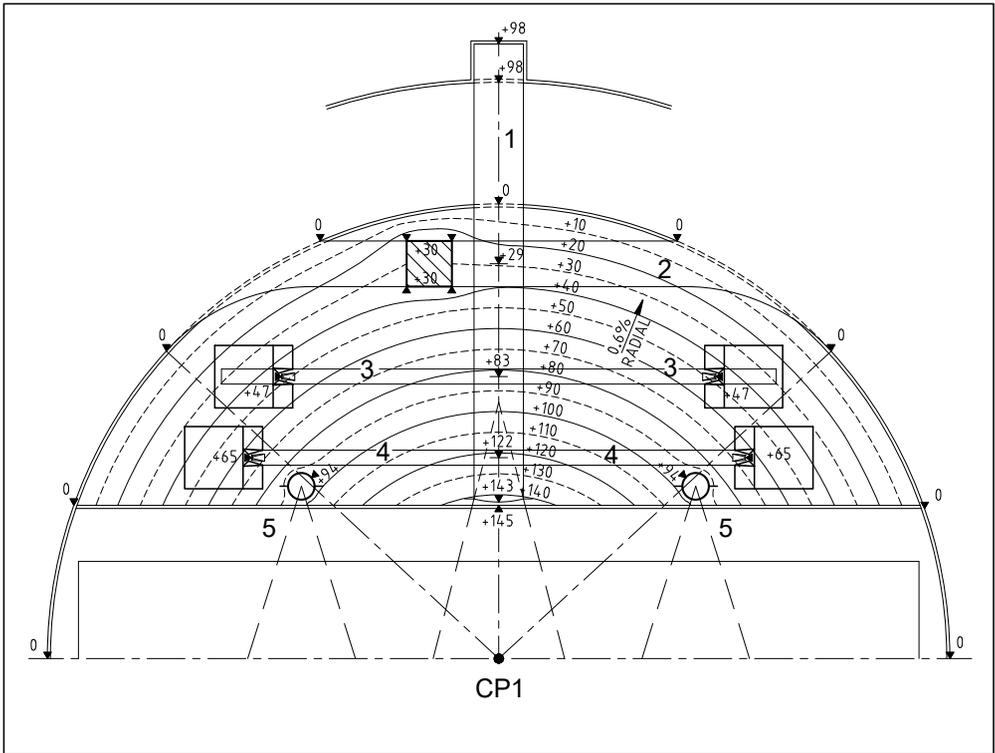


Figure 2.5b - North segment of 400m Standard Track with radial slope of 0.6%
 (Dimensions of distance in m, dimensions of height in mm)

- 1 Javelin Throw runway
 Start of runway: +98mm (Standard 8-lane track at 1.0%)
 End of runway (throwing arc) : +143mm
- 2 Steeplechase track
- 3 Pole Vault facility
 Planter boxes: +47mm
 Centre of runway: +83mm
- 4 Pole Vault facility
 Planter boxes: +65mm
 Centre of runway: +122mm
- 5 Shot Put circle rim: +94mm

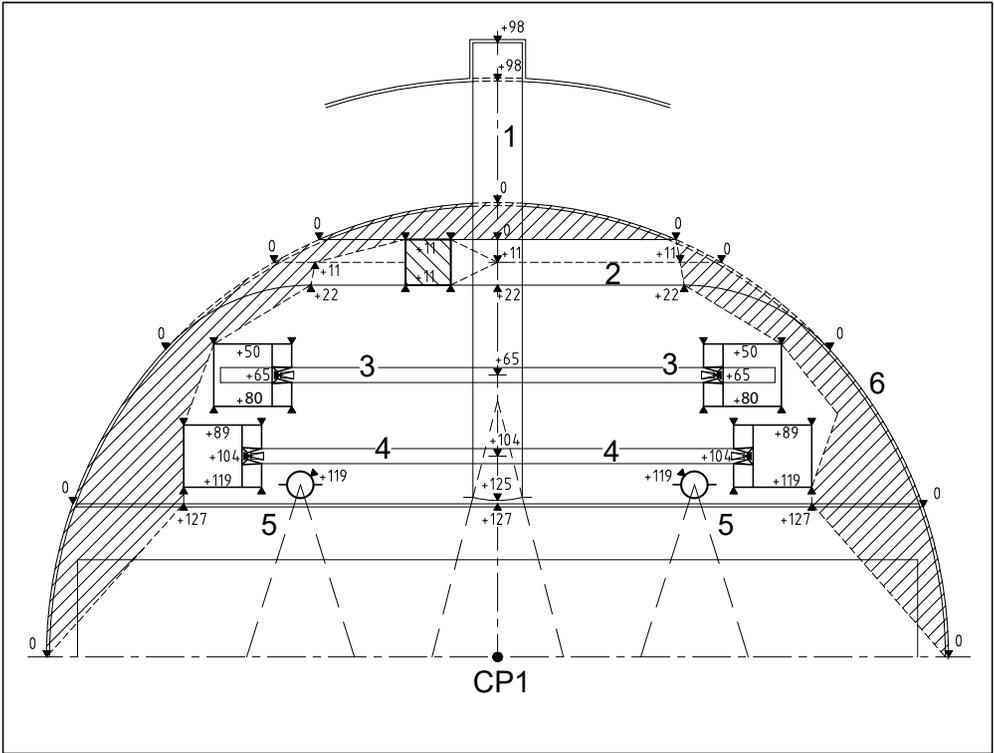


Figure 2.5c - North segment of 400m Standard Track with lean-to-slope of 0.6%
 (Dimensions of distance in m, dimensions of height in mm)

- 1 Javelin Throw runway
 Start of runway: +98mm (Standard 8-lane track at 1.0%)
 End of runway (throwing arc): +127mm
- 2 Steeplechase track
- 3 Pole Vault facility
 Planter boxes: +65mm
 Centre of runway: +65mm
- 4 Pole Vault facility
 Planter boxes: +104mm
 Centre of runway: +104mm
- 5 Shot Put circle rim: +119mm

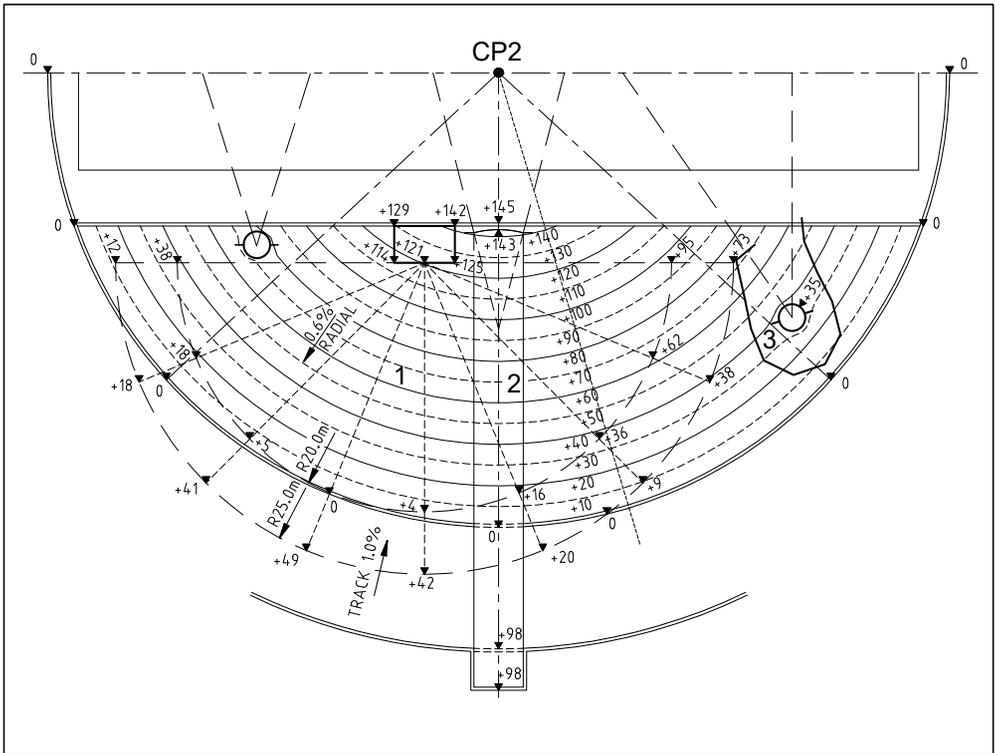


Figure 2.5d - South segment of 400m Standard Track with radial slope of 0.6%
 (Dimensions of distance in m, dimensions of height in mm)

- 1 High Jump facility
 Take-off point: +121mm
 Start points on runway length 20m: +38mm to +95mm
 Start points on runway length 25m: +12mm to +73mm
- 2 Javelin Throw runway
 Start of runway: +98mm
 Throwing arc surface: +143mm
- 3 Discus / Hammer Throw circle rim: +35mm

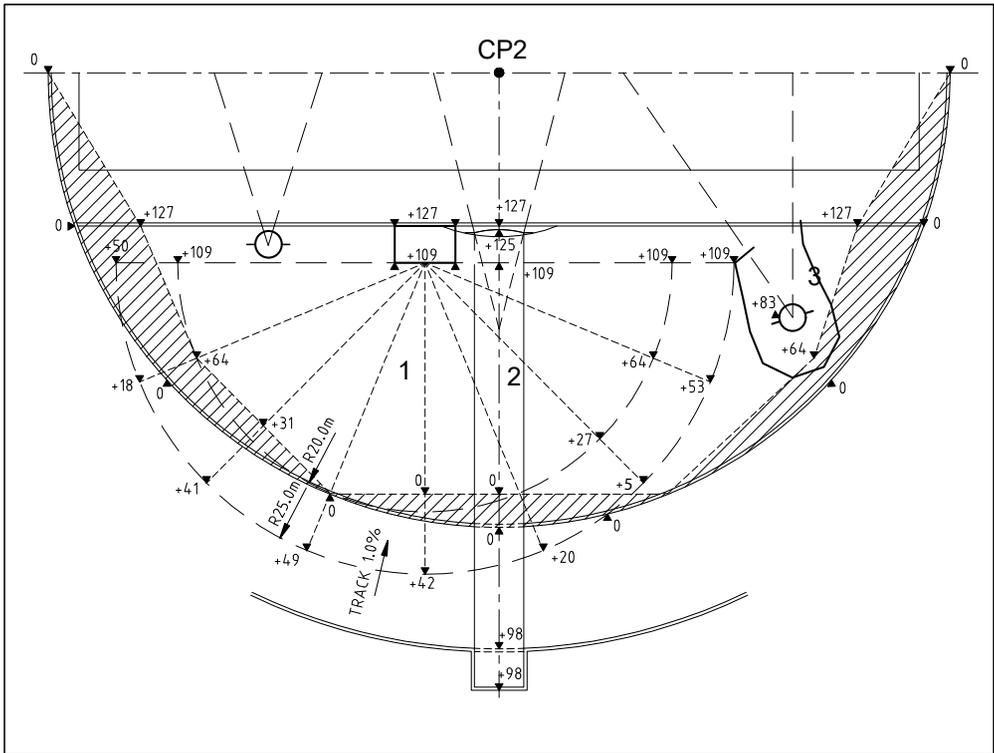


Figure 2.5e - South segment of 400m Standard Track with lean-to-slope of 0.6
(Dimensions of distance in m, dimensions of height in mm)

- 1 High Jump facility
Take-off point: +109mm
Start points on runway length 20m: +109mm to +109mm
Start points on runway length 25m: +50mm to +109mm
- 2 Javelin Throw runway
Start of runway: +98mm
Throwing arc surface: +125mm
- 3 Discus / Hammer Throw circle rim: +83mm

2.6 Alternatives for Training Facilities

During the planning and construction stages for competition facilities, full consideration must be given to the stipulations listed in Sections 2.1 to 2.5. For training facilities, a variety of alternatives are permissible. Long Jump facilities, for example, may have several runways next to each other. High Jump training facilities may be arranged to allow for run-ups from both sides of the landing mats. Shortened runways may also be considered, especially for school sports. The size of landing mats must be commensurate with the height being jumped by the athletes. However, a prerequisite for all facilities is the observance of safety aspects.

Generally, training facilities cater for several events of Track and Field and, where the Track and Field facilities are combined with small pitches, for ball games. Of course, this type of design will normally preclude a simultaneous use of the facilities for the individual sports available there. Organisational measures can be implemented to overcome this disadvantage (e.g. scheduling of training times). On the other hand,

this type of design will result in considerable savings in terms of space and building costs.

Concepts and combinations for training facilities may differ considerably from country to country. The examples shown in Sections 2.6.1 to 2.6.6, therefore, in no way claim to be complete.

If a training facility is ever used for a one-off competition, then the facility for the event must comply with the Rules and the competition must be conducted strictly in accordance with those Rules.

2.6.1 STRAIGHT

If necessary, the Standard Track can be supplemented along the finishing straight by a second straight, so that several groups will have an opportunity to practice simultaneously. The second track can also save time in qualifying rounds at mass events (e.g. school sports competitions). It can serve as a runway for the Long and Triple Jump and the Pole Vault, provided that landing areas and landing mats adjoin the starting or run-out area.

2.6.2 LONG AND TRIPLE JUMP (Figures 2.6.2a to c)

Long and Triple Jump training facilities may be accommodated with two or three runways positioned alongside each other and one common landing area in the north

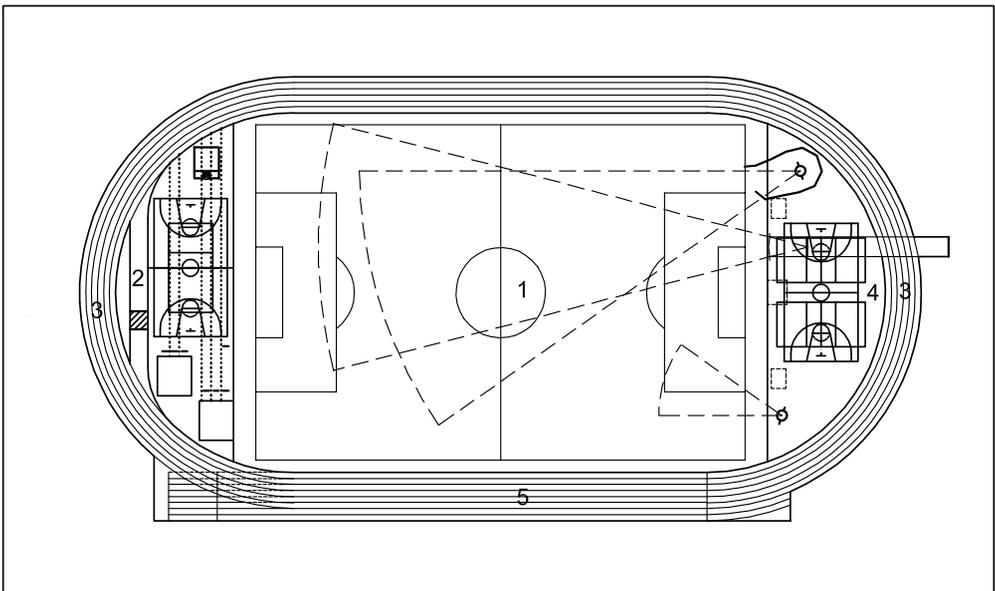


Figure 2.6.2a - 400m Standard Track as a warm-up and training (Dimensions in m)

- 1 Track interior (playing field and landing area for throwing events)
- 2 Segment with water jump, Pole Vault, Long and Triple Jump, and ball games area for basketball and volleyball
- 3 Six-lane oval track
- 4 Segment with Discus / Hammer circle, Shot Put circle, High Jump, Javelin Throw, ball games area for volleyball (2 courts) and basketball
- 5 Eight-lane straight (for details of segments, see figures 2.6.2b and 2.6.3)

segment of a Standard Competition Area with the direction of jumping towards the west (Figures 2.6.2a and b) or on a multi-purpose pitch for ball games and Track and Field Events (Figure 2.6.2c). The possibility of an arrangement in the extension of the finishing straight of a standard arena is discussed under Section 2.6.1.

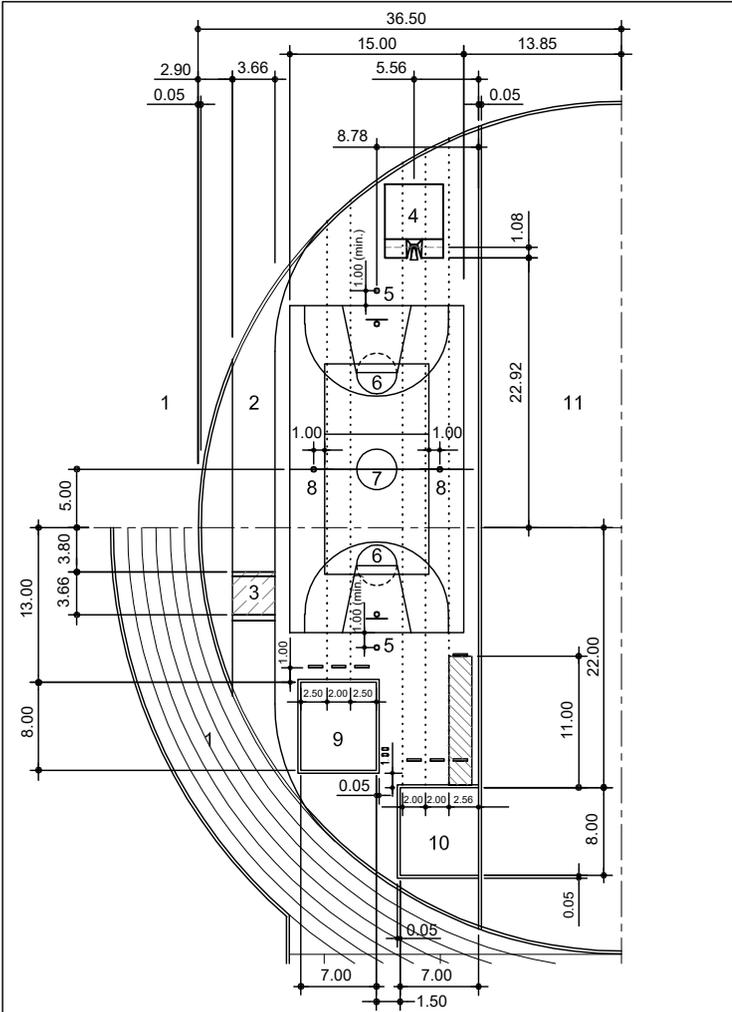


Figure 2.6.2b - Detail of the northern segment of the plan shown in figure 2.6.2 (Dimensions in m)

- 1 Six-lane oval track
 - 2 Steeplechase track
 - 3 Water jump (surface with increased thickness)
 - 4 Pole Vault
 - 5 Ground anchor for basketball backboard support
 - 6 Basketball court, 15m x 28m
 - 7 Volleyball court, 9m x 18m
 - 8 Socket for volleyball net post
 - 9 Three-lane Long Jump with shortened runway
 - 10 Three-lane Long Jump and single-lane Triple Jump
(surface with increased thickness between Triple Jump take-off board and landing area)
 - 11 Grass playing field
- Note: The layout is not adequate for elite athletes.

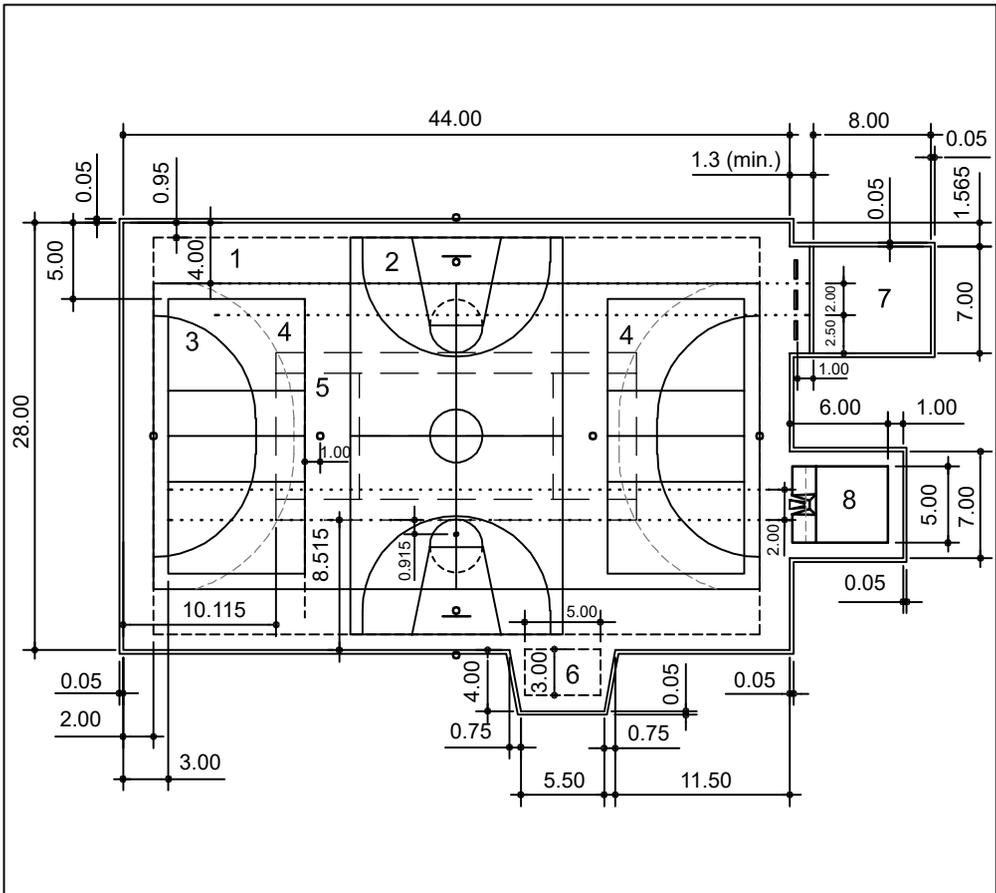


Figure 2.6.2c - Multi-purpose facility for ball games and athletics (Dimensions in m)

- 1 Rectangular field, 26.10m x 40m
- 2 Basketball court, 14m x 26m
- 3 Handball court, 20m x 40m
- 4 Volleyball court, 9m x 18m
- 5 Tennis court, 10.97m x 23.77m
- 6 High Jump
- 7 Long Jump
- 8 Pole Vault

Note: The layout is not adequate for elite athletes.

In multiple jumping facilities for training, a single 4.00m wide synthetic runway will be more economical than two separate 1.22m runways. In such a training facility, a landing area of total width 5.00m will accommodate two landing areas and a 7.00m width will be adequate for a single 6.00m wide runway.

2.6.3 HIGH JUMP (Figures 2.6.2a, 2.6.2c and 2.6.3)

Two High Jump training facilities can be arranged simultaneously in the south segment of a 400m Standard Track. These will allow for training with shortened run-ups with the track kerb in place or with full run-ups with the kerb removed (Figures 2.6.2a and 2.6.3).

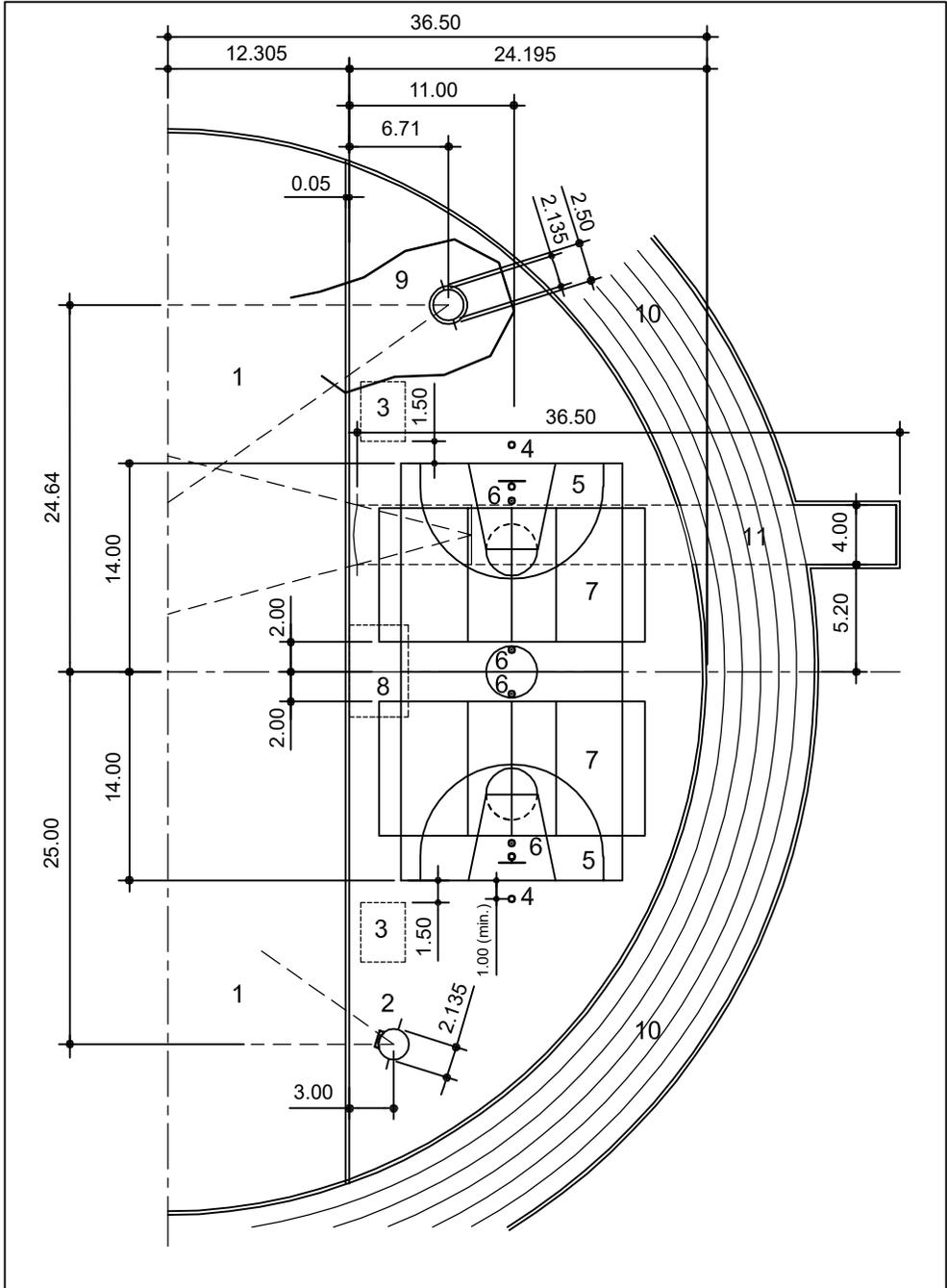


Figure 2.6.3 - Detail of the southern segment of the plan shown in figure 2.6.2a (Dimensions in m)

- | | |
|--|--|
| 1 Grass playing field | 7 Volleyball court, 9m x 18m |
| 2 Shot Put | 8 Competition High Jump with 6m x 4m landing mat |
| 3 High Jump training area with 4m x 3m landing mat | 9 Discus / Hammer Throw |
| 4 Ground anchor for basketball backboard support | 10 Six-lane oval track |
| 5 Basketball court, 15m x 28m | 11 Javelin Throw runway |
| 6 Socket for volleyball net post | |

A facility for training with a landing mat suitable for competition can equally be accommodated on the north side of a small pitch (Figure 2.6.3).

There is also a possibility of temporarily placing landing mats 5.00m × 5.00m or 5.00m × 6.00m in the centre of a small pitch, in order to allow two practice areas to be in use at the same time, even if with shortened run-ups.

2.6.4 POLE VAULT (Figures 2.6.2a and 2.6.2b)

A Pole Vault training facility (direction of jump towards east) can be accommodated, especially in combination with the Long Jump facility described under 2.6.2 (direction of jump towards west), in the north segment of a standard arena.

Other possibilities are demonstrated in Figures 2.6.2c, 2.6.6a, 2.6.6c and 2.6.6d.

2.6.5 THROWS (Figures 2.6.2a and b, 2.6.3, 2.6.5a and b)

Discus, Hammer and Javelin Throw training facilities are combined at one end of a large pitch into one "throwing field" (Figures 2.6.5a). The training Shot Put facility can be provided by laying a concrete foundation with two or more marked throwing circles (without stop board) or by a lowered throwing circle (with stop board) and adjoining sandpit or unbound mineral surface as landing area (Figures 2.6.5b and 2.6.6a to d). If international standard athletes are to use the Shot Put facility, particularly if they use a two-handed over the shoulder training technique, then the length of the Shot Put training area shown in Figure 2.6.5b needs to be increased.

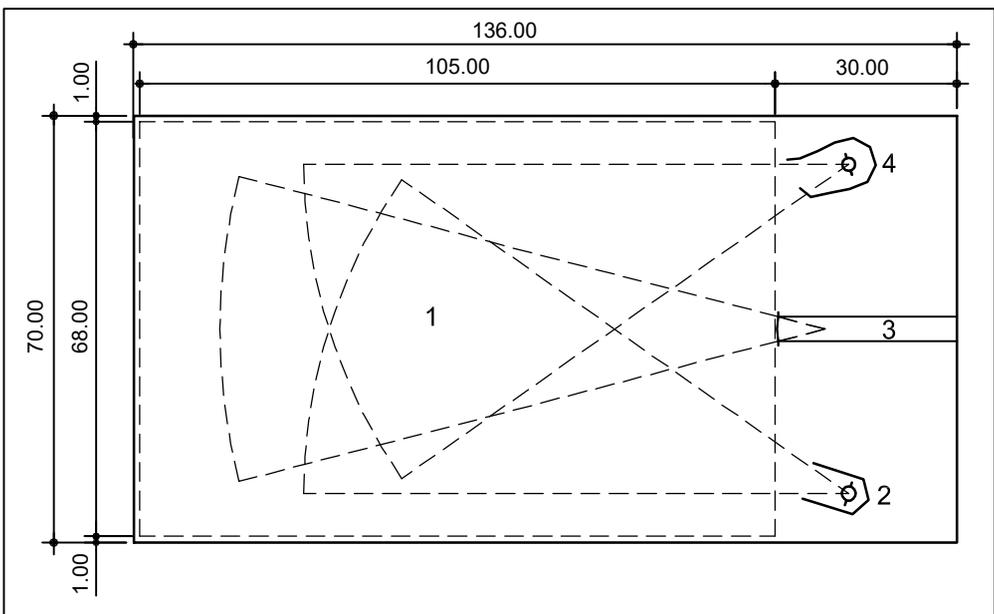


Figure 2.6.5a - Warm-up and training area for throwing events (Dimensions in m)

- 1 Playing field and landing area
- 2 Discus Throw circle with safety cage
- 3 Javelin Throw runway
- 4 Hammer Throw circle with safety cage

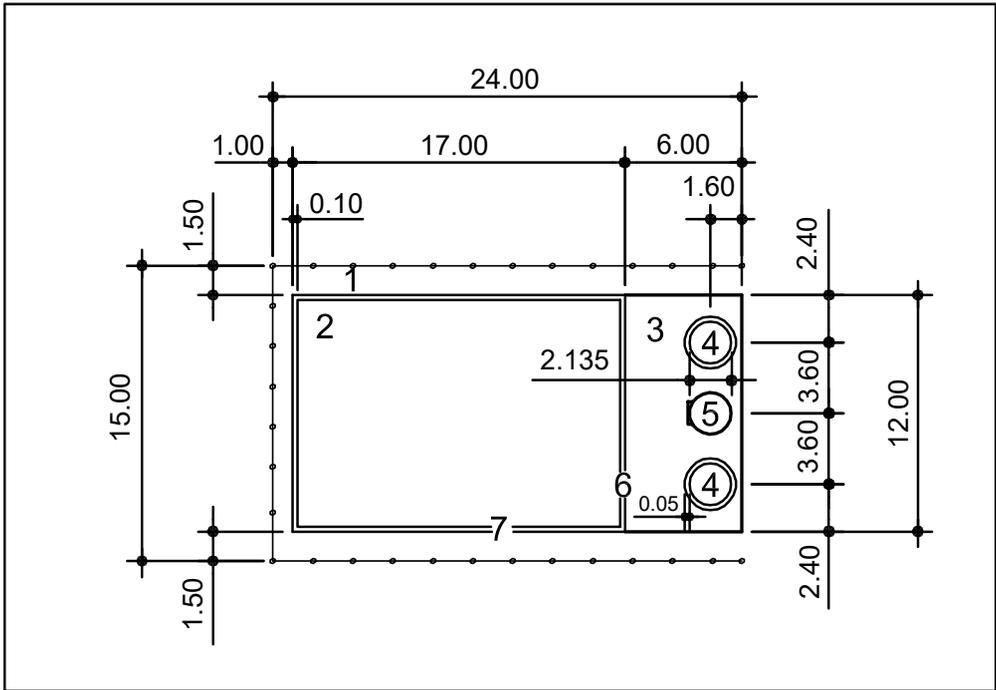


Figure 2.6.5b - Shot Put training area (Dimensions in m)

- 1 Periphery with safety barrier and shot-resistant surface
- 2 Landing area (unbound mineral surface)
- 3 Concrete area with three Shot Put circles
- 4 Marked circle
- 5 Recessed competition circle with stop board
- 6 Separation between concrete slab and landing areas
- 7 Landing area surround with soft covering for safety

2.6.6 OTHER COMBINED TRAINING FACILITIES (Figure 2.6.6a to e)

If the surface of a large pitch is suitable for use as a runway, it will also be possible to combine this area with training facilities for sprints, Long and Triple Jump, High Jump, Pole Vault and Shot Put (Figure 2.6.6a).

Figure 2.6.6b shows a training facility which can be regarded as a first phase of development of a 400m standard arena. Here, a large pitch (grass surface) is combined with synthetic surfaces installed on two adjoining sides for sprints, High Jump and Long Jump, Shot Put and Discus Throw. The oval track can then be added in a further phase of construction.

Figure 2.6.6c shows a training facility in the second phase of a standard arena.

The facilities for Long and Triple Jump and for High Jump and Pole Vault have been accommodated in the segments of the 4-lane oval track. This facility can be used as a warm-up facility in compliance with Table 1.5.3, Chapter 1.

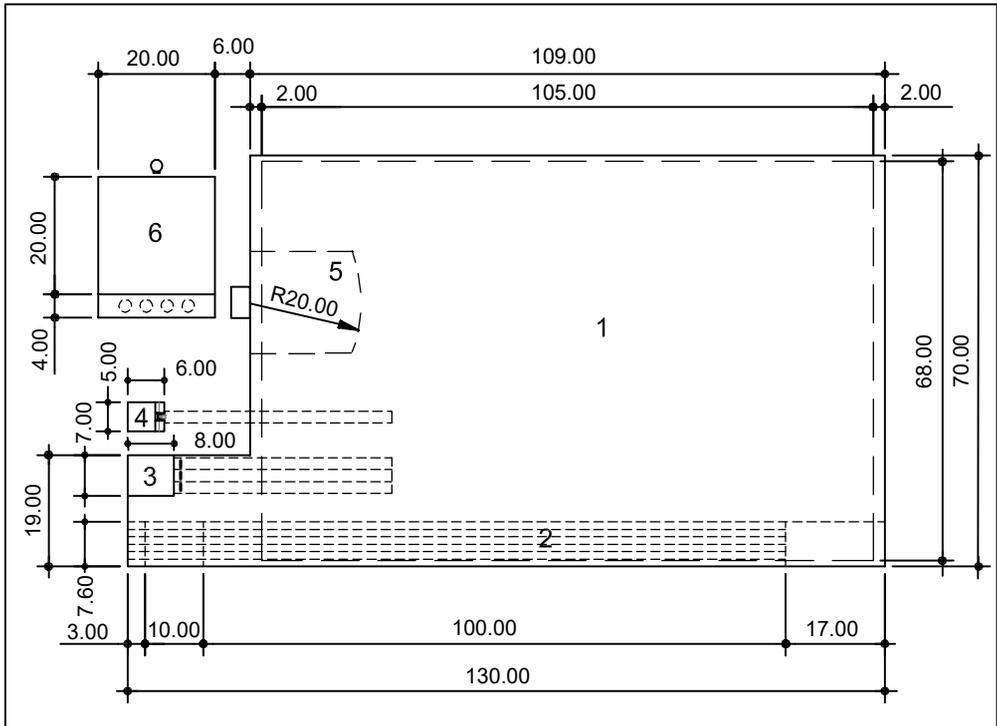


Figure 2.6.6a - Multi-purpose facility for ball games and athletics (Dimensions in m)

- 1 Playing field, 68m x 105m (unbound mineral surface)
- 2 Six-lane straight marked on the playing field
- 3 Three-lane Long Jump
- 4 Pole Vault
- 5 High Jump
- 6 Shot Put area with four painted circles on a concrete slab and one competition circle

Note: The layout is not adequate for elite athletes.

Figures 2.6.6d and 2.6.6e offer suggestions for warm-up facilities in compliance with table 1.5.3, Chapter 1, in park-like or wooded areas. However, the arrangement of the facilities for Shot Put and Throwing Events requires a safe enclosure or close-set surrounding hedge with additional warning notices.

The layout as shown in Figure 2.6.6e offers limited facilities for running on sprint tracks, bend training and relay baton practice.

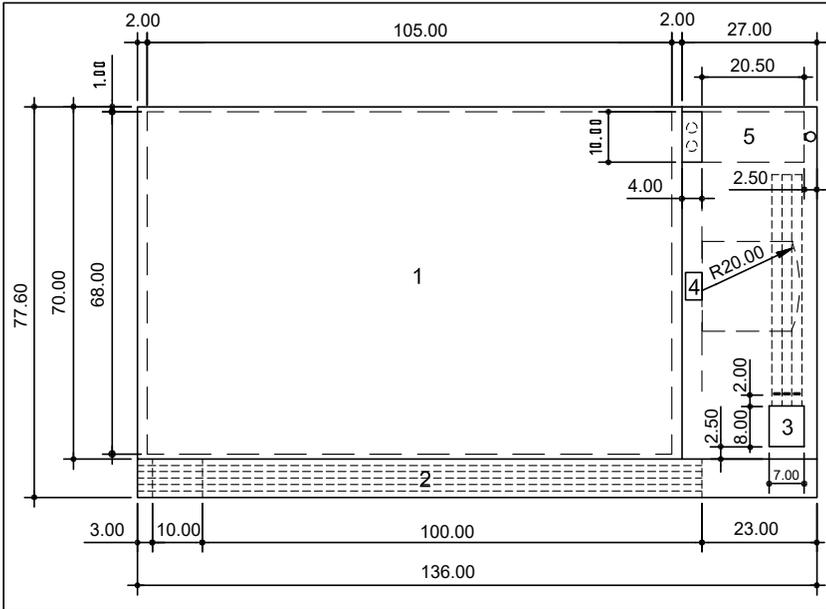


Figure 2.6.6b - Multi-purpose facility for ball games and athletics (Dimensions in m)

- 1 Playing field, 68m x 105m (grass surface)
- 2 Six-lane straight
- 3 Three-lane Long Jump
- 4 High Jump
- 5 Shot Put area with two painted circles on a concrete slab and one competition circle

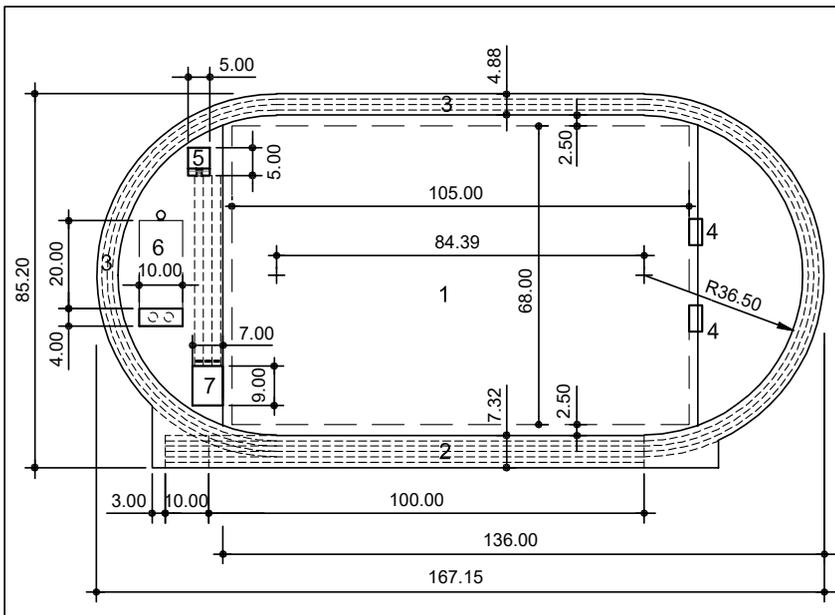


Figure 2.6.6c - Warm-up area with 400m Standard Track and large playing field (Dimensions in m)

- 1 Playing field, 68m x 105m
 - 2 Six-lane straight
 - 3 Four-lane oval track
 - 4 High Jump
 - 5 Pole Vault
 - 6 Shot Put area with two painted circles on a concrete slab and one competition circle
 - 7 Long and Triple Jump
- Note: The Shot Put and Pole Vault layout is not adequate for elite athletes.

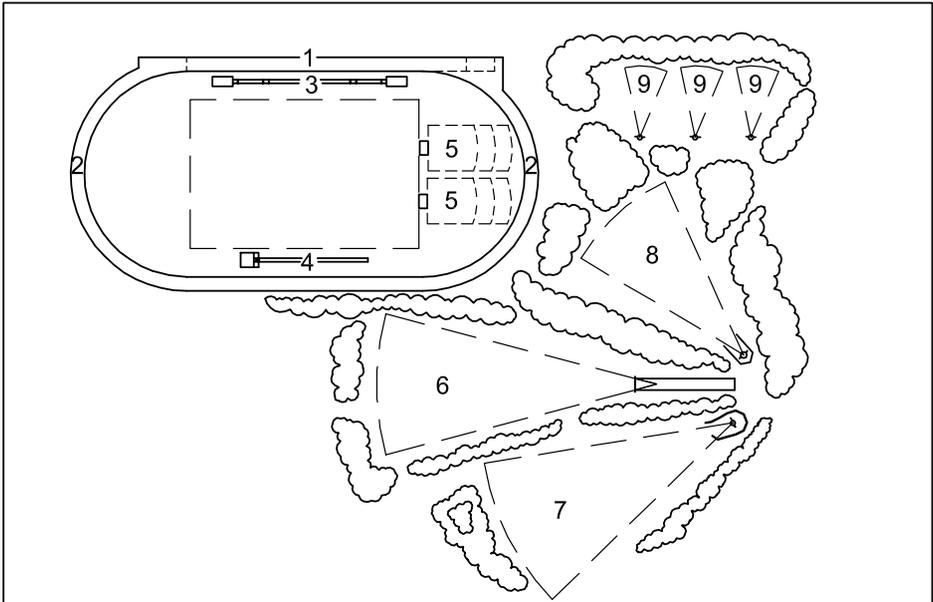


Figure 2.6.6d - Warm-up area with separate areas for throwing events

- | | |
|------------------------|-----------------|
| 1 Four-lane straight | 6 Javelin Throw |
| 2 Four-lane oval track | 7 Hammer Throw |
| 3 Long and Triple Jump | 8 Discus Throw |
| 4 Pole Vault | 9 Shot Put |
| 5 High Jump | |

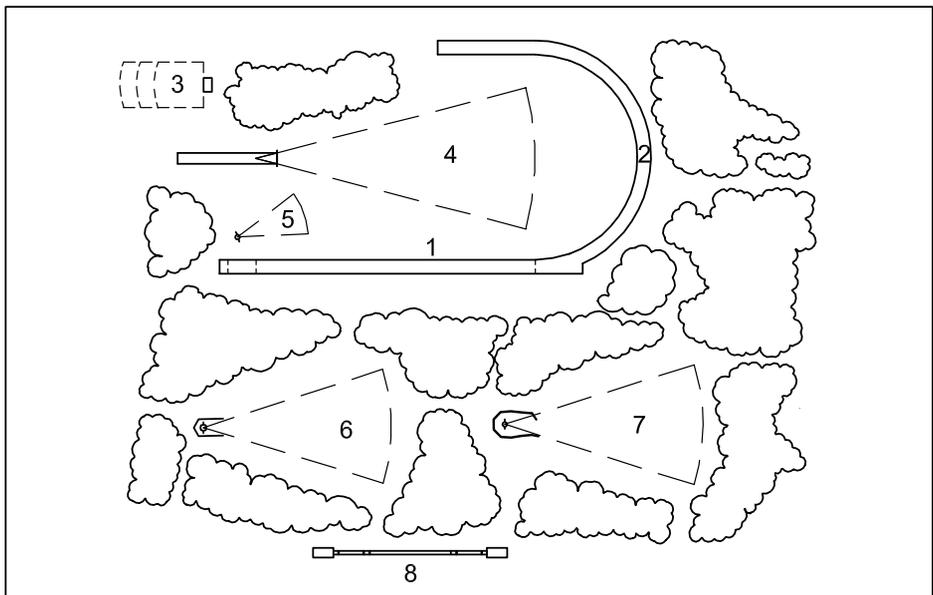


Figure 2.6.6e - Warm-up area, alternative to figure 2.6.6d

- | | |
|---------------------------|------------------------|
| 1 Four-lane straight | 5 Shot Put |
| 2 Four-lane training bend | 6 Discus Throw |
| 3 High Jump | 7 Hammer Throw |
| 4 Javelin Throw | 8 Long and Triple Jump |

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CHAPTER 3

CONSTRUCTION OF THE TRACK

There are three principal types of surface available for athletics. Until the early 1960's, most top-class competitions were held on unbound mineral surfaces (porous water-bound systems), although in some parts of the world national competitions were (and still are) held on natural grass tracks. Today, modern synthetic surfaces have displaced the other two types of surface for all major international events. Such synthetic systems are not only designed for superior dynamic characteristics, but need minimal maintenance compared to the surfacing systems they have displaced. Nevertheless, unbound mineral and natural grass surfaces are still widely used, the latter not only for the track but also, of course, as the infield area.

Information on unbound mineral surfaces and natural grass surfaces, not now included in this manual, is now available on the website and from the Office upon request.

3.1 Synthetic Surfaces

3.1.1 DESCRIPTION

Modern synthetic surfaces for athletics tracks are high performance systems formulated to be durable and designed to offer the best combination of dynamic properties for athletes. Obviously, the surface requirements of sprinters are different to those of the long-distance runners. The technology exists to vary the dynamic characteristics of the surface to favour one type of event against another. Clearly, with major athletics meetings involving all events, such "tuning" of the track to favour one particular group of athletes is not acceptable. For this reason, all surfacing systems should offer a "balance" of dynamic properties which represents a compromise between the various needs of the different athletes using the facilities. The performance requirements stipulated by World Athletics are based on the needs of all athletes. Where facilities are intended for major international competitions, the surface of any warm-up track provided should have the same dynamic characteristics as the surface on the track in the main arena. There are two different construction solutions (Figure 3.1.1) and a number of different synthetic surfacing system types available for athletics.

Most of these systems are offered by a considerable number of different manufacturers and installers. It therefore follows that the number of surfacing products is very large. All synthetic surfaces rely on a good standard of base construction to tight final tolerances equal to that required for the synthetic surface, which is an essential pre-requisite for the successful installation of the surface and for its long-term performance (See 3.2).

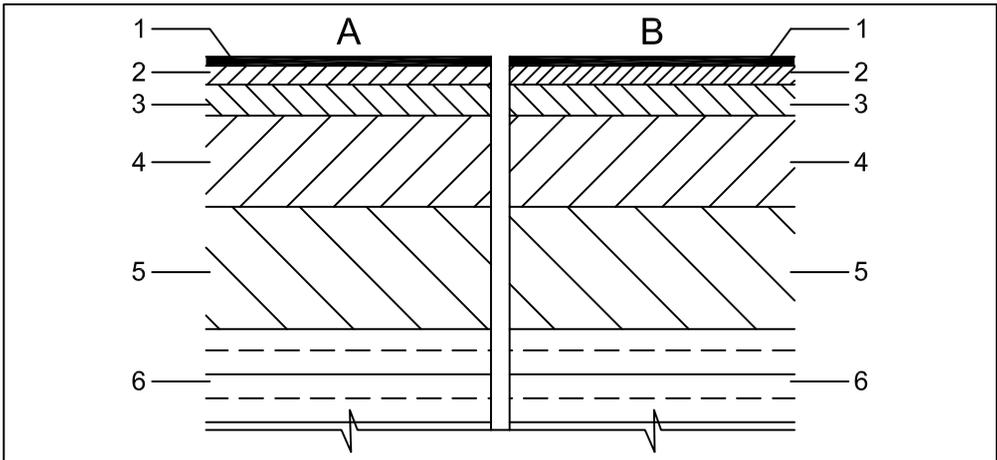


Figure 3.1.1 - Standard cross section of synthetic surfaces

A Water-permeable construction (left)

B Non-permeable construction (right)

- 1 Synthetic surface
- 2 Open grade asphaltic concrete finishing layer
- 3 Dense grade asphaltic concrete correction layer
- 4 Base - crushed stone or gravel
- 5 Subbase - crushed stone or gravel
- 6 Select compacted fill or subgrade

- 1 Elastomer
- 2 Dense grade asphaltic concrete finishing layer
- 3 Dense grade asphaltic concrete finishing layer
- 4 Base - crushed stone or gravel
- 5 Subbase - crushed stone or gravel
- 6 Select compacted fill or subgrade

	Permeable construction			Non-permeable construction			
	A	B	C	D	E	F	G
Design							
Designation	texture coated surfacing	porous coated surfacing	porous surfacing one-layer	cast coated surfacing	cast surfacing multi-layer (solid synthetic surfacing)	cast surfacing (solid synthetic surfacing)	calendared vulcanised, prefabricated sheets
Surface	granular texture	granules flat		strewn-in granules with visible tips			
Top layer (coloured)	rubber granules and elastomer, sprayed	rubber granules and elastomer, trowelled in-situ or prefabricated		elastomer cast and rubber granules strewn-in			calendared vulcanised, differentiated layers of rubber compound
Base layer	rubber granules/fibres and elastomer, poured out in-situ or prefabricated		-	rubber granules/fibres and elastomer, poured-out in-situ or prefabricated	rubber granules and elastomer, cast		a top layer
Typical areas of application	athletics tracks and run up tracks, multi sports	multi-use areas, tennis courts and running/run-up tracks (school sports and combined facilities)		multi-sports	athletics tracks, run-up tracks		athletics tracks, run-up tracks, tennis courts

Table 3.1.1 - Examples of surfacing and fields of application (EN 14877)

There are several sub-divisions of synthetic surface type, some of which are illustrated in Table 3.1.1. Some systems are prefabricated in the factory and delivered to site as rolls of material which are adhesive bonded to the base.

Some are fabricated on site by machine mixing and laying the raw material ingredients. Others are composites of these two systems. Each type has certain advantages and disadvantages.

Latex bound synthetic surfaces are available on the market but so far only one product met the tensile properties requirements. However, such surfacing may be used for non-international competition and training facilities provided all the other performance requirements, particularly with regards to thickness and the Rules, are met.

The safety of athletes and their protection against injury in training and competition is of special significance for the requirements for the sports surface. It is recommended that training facility synthetic surfaces generally have higher shock absorption than competition facilities. Also, ongoing maintenance of the surface is essential to protect the investment and ensure the safety of athletes. The specification and control of the synthetic surface technical data with constant monitoring during installation is paramount to ensuring the life of the surface and its satisfactory properties.

3.1.1.1 Prefabricated Sheet

This type of system is made from a rubber compound processed by calendaring followed by curing and rolling. It is largely non-porous and has an embossed or textured surface finish to improve traction and slip resistance. Obviously, by producing the surfacing material in the controlled conditions of a factory, its performance properties should be very uniform. Also, because the thickness of the sheet can be controlled very accurately, possible problems due to thin areas on the completed facility are avoided. However, the installation of the material requires a high degree of skill and accuracy. This is ensured by the manufacturer using his own skilled installation team. The sheet must be bonded to the base of the track with adhesive. The butt joints must be soundly executed, both between adjacent sheets of surfacing and between the surface and the perimeter edges of the track or runway. The durability of the surface is only as good as the integrity of the bond between itself and the base. The material will obviously conform to any contours and irregularities in the base to which it is bonded. It is therefore important that the asphaltic concrete underneath fully conforms to the stipulated shallow gradients and levels requirements in order to avoid the formation of standing water.

The installation of this type of system involves the use of weather-sensitive adhesives, although the laying of all synthetic surfaces is to some extent a weather-dependent operation but not as much as in-situ systems. Finally, all prefabricated sheet products can contain residual stress within the material. Should any movement occur within the sheet, after installation, the result will be shrinkage away from edges or at joints, or delamination of the surface from the base, or both. Correct selection and careful application of adhesive can help to minimise this problem.

The big advantage of this system is that the thickness is guaranteed, and the dynamic properties are uniform throughout the installation. Also, it is very easy to repair any damaged sections by cutting out the affected area and gluing in replacement sheet cut to size.

3.1.1.2 In-Situ Systems

The other main group of surfacing systems comprises those products which are fabricated on site from their raw materials. These may be sub-divided into three principal types: cast elastomers, resin-bound rubber crumb and composite systems.

For all such systems, the compatibility of the raw material ingredients is of vital importance. All reputable manufacturers and installers of in-situ prepared surfacing systems should ensure by constant monitoring and sample testing that each component does not have an adverse effect on another forming part of the same surfacing product. It is advisable to have a consistent supply of each ingredient and test data to confirm the performance of each combination.

Because the end properties of such systems are very dependent on the nature of the raw materials delivered to site, their mixing and laying, the operation of a comprehensive quality control scheme is a vital prerequisite for a satisfactorily completed facility. All reputable installers willingly submit to independent quality monitoring by experienced test laboratories, and a number of the larger companies also operate their own "in-house" monitoring schemes.

3.1.1.2.1 Cast Elastomers (Full Polyurethane)

These products are laid as free-flowing liquid polyurethane. The cast polyurethane resin is prepared by mixing two components, one a liquid polyol and the other an isocyanate in the correct proportions.

Usually, the mixed polyurethane resin is applied to the track base by spreading to a typically 4mm thickness, and broadcasting chopped rubber crumb on to the uncured surface. After cure, the excess crumb is removed, and another layer applied in the same way. Following cure of this second layer, a third and final application is made, finishing with the broadcasting of the final coloured EPDM granule textured finish.

A certain amount of crumb will become dislodged after the surface is used and it is necessary for this loose crumb to be swept up so that it does not clog drainage outlets or gather on landing area sand.

Obviously, with each operation dependent on good weather, the possibility of delays to the installation is increased with this system.

Some products utilise a different method of forming the upper surface texture. Instead of using partly embedded EPDM granules, the final cast polyurethane surface is allowed to cure to an appropriate consistency and then given a "stippled" finish using a roller covered with a suitable material. The textured resin is then allowed to fully cure.

All cast elastomer systems are non-porous and hence it is of paramount importance that the stipulated gradients and levels requirements are met, otherwise water ponding may occur in "low" areas. The final surface is largely free from joints and should adhere well to the base, if it is totally dry. Such surfaces are strong and durable, provided they are correctly formulated using compatible raw material ingredients, properly mixed and installed under satisfactory environmental conditions.

3.1.1.2.2 Resin-Bound Rubber Crumb (Spray Coat)

These products comprise a principal layer of polyurethane resin-bound rubber crumb, finished with a texturised surface coating of polyurethane paint. The crumb is mixed with a one-component moisture-curing polyurethane resin in the correct proportions. This very viscous mix is then spread by paving machine on to the base of the track, with the thickness controlled by screeding bars. After cure, two coats of a coloured polyurethane paint, containing a fine rubber aggregate, is spray applied to

this rubber base mat, in order to give the finished surface the correct traction and slip resistance.

Because the polyurethane resin used in this type of system is moisture curing, their installation is slightly less weather-critical. Although it would not be sensible to attempt the operation in wet conditions, a shower of rain after the rubber base mat is laid will not prove detrimental and, indeed, may actually accelerate the cure of the resin. However, the spray application of the texturising finishing coats requires not only dry conditions, but also low wind speeds.

These systems have many of the advantages of the cast elastomers, although it is recognised that they are far less durable. One advantage is their porosity, which means that even areas slightly out-of-tolerance for levels, will not water pond. Some spray coat systems may not prove to be porous if too much spray coating is applied. To maintain porosity, it may be necessary on occasion to clean the surface of accumulated dirt by cleaning with a high pressure water spray or suction.

In particularly high wear areas such as at the end of Javelin Throw runways, at the High Jump take off point, and where the starting blocks are fixed, it is common to "reinforce" the surface with cast resin material to thickness and length stipulated in Table 3.1.2.2 prior to spray applying the finishing coats.

3.1.1.2.3 Composite Systems (Sandwich)

As the name implies, these systems are a hybrid of the cast elastomer and the resin-bound rubber crumb products. They are sometimes known as "sandwich" or "double-decker" systems. They are formed from a base mat of resin-bound rubber crumb, typically about 9mm in thickness. After curing, the open textured mat is grouted with a very fine rubber crumb, and then a cast elastomer layer is applied as the top surface. The absolute thickness of this cast layer needs to be at least 4mm to ensure adequate durability, but can be greater than this to further improve the durability of the surface and make it easier to repair by allowing the top of the surface to be ground off before re-topping with cast elastomer. The synthetic surface material suppliers and contractors should make it clear to purchasers that having a cast elastomer layer less than 4mm absolute thickness will give a shorter surface life and may not be able to be resurfaced successfully. The appearance of the finished facility is exactly as for a cast elastomer system, but the surfaces are obviously not as expensive because they utilise less of the expensive cast polyurethane resin.

Composite systems are also available in which a prefabricated base layer is delivered to site in roll form, bonded with adhesive to the base and then coated with a top layer mixed from raw materials and applied on site.

The durability of these composite systems lies in between that of the two other in-situ systems above. The performance of the surface is similar to that of the cast elastomer systems except that the shock absorption and the vertical deformation would tend to be slightly higher (softer) than the full depth cast resin products.

Good adherence of the base layer to the underlying asphalt and between the top polyurethane layer and the base layer is essential for the long-life of the surface. Any moisture trapped in the base layer would be detrimental.

Whilst the system should be non-porous, some designers provide a porous

asphalt layer underneath so that any moisture that may penetrate into the porous bottom layer either from the side or through the upper layer can drain away.

3.1.2 PERFORMANCE REQUIREMENTS

The requirements of a synthetic surface for an athletics track are two-fold:

- Is it effective as an athletics surface?
- Is it durable - that is, will it retain its effectiveness over a reasonable period of time?

An athletics facility should meet these requirements at the time of a competition. However, it is obvious that surfaces must retain their characteristics in the long-term, to maximise the number of good quality facilities around the world, and to give value for money to the owners of the facilities. Synthetic surfaced athletics tracks represent a considerable financial investment, and it is only natural that they should be put to the best possible use. This means that their use for training purposes should be actively encouraged. To achieve a reasonable return on their investment, owners should maintain the synthetic surface to maximise the time before it requires major repairs or a complete renovation or replacement. Obviously, the life of a surface is also dependent on the level of usage and the local weather conditions.

3.1.2.1 Durability

The durability of synthetic surfaces relates to how well they withstand mechanical wear as well as their resistance to environmental factors. Outdoor athletics probably represents the most severe all-round test for synthetic surfaces. The surface must withstand the combined effects of compaction, abrasion, spike-damage, UV light, water, and variations in temperature. Indoor surfaces have somewhat less to contend with in that generally there would be no effects due to water and UV. It is hardly surprising that in the long-term, synthetic surfaces do sustain mechanical damage and, in addition, they may discolour, and change in resilience. Mechanical damage would mainly take the form of loss of texture from the surface layer, together with cutting from the athletes' spiked footwear. Obviously, these effects would be most apparent in the heavily used areas such as the inside two lanes of the track, the end of the Javelin Throw runways, sprint start areas, the High Jump and the Pole Vault take-off points. Loss of adhesion to the base or edge kerbings might occur, as might loss of adhesion between individual layers of multi-layer systems. This adhesion loss would result in delamination of the surface from the base or from itself.

All mechanical breakdown of the surface will be exacerbated by the influence of the environment to which the surface is exposed.

Examples of this "accentuation" of wear are:

- In colder climates, freeze / thaw cycling of entrapped water can have an adverse effect on the physical integrity of spike-damaged areas, can further weaken areas of surface delamination, and can have a generally debilitating effect on areas of a porous surface where through-drainage is not as good as it should be.
- In hotter climates, spike damage creates larger surface areas over which UV attack can occur. This can be further exacerbated, in the case of composite surfaces such as sandwich systems and texturised paint coated resin-bound

rubber crumb systems, by the fact that mechanical damage can often expose the lower layer of the surface. These lower layers may not necessarily have been formulated for prolonged exposure to weathering.

- Hot and high humidity environments can progressively weaken the bond between the synthetic surface and the base or edge kerbings.

Discolouration and changes in resilience, if they occurred at all, would tend to occur over the entire surface area of the facility. These were fairly common problems in the early life of the synthetic surfaces industry, in the late 1960's. However, modern formulations and the attention now paid by reputable manufacturers and installers of the raw materials to quality control, compatibility and consistency of the products, has meant that the synthetic surface is likely to retain its performance properties within reasonable limits, for its full anticipated service life.

Bubbling of the synthetic is often evidence of water penetrating under the synthetic surface. The point(s) of water penetration should be determined immediately, eliminated and the damaged surface repaired to prevent further damage and also for athlete safety.

3.1.2.2 Effectiveness

The effectiveness of the surface is a matter of prime concern to all users of a facility. Certain performance requirements must be met, if athletics is to take place on the surface with comfort and safety for the athletes.

These fundamental requirements, detailed in Section 3.1.3, have been laid down by World Athletics, and are as follows:

- Imperfections
- Evenness
- Thickness
- Shock Absorption (SA)
- Vertical Deformation (VD)
- Friction
- Tensile Properties
- Colour
- Drainage

3.1.3 TESTING

Systems developed for athletics tracks should always undergo a programme of laboratory testing before being introduced by manufacturers and installers. These tests would have the following principal aims:

- To ensure the compatibility of all the raw materials in the formulation
- To ensure that the system can be successfully installed in most normal climatic conditions
- To ensure that the surface has satisfactory durability
- To ensure that the performance characteristics of the surface are satisfactory for athletics
- To ensure that the formulation has no unsatisfactory environmental characteristics with respect to its raw materials ingredients, method of installation, or long-term performance

All of these aspects may be investigated by suitable laboratory tests. The likely durability can be predicted by accelerated tests for abrasion, spike resistance, compaction, the effects of UV, water and varying temperatures, etc. However, most of the tests, which have been developed will only assess one aspect of durability. In practice, of course, these surfaces deteriorate under the action of combined wear and environmental factors. For this reason, observations on actual installations of products, preferably several years old, are invaluable.

The performance of the surface for athletics is obviously of paramount concern to World Athletics, and the requirements which they stipulate in this respect are detailed earlier in this Chapter. The precise methods by which an athletics track is tested for these various parameters are given below. It cannot be stressed too highly that the testing and investigation of these facilities is a very specialised activity, requiring complicated test apparatus and considerable experience in its use, and the interpretation of the results generated. It is for this reason that World Athletics has enlisted the assistance of a network of test laboratories around the world, all suitably equipped and experienced in athletics track testing. The list of current accredited laboratories for testing synthetic track surfaces can be found on the website. It is quite possible that there are other laboratories that have ISO 17025 accreditation for some of the tests listed below. If in doubt, the Office may be consulted for advice on what is entailed in having a local laboratory meet the testing requirements.

The best check of the quality of the finished track facility is to have an in-situ performance test undertaken by an accredited laboratory. Such a test is mandatory for a facility seeking a Class 1 certificate. Where an in-situ test is not being undertaken, it is recommended that for quality assurance purposes the surfacing installer is instructed to prepare control samples at the rate of one sample per 600m² of installed surface. The samples should be cast beside the track using the same materials and techniques. The absolute thickness of the samples should be the same thickness as listed on the Product Certificate for the synthetic material. The size of the samples should not be less than 600mm x 600mm. If the completed facility is undergoing full testing, the quality assurance samples should still be prepared to enable the tensile properties to be measured without the need to cut out areas of new surface. In this case, each sample size can be 300mm x 300mm. Where surfacing systems rely on curing to develop their properties, e.g. 2-part polyurethane elastomers, the surface installer should be careful to ensure that the samples are fully cured before submitting them for test. If not, there is a risk that the test result may not be truly representative of the performance that will be exhibited on site.

It is recommended that, when a full in-situ performance test is not to be undertaken, the construction supervisor ensures the quality of the finished product by examining the surface for obvious bumps and imperfections. This can be done quickly by visual examination followed up by the straight edge test if necessary. To ensure that the Product Certificate thickness of synthetic material is provided for poured systems, a less rigorous sampling of thickness at say 20m intervals around the track may be undertaken. Flooding of the track or examining the surface after rain will quickly locate depressions in the finished surface.

3.1.3.1 Imperfections

Requirement

It is obvious that serious surface imperfections such as bubbles, fissures, delamination, uncured areas, etc. are unacceptable on grounds of safety and because of the effect they may have on durability and on dynamic performance of the surface. Wherever they occur, they must be rectified as a matter of priority.

Method

A thorough visual examination of all areas of synthetic surface should be conducted, and the positions and extent of all imperfections noted on a plan of the facility.

Where appropriate, photographs may be taken of any imperfections in order to illustrate the test report.

Note: In some cases, uncured areas may not be detected until the thickness survey is undertaken (see 3.1.3.3). For instance, uncured material might only be detected for the first time when a thickness probe is withdrawn from the surface and is found to be smeared with sticky resin. This may happen with multi-layer systems where one or more of the lower layers is uncured, but the upper layer appears sound. It is important that the extent of any area of uncured material is fully identified.

3.1.3.2 Evenness

Requirement

The very tight tolerances for overall gradients permitted by World Athletics are well known, because of the need to ensure that the slope of the surface gives no assistance to athletes. The surface shall be installed so that, on a localised level, there shall be no bumps (high spots) or depressions beneath a 4m straightedge exceeding 6mm, or beneath a 1m straightedge exceeding 3mm, at any position and in any direction. There shall be no step-like irregularities greater than 1mm in height, for instance at bay joints in in-situ surfaces or at seams in prefabricated sheet. The intent is to ensure the safety of the athlete and provide an even running surface.

These limits are laid down not only to ensure safety for the athletes, but also to minimise standing water after rainfall on non-porous surfaces. The presence of large areas of standing water, or of water ponding to any significant depth in key areas of the facility such as the High Jump take off point, can lead to serious delays in the scheduling of events. The possible effect of such delays on major international events which are being televised world-wide, can easily be imagined. Even for smaller national competitions, such delays can create severe difficulties for athletes, officials and spectators.

Method

Place the 4m straightedge on the surface over lanes 1-3 at 90° to the kerb and drag it around the entire circuit. Move it out to the next three lanes and repeat the drag around the entire circuit. For circuits with more than 6 lanes, continue until all lanes have been dragged. Turn the straightedge through 90°, place on the surface in lane 1 (parallel to the kerb) and drag it to the outer kerb. Move it along 4m and drag it back

to the inner kerb. Move it along 4m and drag it back to the outer kerb. Repeat until the entire circuit has been dragged.

On runways, place the 4m straightedge on the surface parallel to the kerbs and in the centre of the runway, and drag it from one end to the other.

On the "D" areas, drag the 4m straightedge across its width, move it along 4m and repeat the drag back across its width. Repeat again until the full width of the "D" has been dragged. Repeat the entire process along its length.

Use continual visual observation to determine if a gap exists under the straightedge. Should a gap exist, verify that both ends of the straightedge rest on the surface, moving the straightedge if necessary, then use a calibrated wedge to determine the actual size of the gap.

The intention is that the entire area of surface should be dragged with the 4m straightedge. Placing the straightedge on a regular "grid" of individual locations is not an appropriate method for assessing the entire surface.

Whenever, during the 4m straightedge survey, a step-like or other irregularity is visually identified which gives a wedge reading below the maximum permitted, but which is considered to be likely to give a wedge reading above the 1m straightedge maximum, the 1m straightedge should be placed across the irregularity, and its exact height measured using the calibrated wedge.

Any location where a gap is found exceeding the maximum permitted, is recorded on a plan of the facility. The record should also identify whether the deviation is a high spot or a depression.

Note: Sometimes, in moving the straightedge slightly to find the maximum gap, it becomes clear that the irregularity is a high spot rather than a depression. In order to find the magnitude of the high spot, place the centre point of the 4m straightedge on the high spot and rotate the straightedge through 360° until the maximum gap is obtained under one end of the straightedge by pressing the other end down against the surface. Measure the gap beneath the elevated end of the straightedge, and then divide this figure by two to give the magnitude of the high spot.

3.1.3.3 Thickness

Requirement

Thickness is of fundamental importance to the characteristics exhibited by the synthetic surface. The durability of the surface and the safety of the athlete can be affected by the thickness and, to a certain extent, the durability of the surface is dependent on its thickness, particularly with respect to mechanical wear. The use of spikes enhances this requirement for a minimum thickness.

It is also quite apparent that if the Rules permit athletes to use footwear with spikes of a certain length, the surface must be of a thickness which will be adequate to take that length of spike, plus an excess of thickness to allow for wear and weathering. It is obviously for this reason, the safety of the athlete and the durability of the surface, that certain areas on a facility, such as at the throwing end of the Javelin Throw runway and at the ends of other runways where an athlete plants his foot with considerable force and there is a greater impact on the athlete's legs, shall be of

greater thickness than most areas of the synthetic surface (“high stress areas”). This additional thickness shall not affect the evenness of the surface. Not only do the longer spikes permitted for the High Jump and Javelin Throw penetrate deeper into the surface, but the degree of damage which they inflict on the surface is that much greater (Figure 3.1.2.2 and Table 3.1.2.2). Where the synthetic surface has to be thickened, the base layer should accordingly be reduced in thickness.

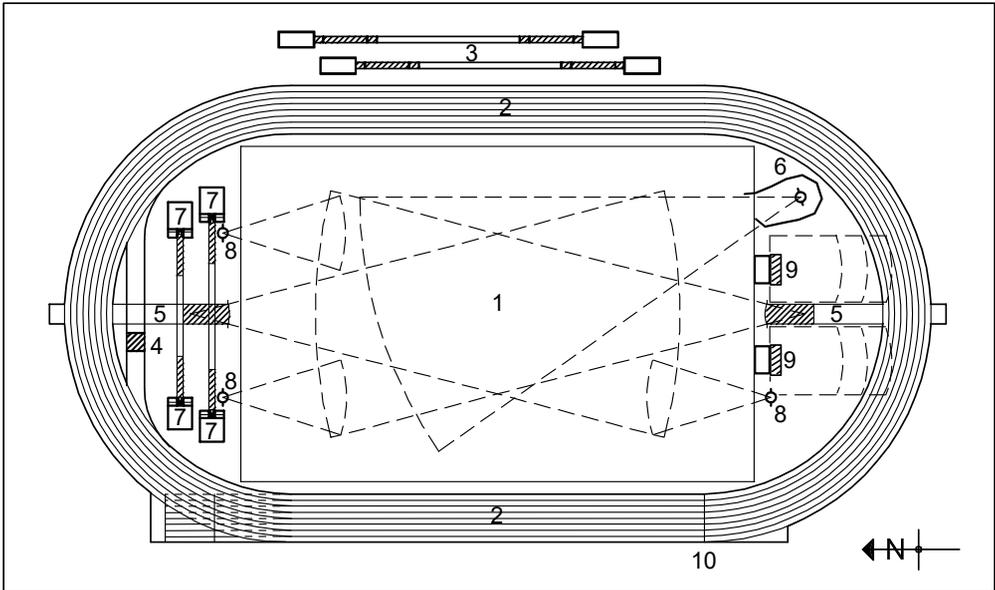


Figure 3.1.3.3 - Areas with thicker layers of synthetic surface (shaded)

- 1 Football pitch
- 2 Standard Track
- 3 Long and Triple Jump facility
- 4 Water jump
- 5 Javelin Throw facility
- 6 Combined Discus and Hammer Throw facility
- 7 Pole Vault facility
- 8 Shot Put facility
- 9 High Jump facility
- 10 Finish line

Runway	Thickness mm	Length
High Jump	20	Last 3m
Triple Jump	20	Last 13m
Pole Vault	20	Last 8m
Javelin Throw	20	Last 8m plus overrun
Steeplechase Water Jump	25	Water jump landing

Table 3.1.3.3 – Required thickening of synthetic surface

Even if there is only a Long Jump take-off board installed in the runway, the end of the runway should be thickened to allow for the possible installing of Triple Jump take-off boards at a later date. The thickening requirement in the case of High Jump is applicable to the designed, permanent site of the event and it is accepted that, as the location of the High Jump competition(s) may be changed to meet competition scheduling, etc. at major championships, it is not practicable to provide thickening at all possible locations.

By far the most important reason why a minimum thickness must be stipulated is that the dynamic characteristics of the synthetic surface are critically dependent on its thickness. If the surface is too thin, its shock absorption and deformation properties will be adversely affected, for example it will feel hard and unyielding to athletes. However, if it is over thick, the converse does not usually apply, that is, it will not necessarily feel too soft and compliant. It is for this reason that it is not necessary to stipulate a maximum thickness of synthetic surface.

The thickness of the surface shall be determined to meet shock absorption and vertical deformation requirements hereunder. The Product Certificate for a synthetic surface material indicates the absolute thickness at which a sample of the material, tested in a laboratory at laboratory temperature (23°C), complied with the acceptable range in the Track and Runway Synthetic Surface Testing Specifications. The average absolute thickness laid will probably have to be greater to ensure that no in-situ test result will fail. The total area over which the absolute thickness falls more than 10% below the absolute thickness given in the Product Certificate for the material used shall not exceed 10% of the total surface area. The high stress areas with a deliberately thickened surface shall not be taken into account in computing these percentages.

The website contains details of all Certified Products and the absolute thickness at which they meet the dynamic characteristics required by World Athletics. Note that shock absorption and vertical deformation performance requirements take precedence over the thickness requirements. It is important to remember that the absolute thickness shall not be determined to the very top of the surface crumb or texture, but to a point somewhat below that as laid down in a precise method of test given below.

Method

A full description of the apparatus and details of the method are given in EN 1969. The calibrated 3-prong depth-measuring probe is used to determine the overall thickness of the surface. Care must be taken not to penetrate the asphalt or bitumen / asphaltic concrete base beneath the surface with the probe. Only if the indicator is close to the probe upper mark should the reading be rounded up. The overall thickness is measured by starting at the finish line and taking sets of readings at 10m intervals around the circuit. The first set of readings is to be taken in the even lanes (2, 4, 6, 8) and the next set in the odd lanes (1, 3, 5, 7), alternating between even and odd lanes every 10m around the circuit. Readings shall be taken in the centre of each lane. At the 110m start position on each straight, readings shall be taken in the centre of each lane. Runways including the steeplechase lane on the circuit shall be probed at 5m intervals centred along the length. The "D" areas shall be probed at 5m intervals along parallel axes in two directions.

Where exceptionally thin areas are detected, additional probe readings shall be taken in all directions until an acceptable thickness is measured. An exceptionally thin section is defined as where the absolute thickness is less than 80% of the Product Certificate absolute thickness. The laboratory shall determine, depending on the extent of the exceptionally thin area, its location and the minimum thickness measured, whether to recommend that the area be cut out and reinstated to greater thickness. Additionally, the exact extent of over-thickness (reinforced) areas shall be determined by probe readings in the same way as above. All measurements taken are recorded (but see next paragraph), and the test points listed in the test report.

At a number of locations, a core (15mm to 25mm in diameter) is removed and measured using the following method to determine absolute thickness. At least four cores shall be removed, but more than this number are required if the surface is thin over large areas. All core holes to be repaired immediately. The surface texture of the core is abraded with a grade 60 abrasive for approximately 50% of the surface area of the core. The thickness of the abraded area of the core is measured using a thickness gauge fitted with a 0.01mm accuracy dial, a plunger with a flat measuring surface of 4mm diameter and with a measurement force between 0.8N and 1.0N. The measurement is recorded to the nearest 0.1mm. The difference in thickness between the actual surface and the abraded surface is calculated and the difference deducted from all of the actual probe measurements. These amended figures are recorded as the absolute thickness of the surface for the purpose of the report.

3.1.3.4 Shock Absorption (SA)

Requirement

The dynamic interaction between the athlete and the surface is significant to the performance and safety of the athlete. Therefore, the ability of the surface to reduce force (absorb energy) is important.

The dynamic behaviour of athletics track surfaces is complex. Two of the major components of the interaction between an athlete and the surface are the deformation under load of the surface and the ability of the material to either absorb or give back the energy of impact of the foot. Biomechanical studies over many years have confirmed the complexity of the foot / surface "model" and have revealed the extent of the variation in loading and duration of load between not only different sports, but different athletics events.

As has been explained elsewhere in this chapter, it is possible to formulate synthetic surfaces which favour, or are more suitable for, one type of event against another. All current surfacing systems therefore represent a compromise between the various needs of the different athletics events.

Shock absorption, like all dynamic properties of elastomeric surfaces, is temperature dependent. Most major athletics competitions take place with a surface temperature in the range of 10° C to 40° C. World Athletics stipulates that the shock absorption of the surface at any temperature within this range shall be between 35% and 50%. If, at the time of measurement, the temperature of the surface is outside this range, it shall be permissible for the results obtained to be corrected for temperature by interpolation from a graph of shock absorption against temperature for the precise surfacing system installed previously obtained by laboratory testing. If no graph is available, then testing outside the surface temperature range shall not be undertaken.

The stipulated values are those for the installed facility. Because of the fact that it is required to install greater thicknesses of synthetic surface at high stress areas, it is possible that results obtained in these areas may fall outside the above range.

It should also be remembered that the shock absorption values obtained on the synthetic surface might vary according to the type of base employed. Concrete is essentially a completely non-resilient base. However, the more commonly used bitumen / asphaltic concrete or asphalt bases have a certain amount of compliance,

and therefore might influence slightly the shock absorption of the surface laid above it.

Method

The shock absorption of the surface is measured using an "artificial athlete", in which an impact load is applied via a spring to a test foot with a spherical base resting on the synthetic surface. The foot is fitted with a force transducer, which enables the peak force during the impact event to be recorded. This peak force is compared with the result obtained on a rigid (concrete) floor, and the percentage force diminution calculated for the synthetic surface.

A full description of the apparatus and details of the method are given in EN 14808, except that the low-pass filter shall have a 9th order Butterworth characteristic.

The 95% confidence limits of this method are calculated at plus or minus 1%.

At least one measurement shall be made for every 500m² of normal thickness synthetic surface, with a minimum of twelve measurements over the facility. The test positions shall be as follows:

1. At the discretion** of the test laboratory, in any lane around the first radius*
2. In the centre of lane 2 at the 130m mark on the back straight
3. In the centre of lane 5 at the 160m mark on the back straight
4. At the position of lowest thickness on the back straight*
5. At the discretion** of the test laboratory, in any lane around the final radius*
6. In the centre of lane 1 at the 320m mark on the main straight
7. In the centre of lane 4 at the 350m mark on the main straight
8. In the centre of the outer lane at the 390m mark on the main straight
9. At the position of lowest thickness on the main straight*
10. At the discretion** of the test laboratory, at any position (except the High Jump take-off point) over the "D" area. Where there are two "D" areas, a test shall be performed on each of them
11. At the discretion** of the test laboratory, at any position (except the reinforced high stress areas) on each of the runways (Long Jump, Triple Jump, Pole Vault, Javelin Throw) and in the Steeplechase lane

**Whenever the selection of the test location is left at the discretion of the laboratory, that location must be close to the average thickness of the track as a whole or the particular field facility as the case may be.

*For the purposes of testing, the first radius is defined as 10m to 100m, the back straight as 110m to 200m, the final radius as 210m to 300m, and the main straight as 310m to 400m. If a position of lowest thickness is at one of the above designated test locations, then an additional test location on the same straight shall be selected.

If the area of synthetic surface is exceptionally large (for example 10- or 12-lane straights), any necessary additional tests shall be at locations selected by the test laboratory.

At each location, the temperature of the surface shall be measured with a needle temperature probe and recorded. Each test position shall be recorded on a plan of the facility with the results recorded in the report.

Note: If the surface temperature is outside the permitted range of 10°C to 40°C, temperature correction of the results may be employed on the basis of interpolation from laboratory results as described in the first paragraph. If no graph is available, then testing outside the surface temperature range shall not be undertaken. However, it is sometimes possible to avoid the need for this, by conducting the testing at a different time of day. For instance, if the facility is in a hot region, testing early in the morning or in the evening can result in the surface temperature falling to within the above range.

3.1.3.5 Vertical Deformation (VD)

Requirement

The dynamic interaction between the athlete and the surface is significant to the performance and safety of the athlete. Therefore, the ability of the surface to deform under load is important. Deformation is a second major component of the foot / surface interaction.

If the deformation of the surface under foot load is too high, it represents a waste of kinetic energy and impairs the athlete's performance. In addition, high deformations lead to instability of the foot, and can affect the safety of the athlete, especially for athletes running around bends. Conversely, if the surface deformation beneath the foot is too low, because of a very low compliance or because the synthetic surface is of inadequate thickness, then the deceleration forces experienced by the athlete's foot on impact with the surface will be high, and injuries might result.

Once again, therefore, it is necessary to arrive at a compromise range of values which will retain the advantages of a surface which stores and reflects energy imparted to it, without imposing excessive deceleration forces.

As for shock absorption, the deformation of the surface will vary with temperature. Therefore, the range of vertical deformation values stipulated by World Athletics, of between 0.6mm and 2.5mm, is with the surface at any temperature between 10° C and 40° C. The comment about temperature correction, and areas of greater thickness giving values outside the stipulated range also applies for this parameter.

Method

The vertical deformation of the surface is measured by another "artificial athlete" in which an impact load is applied via a spring to a test foot with a flat base resting on the synthetic surface. The foot is fitted with a force transducer, which enables the peak force during the impact event to be recorded. Simultaneously, the deformation of the test foot is measured by means of movement transducers mounted either side of the foot.

A full description of the apparatus and details of the method are given in EN 14809.

The 95% confidence limits of this method are calculated at plus or minus 0.1mm.

At least one measurement shall be made for every 500m² of normal thickness synthetic surface, with a minimum of twelve measurements over the facility. The test positions shall be as follows:

1. At the discretion** of the test laboratory, in any lane around the first radius*

2. In the centre of lane 2 at the 130m mark on the back straight
3. In the centre of lane 5 at the 160m mark on the back straight
4. At the position of lowest thickness on the back straight*
5. At the discretion** of the test laboratory, in any lane around the final radius*
6. In the centre of lane 1 at the 320m mark on the main straight
7. In the centre of lane 4 at the 350m mark on the main straight
8. In the centre of the outer lane at the 390m mark on the main straight
9. At the position of lowest thickness on the main straight*
10. At the discretion* of the test laboratory, at any position (except the High Jump take-off point) over the "D" area. Where there are two "D" areas, a test shall be performed on each of them
11. At the discretion** of the test laboratory, at any position (except the reinforced areas) on each of the runways (Long Jump, Triple Jump, Pole Vault, Javelin Throw) and in the steeplechase lane

**Whenever the selection of the test location is left at the discretion of the laboratory, that location must be close to the average thickness of the track as a whole or the particular field facility, as the case may be, not including areas deliberately thickened.

*For the purposes of testing, the first radius is defined as 10m to 100m, the back straight as 110m to 200m, the final radius as 210m to 300m, and the main straight as 310m to 400m. If a position of lowest thickness is at one of the above designated test locations, then an additional test location on the same straight shall be selected.

If the area of synthetic surface is exceptionally large (for example 10- or 12-lane straights), any necessary additional tests shall be at locations selected by the test laboratory.

At each location, the temperature of the surface shall be measured with a needle temperature probe and recorded. Each test position shall be recorded on a plan of the facility with the results recorded in the report.

Note: If the surface temperature is outside the permitted range of 10°C to 40°C, temperature correction of the results may be employed on the basis of interpolation from laboratory results as described in the first paragraph. If no graph is available, then testing outside the surface temperature range shall not be undertaken. However, it is sometimes possible to avoid the need for this, by conducting the testing at a different time of day. For instance, if the facility is in a hot region, testing early in the morning or in the evening can result in the surface temperature falling to within the above range.

3.1.3.6 Friction

Requirement

An important requirement of an athletics track is the need to ensure that no undesirable slip occurs between the surface and the athlete's foot. This requirement should be maintained irrespective of whether the surface is wet or dry. The correct friction value is achieved by giving the surface a textured or embossed finish. Friction is a characteristic of not just one surface but of two surfaces in contact. Because of the complications, which this fact introduces, it is normal for test measurements of friction to standardise on one particular type of foot on the test apparatus.

The coefficient of dynamic friction, which World Athletics stipulates, shall be no

less than 0.5 under wet conditions. All synthetic athletics surfaces yield higher coefficient of friction values when dry than when wet, and so, it is only necessary to specify a minimum under wet conditions.

Note: This corresponds to a scale reading of 47 on the TRRL machine.

Method

There are two widely used items of test equipment and methods for the measurement of the frictional properties of installed synthetic track surfacing. One is a pendulum device fitted with a spring-loaded foot shod with a standard grade of rubber (method "A"). The other apparatus utilises a standard leather foot which operates under a fixed load and is allowed to rotate down on to the surface under test (method "B").

The test shall normally be undertaken in-situ but it is permissible in the case of prefabricated products for samples of the surface to be cut from rolls on site to be later tested in the laboratory.

Method "A" involves the use of the British Transport and Road Research Laboratory (TRRL) Portable Skid Resistance Tester.

A full description of the apparatus and details of the method are given in EN 13036 Part 4 and EN 14903.

The 95% confidence limits of this method are calculated at plus or minus two scale divisions.

Method "B" involves the use of the German slide resistance apparatus.

A full description of the apparatus and details of the method are given in EN 14903.

The 95% confidence limits of this method are calculated at plus or minus 0.01.

Using either method, at least one measurement should be made for every 1000m² of normal thickness synthetic surface, with a minimum of six measurements over the facility.

The test positions shall be as follows:

1. At the discretion of the test laboratory, in any lane around the first radius*
2. At the position of apparent lowest texture in any lane on the back straight*
3. At the discretion of the test laboratory, in any lane around the final radius*
4. At the position of apparent lowest texture in lane 1 on the main straight*
5. At the discretion of the test laboratory, at any position (except the High Jump take-off point) over the "D" area. Where there are two "D" areas, a test shall be performed on each of them
6. At the discretion of the test laboratory, at any position on one of the runways

*For the purposes of testing, the first radius is defined as 10m to 100m, the back straight as 110m to 200m, the final radius as 210m to 300m, and the main straight as 310m to 400m.

If the area of the facility is exceptionally large (for example 10- or 12-lane straights), any necessary additional tests shall be performed at locations selected by the test laboratory.

Each test location shall be marked on a plan of the facility with the results recorded in the report.

3.1.3.7 Tensile Properties

Requirement

The tensile strength and elongation at break of a synthetic surface is a vitally important "screening" test for surfaces, to ensure that the correct raw materials are used, in the correct proportions, properly laid, consolidated and cured.

The minimum values, which are stipulated, can be met by quality systems from reputable manufacturers and installers.

There are a number of situations in which a surface might fail to meet the requirements:

- If the rubber has not correctly cured, such as for reasons of incorrect mixing or proportioning of raw materials, incompatibility of raw materials, or adverse weather conditions during the period allowed for cure.
- If the raw materials are substandard in any way, for instance, if the rubber granules are incorrectly graded for particle size, if their source is inadequately controlled, or if the resin contains too high a proportion of inert filler.

Any of the above problems are likely to result in a surface, which might fail to meet certain other key performance requirements. Testing the completed facility could, of course, identify such a failure. However, if the formulation is "adjusted" only to a lesser extent, the far more insidious situation might arise where the surface meets the dynamic requirements when newly completed but deteriorates by mechanical wear and under the action of weathering, more rapidly than it should. The long-term effectiveness of the surface is therefore compromised.

Conducting tensile tests on samples of the surface should give a useful indication that its strength and likely durability are as they should be for that type of system. The minimum values stipulated by World Athletics are 0.40MPa for tensile strength and 40% for elongation at break.

Method

The test shall be conducted on a minimum of four specimens and the result quoted is the average of the four results.

A full description of the apparatus and details of the method are given in EN 12230.

The 95% confidence limits of this method are calculated as:

Tensile Strength uncertainty $\pm 0.01\text{Mpa}$.

Elongation uncertainty $\pm 3\%$.

In the case of newly installed tracks, it is sometimes acceptable to conduct this test on sample "trays" of synthetic surface prepared by the contractor as work proceeds, or in the case of prefabricated surfaces, on samples cut from individual rolls of material on site. However, in the event of dispute, or if the quality of the installed surfacing is suspect, samples must be taken from the track itself.

If it is necessary to cut samples of surfacing from the track for this test, these should obviously be removed, where possible, from non-critical areas of the facility such as run-outs at the ends of straights, at the corners of “D” areas, etc. In the event that samples must be removed from a specific location because a defect is suspected, these samples should be cut from a low-wear area within that location.

In the case of prefabricated products, it is recommended that samples are removed across a number of the bonded seams, in order that the strength of the bond can be assessed.

It may prove necessary to remove some of the finishing layer of the road construction, if a cohesive sample of the synthetic surface is to be obtained.

All areas from which samples have been removed, should be repaired immediately with fresh synthetic surfacing.

In the case of synthetic surfacing formed with the use of single-component, moisture-curing polyurethanes, at least 14 days curing time should be allowed before conducting tensile strength tests. If such a system fails to meet the stipulated limits, repeat tests should be conducted on further samples after another 14 days, or after a period of accelerated curing in the laboratory.

Dumbbell samples cut from prefabricated sheet should include as many whole “squares” as possible and not be abraded.

Dumbbell samples should be cut using a template cutter mounted in a press.

Each test location shall be marked on a plan of the facility and the results obtained on samples from each location included in the test report.

3.1.3.8 Colour

Requirement

The actual colour of a synthetic surface for athletics is not important provided the line markings are easily discernible. In practice, many outdoor athletics tracks have red surfaces and the World Athletics marking colours are based on red surfaces.

The evenness of the colour of the running surface assists in the concentration of the athlete and provides a focus in relation to the line and event markings. The colour must be consistent within the design of the surface and, when fading occurs as a result of weathering, this must occur evenly. If it is not the case, for reasons perhaps of differing effects on different batches of the materials used, and hence on different areas of the facility, then it may be necessary to resurface the track. The colour shall be uniform to within one position on the recognised colour reference card or plate system used. For deliberately designed multi-colour facilities, each discrete colour shall be similarly uniform.

Method

There are a number of different assessment systems for colour. Most utilise some form of colour chart or series of colour cards or plates. Any system used for assessing colour must be capable of identifying and, if necessary, quantifying the consistency of the colour of the surface over the facility. Areas of inconsistent colour shall be marked on a plan of the facility.

3.1.3.9 Drainage

Requirement

The very slight gradients, which are permitted for athletics facilities, make the shedding of water from non-porous surfaces difficult, although not impossible.

It has already been explained that the presence of large areas of standing water, or of small areas in key locations such as the High Jump take-off point, can seriously delay the schedule of a competition and water in excess of the height of the texture of the running surface can affect the safety and performance of the athlete. It is for this reason that World Athletics stipulates that when completely covered with water and allowed to drain for 20 minutes, there shall be no area of synthetic surface where the depth of residual water exceeds the texture depth of the surface. Porous surfaces should rarely give problems of this nature. If such problems do occur, they are invariably the result of either the excessive application of the texturised paint coating, or of inadequate porosity in the subbase foundations for the facility, or in the drainage system taking water away from the base construction.

Method

The synthetic surface is flooded with water by any appropriate means and the 20 minutes is measured from the time the flooding stops. After that time, the surface is examined for standing water. Locations with standing water above the top of the surface texture of the synthetic surface are noted on a plan of the facility with the approximate square metres and the maximum depth of the water, and included in the report.

Note: It is sometimes difficult to deliver the necessary quantities of water to the surface from a hose supply. In this event, it may be necessary to evaluate this parameter just after heavy rainfall, if at all possible. Alternatively, selective watering from a hose supply should be applied to those areas of the facility which are particularly susceptible to water run-off problems, such as the "D" areas.

3.1.3.10 General

The above programme of testing is considered adequate for a facility in good condition. Where the surface is showing evidence of problems, it may be necessary to extend the testing to other areas, to increase the frequency of tests, or to modify the procedures employed to properly identify the nature and extent of the surfacing defects. These are matters best left to the professional judgement of an accredited test laboratory.

3.1.4 REPAIRS AND REFURBISHMENT

Any bubbles, tears or gouges in the synthetic surface should be professionally repaired as soon as possible, firstly for the safety of the athletes, but also to prevent accelerated deterioration of the surface.

After a number of years of use, typically somewhere soon after five years, it would be expected that an athletics surface would be in need of some repair, or even complete renovation if usage levels have been high. Naturally, the extent of wear which the synthetic surface experiences will depend upon the degree and type of usage. Use levels vary enormously from one facility to another.

In the case of porous surfaces, wear will be most apparent as a loss of the textured surface coating, leading to the resin-bound rubber crumb base mat showing through and becoming more exposed to increased spike damage and weathering effects. Naturally, this will first become apparent in the high wear areas of the track. If identified early enough, it may be possible to reduce the rate of further wear by the spray application of an additional textured paint coating. The areas to be repaired should be thoroughly cleaned and, if necessary, high pressure washed and allowed to dry before the application of further textured coating. If significant damage to the base mat has already occurred then, at this stage, it would be best to cut out all those damaged areas down to the bitumen / asphaltic concrete and reinstate with fresh base mat before applying the new textured coating.

Non-porous systems tend to have a superior resistance to abrasive and spike wear. Composite systems with an upper surface of cast elastomer also have this characteristic, although once this upper layer is penetrated by spikes, wear occurs more rapidly in the underlying base mat than it would if the system was solid rubber. This is one of the reasons why an absolute thickness of at least 4mm is preferable for the upper cast layer of a composite surface. When the loss of texture has reached a point where the surface is in need of repair, the usual way of doing this is to grind off the upper rubber layer and granular texture and apply a fresh flood-coat layer of polyurethane resin with overcast granules in the usual way. If this is done on a patch repair basis it is inevitable that the appearance of the surface will be very noticeably different on the repaired areas compared to the existing surface.

Not all repairs that are necessary will be due to wear. A surface may "harden" over a period of time to an extent where it no longer meets the dynamic properties laid down by World Athletics. In such a case, grinding off some of the thickness and over-topping with fresh surfacing may be an option. It is recommended that a trial area is installed first to demonstrate the acceptability of the technique in bringing the dynamic properties back within the specified range.

Another problem that can occur in tracks of some age is slight shrinkage of the synthetic surface away from the edge kerbing to leave a gap. If this occurs to any significant extent, the full thickness of the surface should be cut back from the kerb a minimum distance of 75mm and fresh material re-instated to full thickness after the application of a suitable primer to the kerb edgings.

Eventually, the synthetic surface will have deteriorated to the point where patch repairs or a complete overcoat of cast resin or spray-applied textured paint are no longer adequate to bring the facility back into good condition. When this time comes it is necessary to undertake the complete removal of the old synthetic surface and its replacement with new.

For renovation of synthetic surfaces, see 7.2.1.9.

3.2 Foundation Requirements

No facility lasts for ever, but it is entirely reasonable to expect the foundation of an athletics track to continue to function effectively over a time period that may encompass several replacements of the synthetic surface. To do this, it is necessary

to ensure that a very good standard of road construction is employed. The total depth of base, necessary to ensure long-term stability of the finished track surface, will depend upon the nature of the site on which it is to be built. It should be noted that, even on the most ideal site, a minimum of 150mm of free-draining aggregate below a minimum of 60mm bitumen / asphaltic concrete will prove to be necessary. On less than ideal sites, a build-up of 400mm or 500mm is quite likely to be needed. The bitumen / asphaltic concrete would typically comprise a base layer 40mm to 60mm thick and a finishing course 25mm to 30mm thick. Great attention must be paid to the accuracy of the final bitumen / asphaltic concrete layer, because of the very strict requirements for surface evenness and minimum overall thickness of the synthetic surface.

It is recommended that a geotechnical survey of the ground conditions over the site is carried out at an early stage, and the results of such a survey should be made available to an independent consultant engineer in order that an adequate base to the track can be designed. It is important that, during construction, quality control of all aspects of the work is rigorously adopted. This should extend from the installation of the drainage system, through the entire project, to the application of the finished synthetic surface and line markings. The assistance of an independent, suitably experienced and competent test laboratory should be sought, in particular for the quality control of the synthetic surface and to conduct a comprehensive inspection of the finished facility, in order to ensure compliance with the performance parameters. When selecting such a laboratory, the specialised requirements of the Track and Runway Synthetic Surface Testing Specifications must be carefully considered.

The extremely strict tolerances for gradients and evenness which are stipulated by World Athletics, mean that the construction of an adequate foundation is of supreme importance. These tolerances are required to be met not only by the newly completed facility, but also over the life of the track. This life would be expected to extend over two or three times the expected life of the synthetic surface. That is, the base construction should be adequate for at least 25 or 30 years without showing signs of movement in the form of settlement or heave.

3.2.1 ESSENTIAL CRITERIA

The foundation to any synthetic surfaced athletics track should be designed to meet the following criteria:

- It should be capable of supporting and transmitting to the existing ground the loads of all vehicles, construction machines and materials to be used in the construction, without causing deformation of the site, or exceeding the ground-bearing capacity.
- It should be capable of supporting and transmitting all the loads on the surface from athletes and maintenance equipment, without permanent deformation of the surface.
- It should provide protection to the surface from the effects of ground water, subsoil ground movement and frost heave.
- It should ensure that water, whether rainwater or natural groundwater, will drain away freely, either into the subsoil, or into a drainage system.
- It must guarantee porosity to rainfall in excess of the heaviest likely rainstorm and ensure that no standing water remains on the track surface which could

impair the use of the facility. Porous surfaces must permit such rainwater to seep away freely.

- It should contribute towards providing suitable performance characteristics of the surface, in respect of athlete / surface interaction.
- It should ensure that the above criteria are retained throughout the life of the installation.
- It should provide all the above at the most economical costs, in terms of initial capital outlay and subsequent maintenance costs.

3.2.2 FOUNDATION CONSTRUCTION TECHNIQUES

General

The basic construction for all foundations will be similar and may be likened to high quality road construction. The differences being in the overall thickness and nature of the layers of stone.

The procedure adopted for the foundation construction will normally consist of the following operations:

- Excavation to remove vegetable matter, soil, loose or frost susceptible material down to a firm, load-bearing strata.
- Rolling or other treatment, to identify any weak or soft spots which should be dug out and replaced with suitable compacted hard, non-degradable filling.
- On some sub-soils, compaction only may be necessary.
- Drainage installation for subsoil or sub-base, in accordance with sub-section 3.3.
- Laying and compacting of first stone base. A crushed, hard, frost-resisting layer of stone is the normal material, but clean crushed brick, concrete or clinker may be suitable. This layer should not exceed about 200mm thickness and if the sub-soil is frost-resistant gravel, this may be the only stone layer required. It should be graded to falls, and checked for accuracy of finished level within the tolerances specified.
- Laying and compacting second (and subsequent, if necessary) stone layer(s) as above, to provide total construction height of the unbound base layers.
- Blinding with small, angular crushed stone (sand or ash may be acceptable, depending on the finishing (top) course).
- Laying and compacting bitumen-bound base and finishing (top) courses. There are a number of alternative forms of finishing course on offer. The choice is determined in consultation with the surfacing installer, in the light of the particular synthetic surfacing system to be used. The bitumen binder in bituminous bases should be "straight run", unfluxed, unless the finishing course is intended to be left exposed for sufficient time to allow all solvents to evaporate.

A bitumen-bound two-layer build-up at least 60mm thick will be required, typically comprising a lower layer, 40mm to 60mm thick, and an upper layer, 20 to 30mm thick. Great attention must be paid to the accuracy of the final layer because of the very strict requirements for evenness and gradients, together with the thickness and shock absorption requirements of the synthetic surface. The evenness and gradient tolerances for the bitumen / asphaltic concrete shall be as demanded in 3.1.3.2 for the synthetic surface under 1m and 4m long straight edges. All corrections to the asphalt

shall be by mechanical grinding off high spots and/or filling low spots with non-compressible material. In this way, a poured synthetic surface will not require the application of a larger quantity of more expensive synthetic material so as to meet the minimum absolute thickness specified in the material Product Certificate. Further, it will minimise the variation in the synthetic surface properties which can affect athlete performance and safety.

It is quite likely that, in order to achieve the required tolerances, corrective work to the final layer will be necessary. Time should be allowed for this in the construction programme. The synthetic surface contractor should formally accept the condition of the bitumen / asphaltic concrete before laying the synthetic surface.

Reinforced concrete may be substituted for the bitumen layers and some of the stone layers. The reinforced concrete should be laid in a "hit and miss" pattern to allow for concrete shrinkage before placing concrete in the adjoining slabs. The slab joints shall be constructed so as to prevent relative vertical movements and limit relative horizontal movements to a maximum of 2mm. The slab must be properly sealed on all sides, so as to prohibit penetration of ground moisture, rain and irrigation water.

Deliberations about Investigation of the Sub-Soil

It is apparent from these criteria that the foundation in its precise construction and thickness is dependent upon the location. The ground conditions existing beneath each site must be accurately determined by means of a comprehensive geotechnical investigation. It is important to ascertain the strata at depths down to approx. 2.5m, the load bearing capacity of the soils, their shear strength and their permeability. Some of the tests necessary to generate this information must be conducted in the laboratory on samples removed from site. Certain tests need to be undertaken in-situ, at various depths below the surface. All sub-soil investigation should be undertaken at design stage, in advance of tender period and construction.

Summary

Because of the complexity of the topic, it is not possible to lay down comprehensive guidelines for the required base foundation. The considered judgement of experts in this field is necessary for every new installation, in the light of the geotechnical information available. It is important to remember that the construction and tolerances required involve a good standard of road-making.

In latitudes where winter temperatures below zero are regularly encountered, construction depths greater than this may be needed to avoid problems of frost "heave".

Due to the high cost, extremely troublesome sites, such as old landfill areas, should be avoided due to the risk of ground movements and the greater number of structural measures then needed to ensure stability. Filled areas are to be avoided if at all possible. Any filling should be properly compacted in a controlled manner under competent supervision. Testing on completion of compaction may be ordered by a supervising geotechnical engineer.

3.3 Surface Drainage

3.3.1 GENERAL REMARKS

With the exception of the water needed for maintaining the grass of the turf surface infield, water is disruptive of sports training and competition facilities. Water in, or on sports surfaces considerably alters the performance properties of the surface. For example, on synthetic surfaces a hindrance may occur as a result of a kind of aquaplaning. The removal of any surface water from sports areas by means of a drainage system is therefore vital.

Surface water mainly accumulates from precipitation, such as rain, mist, dew and snow. In rare cases which are mostly attributable to planning error, surface water may also be derived from extraneous sources originating from surface or ground and stratum water, which develops from outside areas and has a hydraulic slope to the sports area. In this case, special measures have to be considered.

The surface water, which has to be removed, accumulates not only on the sports surface, but also in the spectator areas, adjacent traffic areas and on other neighbouring sports surfaces and ancillary areas.

Figure 3.3.1 shows the direction of flow of the surface water and indicates the discharge coefficients of the respective surfaces.

Generally, a distinction is drawn between the following systems of drainage:

- Drainage of the surface water into suitable intakes, such as gutters or individual inlet channels, which carry the water through drain pipes to the recipient.
- Drainage of the water through the installation in the form of seepage water which is passed into a porous subsoil or carried through a draining system to the recipient.

Drainage design should use the best available local design practice that takes into account local climatic conditions.

3.3.2 REQUIREMENTS AND CONSTRUCTION

3.3.2.1 Track Surround Gutters

Surround gutters (Figures 3.3.2.1a to 3.3.2.1c) are installed in lengths of 33m to 35m and connected to the collection line via 6 to 8 feed boxes. The feed boxes should be fitted with sand traps.

Such gutters are mostly polyester hollow section gutters. They have removable covers and they usually have a cross section of 125mm. They are designed as mirror-gradient gutters.

3.3.2.2 Open Gutters

Open gutters are used for surface water drainage of ancillary areas (Figure 3.3.2.2). They are open channels and are made of concrete or concrete polyester. These gutters are fitted with drains in the form of individual inlet channels or feed boxes at fixed intervals and should not generally be used as track surround gutters because athletes could turn an ankle if pushed to the infield.

The gutters are inserted as surround gutters in the concrete bedding.

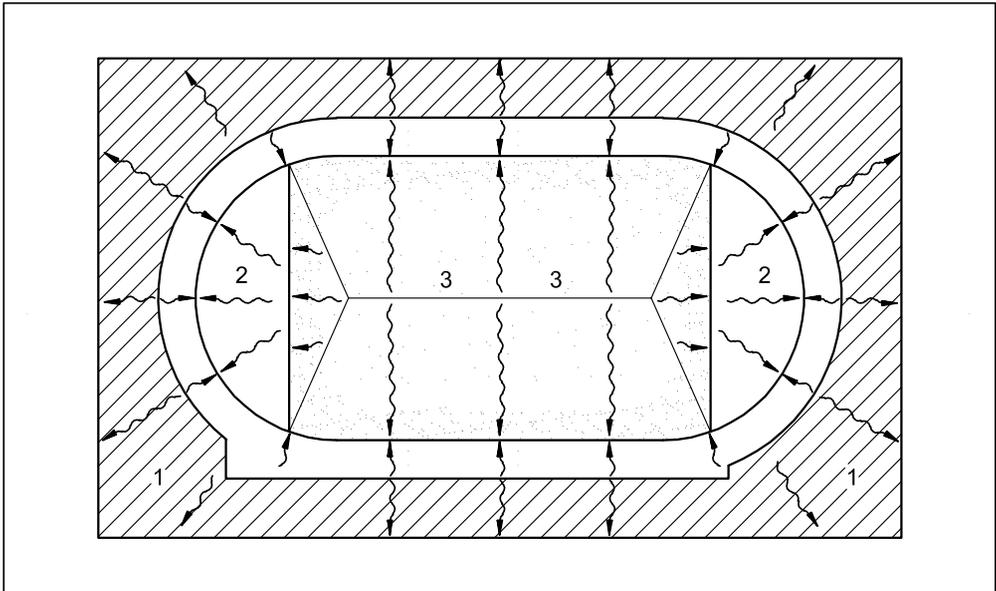


Figure 3.3.1 - Direction of flow of the surface water and discharge coefficients of the respective surfaces (in brackets)

- 1 Groundwater, vegetation areas (0.25), paved paths (0.60), asphalted paths (0.80), waterbound paths (0.30)
- 2 Unbound mineral surface (0.50), non-permeable synthetic surface (0.90), permeable synthetic surface (0.50), turf (0.25)
- 3 Turf (0.25), synthetic turf (0.60)

3.3.2.3 Surface Water Drainage Systems

Running Track

Figure 3.3.2.3a shows the slope and the direction of drainage from the outer edge of the track to the drainage gutters on the inside.

Segment

The discharge of the surface water from the segments to the inside of the track can be seen in Figure 3.3.2.3b. In this figure, a, b, and c refer to the gutter types described in Section 3.3.2.1. Gutter type b is used when there is a synthetic surface on the adjoining part of the segment.

Water Jump

Figure 3.3.2.3c shows the connection of the water jump to the drainage system. The outlet made of cast iron or plastic pipe (diameter 100mm) is controlled by a slide valve.

Landing Areas for Long and Triple Jump

The drain situated in the middle of the landing area receives, via the drainage layer beneath, the surface water from the surrounding grid (Figure 3.3.2.3d).

Landing Areas for Field Events

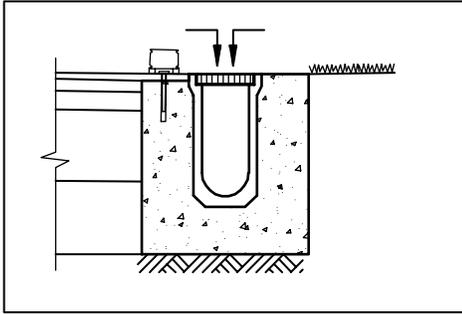


Figure 3.3.2.1a - Example of a gutter with top-mounted kerb between track and infield fed from above

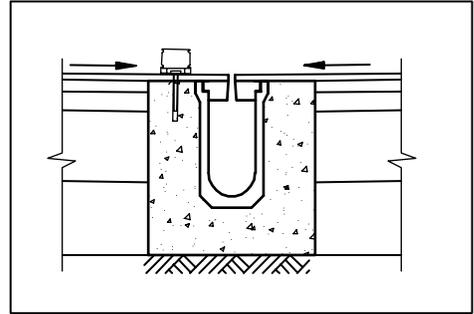


Figure 3.3.2.1b - Example of a gutter fed from above with a demountable, top-mounted kerb fed from two sides

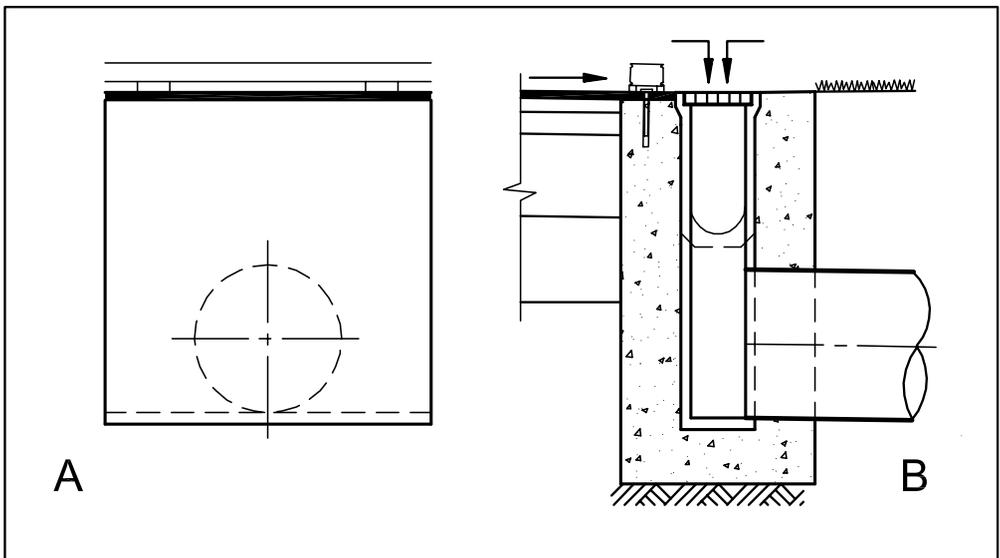


Figure 3.3.2.1c - Individual inlet channel fed from above and top-mounted kerb

- A Cross section
- B Longitudinal section

Figure 3.3.2.3e shows the two alternative drainage methods for the Javelin, Discus, Hammer Throw and Shot Put landing areas at a training facility. Along the left-hand side is a gutter with a slit-type grid whilst along the right-hand side the water is collected in an open gutter and discharged via outlets.

Shot Put Circle

The floor plan and cross section in Figures 3.3.2.3f and 3.3.2.3g, respectively, show the drainage of a Shot Put circle which also applies to Discus and Hammer Throw circles. The four outlets in the concrete slab are connected to the drainage system by means of drain pipes (diameter 65mm).

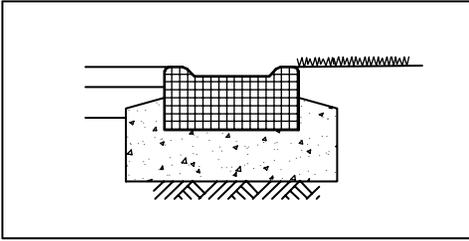


Figure 3.3.2.2 - Open gutter made of concrete or polyester concrete

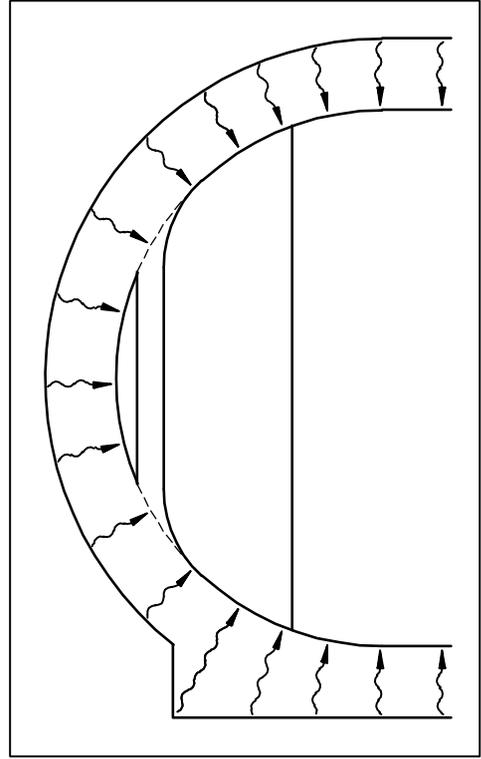


Figure 3.3.2.3a - Slope and direction from outer edge of the track to the drainage gutters

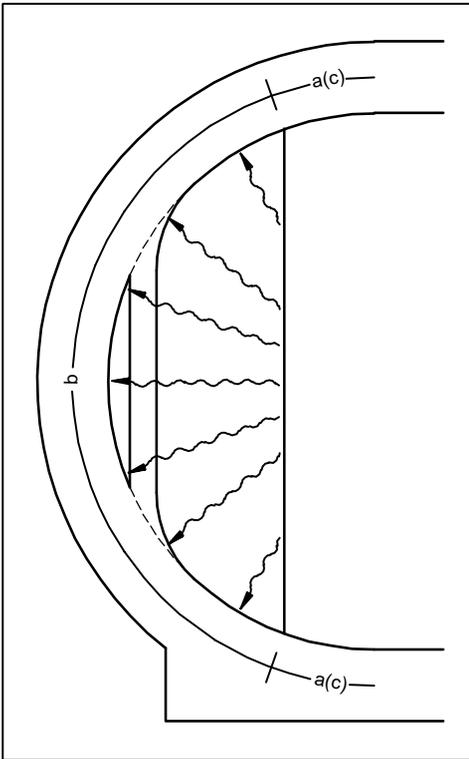


Figure 3.3.2.3b - Drainage of a segment

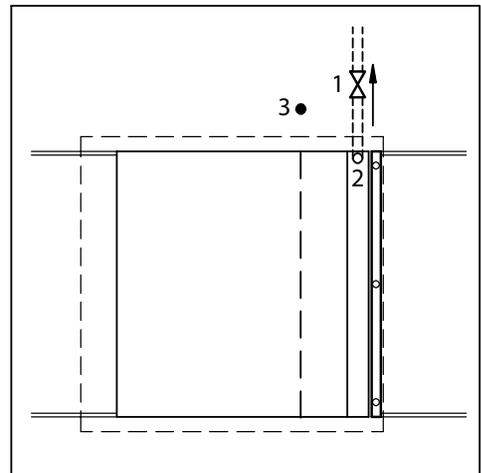


Figure 3.3.2.3c - Draining and filling the water jump pit

- 1 Stop-cock
- 2 Discharge pipe (cast or synthetic)
- 3 Water hose connection

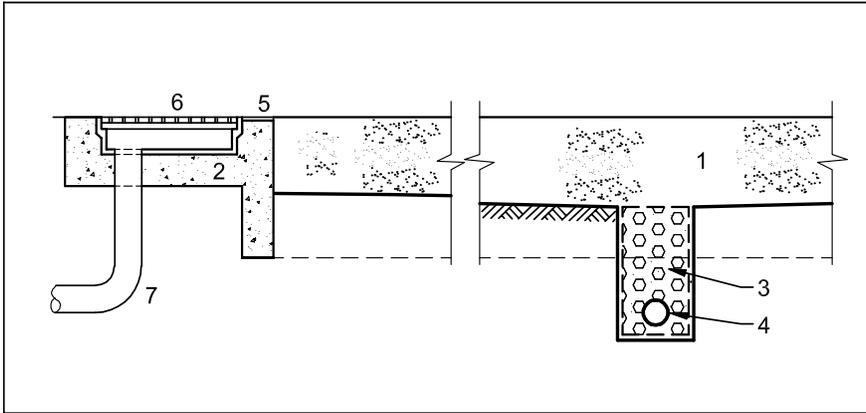


Figure 3.3.2.3d - Draining Long and Triple Jump pits and adjacent sand scraping grid (Cross Section)

- 1 Sand
- 2 Concrete
- 3 Drainage layer
- 4 Drainage ditch and drain pipe
- 5 Soft protective surround
- 6 Sand scraping grid
- 7 Cast or synthetic pipe

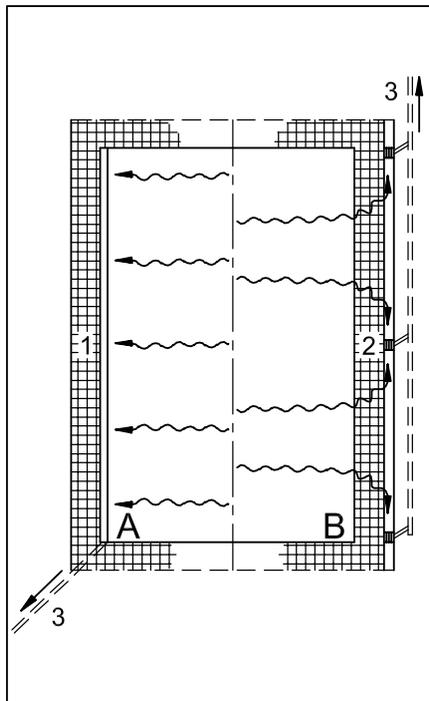


Figure 3.3.2.3e - Alternative drainage methods for landing areas for Javelin, Discus, Hammer, Shot Put

- A Drainage system with gutter covered with grid
- B Drainage system with open gutter and gulleys

- 1 Paved passage with grid gutter
- 2 Paved passage with open gutter
- 3 Seepage line (canal)

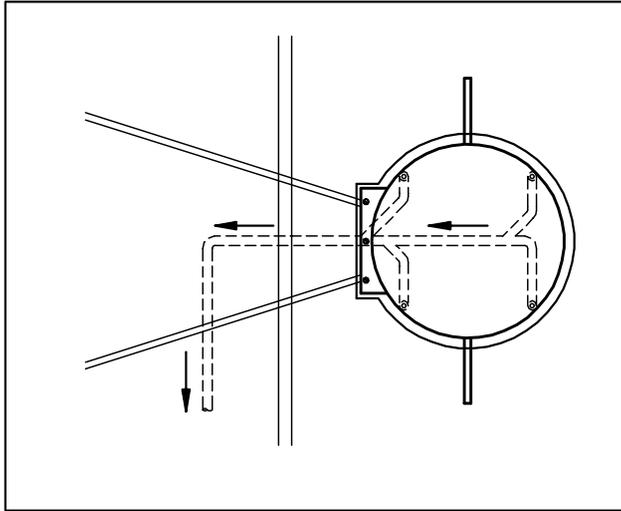


Figure 3.3.2.3f - Drainage of Shot Put circle
(also applies to Discus and Hammer)

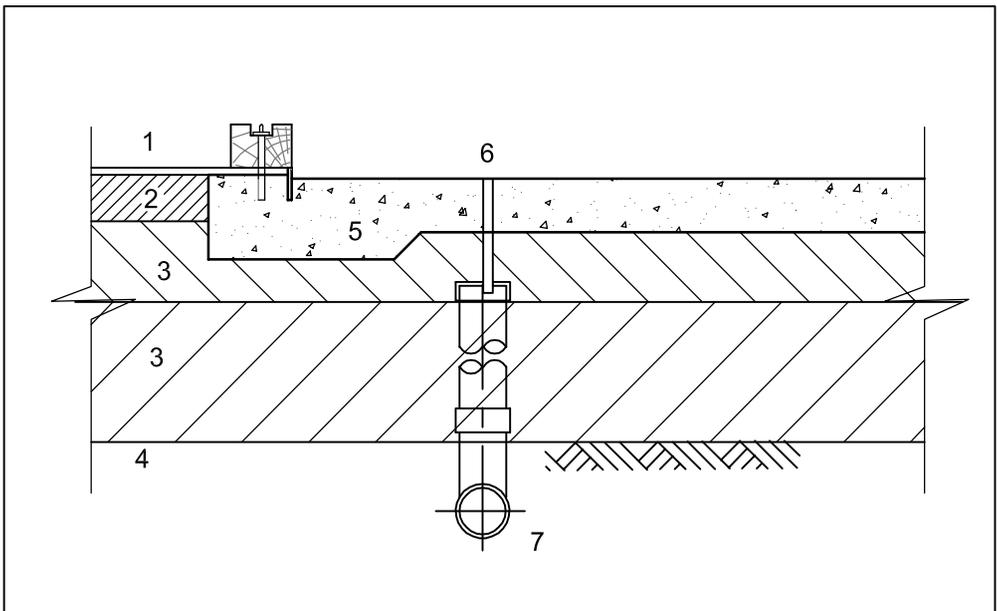


Figure 3.3.2.3g - Drainage of Shot Put circle (also applies to Discus and Hammer) (Cross Section)

- 1 Synthetic surface
- 2 Asphaltic concrete
- 3 Gravel base layer
- 4 Subgrade
- 5 Concrete base
- 6 Drainage hole
- 7 Drain pipe

3.4 Ground Drainage

3.4.1 GENERAL REMARKS

The ground drainage of running tracks and other athletics facilities includes drainage of the surface located above it. When draining the top surface, the water which has infiltrated by seepage (seepage water) is collected and, on impermeable ground, is fed through drainage channels to the existing drainage system. In the case of porous ground, the seepage water is carried off into lower layers of the ground. The ground must be drained so that the load-carrying ability can be maintained. Penetrating stratum water is also carried away to the recipient through the ground drainage system.

For ecological reasons, the possibility of seeping the surplus water which accumulates from the sports areas on site instead of into the sewage system should always be checked. This will only be possible if the ground has a seepage capability. If the gathering grounds are sufficiently large, the installation of a cistern is recommended.

The drainage system usually consists of a surface drain comprising a porous, unbound base layer of gravel and crushed stones and drainage channels which carry the surplus water to the existing drainage system.

3.5 Watering of Sports Surfaces

The water supply for sports surfaces has the task of ensuring the growth of grass if the sports surface is turfed, cleaning synthetic surfaces and throwing circles, wetting landing area sand and filling steeplechase water jump pit. Quick-release hose points shall be located around the arena, adjacent to the throwing circles, landing area sand pits and steeplechase water jump pit.

Sports surfaces can be irrigated from above (sprinkling) or below (capillary irrigation), for example from the underlying layers. In the case of irrigation from above, the water is pressurised and applied to the surface by sprinklers. In the case of underground irrigation, the water is accumulated in a sealed reservoir from which it seeps by capillary action through the substructure to the layers requiring the water:

- The root zone of the grass surface.
- The dynamic layer and surface of the unbound mineral surface.

The latter system is not suitable for watering artificial grass surfaces. For sports surfaces, preference should be given to sprinkling, preferably with stationary systems using pop-up sprinklers.