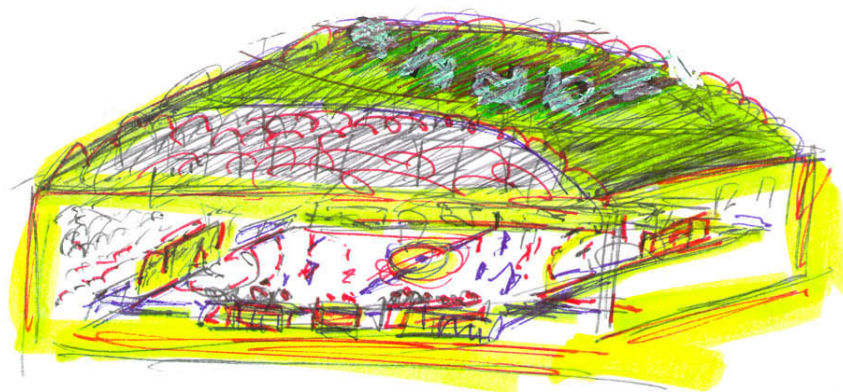




# **Recommendations and Guidelines for the Construction of**



## **Handball Playing Halls**

**6 - E**

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we make equipment for it



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## **Preface**

During the relatively young history of the sport of handball a frequently recurring issue on the agenda has been the quality of indoor playing fields in existence.

Advances in technology but also, unfortunately, too many accidents convinced our federation, athletes, clients as well as architects and engineers that - as long as financially acceptable - we have to consider everything conceivable which could affect the athletes' security and their environment. One such accident, which occurred to Joachim Deckarm, is one too many and by all means must be prevented from occurring another time.

Individual sports have very different demands on playing facilities. As could have been expected the following lines have been written from the viewpoint of a handball player. Nevertheless we did not target the other kinds of sport nor that bigger sport halls, which we are happy to use for major, representative events, also must be usable for activities other than sport events - in order to assure a liable management. Such activities may be cultural events, concerts of various kinds, exhibitions as well as political sessions and elections. As a result the use of such halls becomes very complex and certain compromises cannot be avoided.

In addition differences in climatic conditions make it impossible to find one ideal formula for the construction of sport halls. Still another factor to influence the decision on how to construct a sports hall are cultural differences.

Therefore the following recommendations and guidelines can only form the scaffolding for the construction of a sports hall - a scaffolding which should not be changed but which can be supplemented and extended in a multitude of ways.

Erik Larsen

## TECHNICAL MEASURES HANDBALL

### General

#### The team

A handball team consists of 12 players. No more than 7 players (6 court players and 1 goalkeeper) may be present on the court at the same time. The remaining players and a maximum of 4 team officials as well as any suspended players must remain in the team's substitution area near the centre of the playing court at one of the side lines.

The playing time for all male and female teams is 2 halves of 30 minutes with a half-time break of 10 minutes. For players of younger age the playing time can be shorter. After the half-time break the teams change ends.

#### Competition officials /Technical delegates

The following officials / technical delegates are needed for a game.

On the playing court:

- 2 referees - on a lower level one referee is sufficient

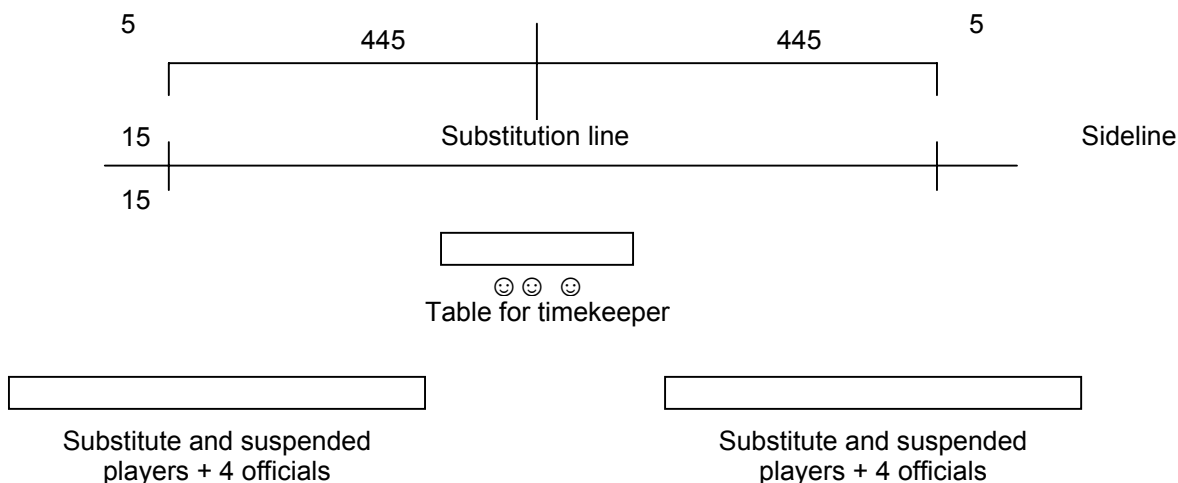
At the table for the timekeeper:

- 1 timekeeper { }                      may be one
- 1 secretary { }                        person only
- 1 speaker                                not compulsory

At official IHF games an additional number of at least one and up to three IHF officials are placed at the timekeeper table. In case of electronic timekeeping operated from the table and which can additionally be used to display external information - e.g. results from other games etc. - a technician is also to be placed at the table.

## TECHNICAL MEASURES HANDBALL

### Substitution Line and Substitution Area



The table for timekeeper and scorekeeper and the benches for substitutes have to be placed such that the timekeeper / secretary can see the substitution markings.

### Dimensions of the playing court for international matches

	Width		Length		Height
	A	B	C	D	H
m	22	20	44	40	7

For the height of the hall a linear or convex reduction of the height is acceptable starting from 3 m distance inside the sideline and/or outer goal line towards the walls of the hall. Above the sidelines the height must not be less than 5.5 m.

### Tolerances of measures

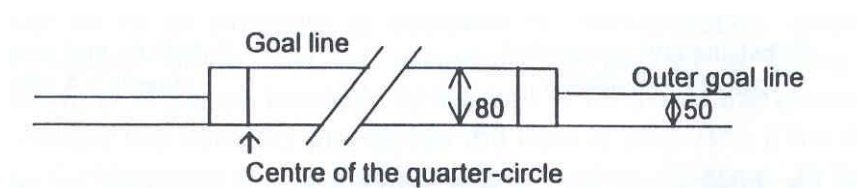
Tolerances of measures must meet ISO 2768 -v standards.

## TECHNICAL MEASURES HANDBALL

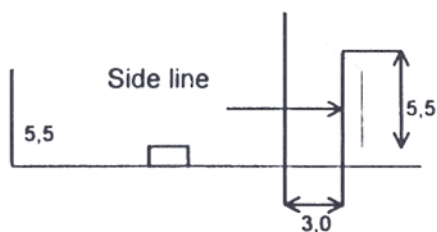
**Lines**

**Colours:** Any clearly distinguishable colour is possible. In case of several colours, a colour different to the others is preferable. However this may be the same colour as for volleyball on the condition that the two playing fields have the same centre, and length and width in the same direction.

**Width:** General: 50mm  
Between the goalposts (goal line) 80mm

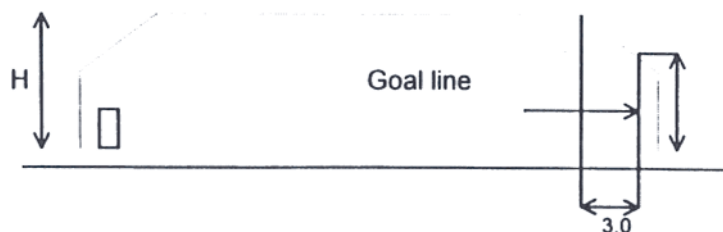
**Smallest inner profile**

**Cross section**



(measures in m)

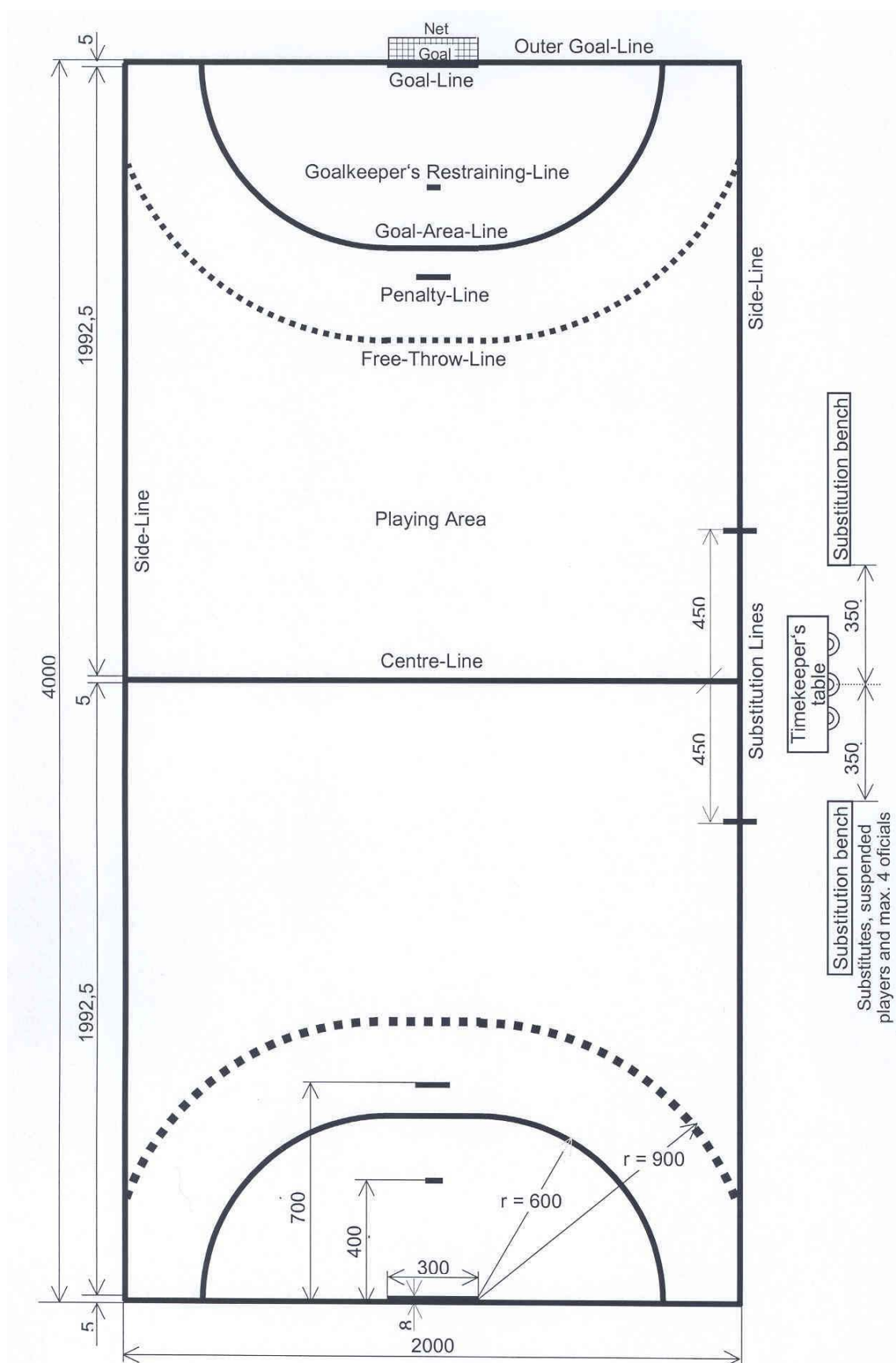
**Vertical section**





# TECHNICAL MEASURES HANDBALL

## The Playing Court



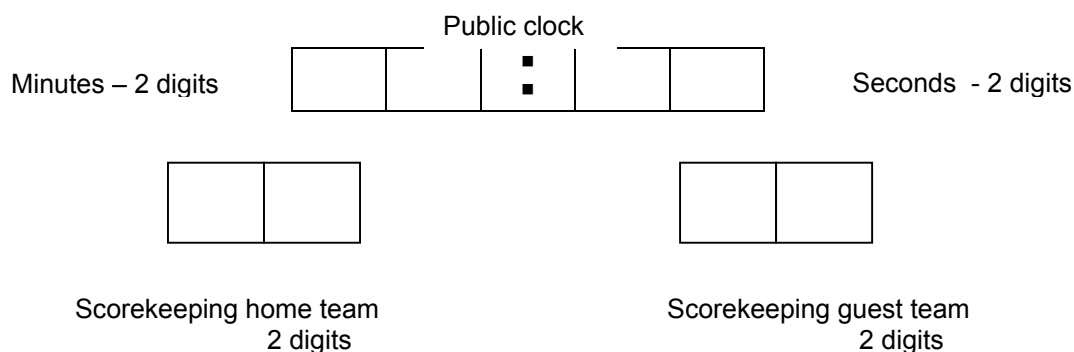
## TECHNICAL MEASURES HANDBALL

**The Goal**

The goal is placed in the centre of each outer goal line. The goals must be firmly attached to the floor. They have an inferior height of 2 metres and a width of 3 metres.

The goalposts are joined by a horizontal crossbar. The rear side of the goalposts shall be in line with the rear edge of the goal line. The goalposts and the crossbar must consist of a uniform material (e.g. wood, light metal or synthetic material) and have a 8 cm square cross section with the edges curved at a radius of 4 +/- 1 mm.

Handball goals have been standardized under EN 202.10 -1 as EN 749 by CEN (European Committee for Standardization).

**Timekeeping and Scorekeeping****Colours**

The colours of the walls and the floor shall present a restful background for the players and the ball. Thus big contrasts shall be avoided. Light colours are to be preferred because they reflect the light better than dark colours.

No fluorescent colours are allowed.

**Lighting**

Value when new for

the vertical lighting in the centre:	> 400 lux
with a regularity of:	> 0.5

## **1.1 Location of a Sports Hall**

The location of the sports hall is of major importance in order to enable optimum utilization. Therefore it must be carefully considered if it shall be incorporated in a central sport complex or better located in a decentralized area where it can be of better use to the entire local population.

The above decision may be taken based on an analysis of specific needs, such as the age of the potential user and requirements of the different kinds of sport. In addition the requirements of schools have to be included in the calculation since their rather limited time (maximum 45 minutes including changing, shower and changing again) does not allow for long travelling distances.

Further points of consideration for location are the possibilities of public transport and safety of the (hopefully young) users.

## **1.2 Required Utilizable Floor Space**

Besides indoor football (60 x 30 m) and ice hockey handball plays a determinant role when it comes to the floor space of a sports hall.

In detail the floor of the sports hall must be a rectangle of 44 x 22 m of which 40 x 20m are taken up by the playing court and the rest used as safety area, for competition officials and the benches for substitutes.

With the addition of the walls and the supporting construction the floor space thus amounts to 1,000 m<sup>2</sup>, however an additional 1,000 m<sup>2</sup> have to be added for changing rooms, cafeteria, club rooms, sports equipment room, caretaker's rooms and technical installations.

It is also worth considering to increase the width of the hall to 27 m which would allow the placement of three basketball and/or volleyball courts at right angles.

## **1.3 Height of the Hall**

In contrast to badminton and volleyball handball does not have any special requirements for the height of the hall. In principal the minimum height for a handball hall is 7 m over the entire playing court including the first 50 cm of the safety area, i.e. over 42 x 21 m.

In countries with heavy snowfall economical reasons require the use of a bevelled roof, but each additional metre of height is very expensive. For this reason the International Handball Federation allows that the headroom over the last 3 m inside the side lines may linearly or in a vault fall from 7 to 5.5 m in all directions and continue to fall over the safety area (technically a ball thrown from one goal to the

other approximately reaches a height of 6.3 m, at a certain point over the playing court; therefore this negative deviation has been permitted for the area where the ball will not be as high in order to allow a cost-effective construction).

Halls equipped with a big number of seats do not fall under this category because their roof must not fall under 7 m over places for seating; however this roof may be bevelled at a bigger height in order to avoid too heavy a load of snow.

The above-mentioned height of 7 m is to be taken as headroom. It is not permitted to mount installations, panels, clocks, scoreboard or suspended basketball systems such that these installations extend into the free space and thus do not allow for a headroom of 7 m.

As a consequence and under certain conditions it may be a good investment to place a basketball court at right angles.

The height of a hall outside the rectangle of 42 x 21 m only has to meet the national standards for headroom in buildings with public access; there are no specific requirements with respect to the sport. In halls with a big number of spectators the relations change totally.

Ventilation and humidity have to be taken into consideration and may eventually require additional volume.

## **1.4 Change Rooms**

A sports hall should be equipped with at least four change rooms for the athletes and two for the officials (male and female referees).

During a competition it is useful to reserve one room for one team, i.e. for approximately 20 persons. For daily use, however, it is recommended that approximately 30 persons (two teams in one training area) can use the same room so that there is sufficient room during competitions. There should be sufficient coat racks or lockers for the above-mentioned number of persons.

For each change room a separate toilet (preferably two) and separate showers are required. On the other hand it is possible to design two change rooms with shared showers in between. In the latter case it must be possible to shut off the change room from the showers by a door restricting the access to the showers from one change room only, it required.

Direct access from one change room to the other should be avoided (theft - quiet atmosphere for the athletes for tactical discussion etc.)

The referees' rooms shall allow for at least four persons to change. In addition a small table and chairs shall be provided. The referees' separate sanitary installations must be able to be reached directly.

Unfortunately at certain events doping tests have to be considered, too. It is not necessary to provide a separate room for doping controls, however, it has to be considered where - if necessary - such a room may be prepared. The equipment required for a doping control room is the same as for a referee room. Often it is also possible to use an ordinary change room provided that it will be released for this purpose only.

## **1.5 Other Installations**

As concerns all other installations in the sports hall handball does not require anything different from other kinds of sport.

We would merely like to recommend that teachers of a school using the sports hall either have their own change room including shower and toilet or can use a referees room with a small depository for sports equipment and a locker. Club representatives, caretakers and sports teachers sharing the same room has long since proved inappropriate.

## **1.6 Parking Space**

Access to and from the hall must be carefully studied. Pedestrians must be separated from vehicles and any crossing of the two avoided. Parking lots for cars shall be located as near to the main entrance as possible, whereby the closest lots should be reserved for handicapped people and journalists. In addition some parking lots for buses (with turning area) and the athletes as well as for officials and staff shall be provided.

It is not possible to project the amount of parking space for peak times, however, it is very useful to establish a respective plan to be on the safe side.

Access for ambulance and fire brigade must be assured at any time. This would be easier by providing them general and exclusive access to the back entrance of the hall and to emergency exit(s).

In countries where cars are the common means of transport, the number of parking lots should amount to approximately a third of the spectators' seating. If thus capacity for approximately 60% of the possible spectators is provided and for peak times a special plan is established, both economical possibilities and technical requirements would be reached.

NB: There are also countries where many people ride bicycles, as a result a large number of bicycle stands have to be provided.

## 2.1 The Sports (=Handball) Floor

Besides the ball, which has been specifically developed for our needs, the floor is the most important equipment for the handball game.

Unfortunately there is no unanimity among the different kinds of sport with regard to the ideal floor for sports halls. However, this does not come too much as a surprise since the requirements of the individual kinds of sport differ substantially.

First we would like to establish that tennis players have their particular requests. If high-level tennis is to be played in a sports hall it is best to install a tennis floor; and when this hall is to be used for other kinds of sport a mobile sports floor should be laid. There is no other compromise concerning tennis. Mobile sports flooring will be treated at a later point. Tennis as activity game, however, may be played on "our" floors.

If the floor is used by people wearing outdoor shoes it is necessary to find a compromise. A good sports floor would suffer substantially from the dirt, gravel and tobacco residues trampled into the floor.

To date there has only been written that handball floors should not be made of a hard material such as cement or alike. Handball is a fast team game and allows body contact. There is much running involved and the direction of running is changed very often. Thus the spectators closely follow each second of the action in order to make sure to have seen the entire game. In this sense it is a big advantage that besides seeing the game one can also hear it. Most of the spectators really enjoy hearing the players run and the ball be dribbled. A lively game is best played on a living floor. A "dead" floor also results in a "dead" handball game.

A sports floor must not be hard, it must be resilient. There are two different kinds of resilience. On the one hand a floor can be resilient at a point (point resilience), i.e. only the part stepped on shows resilience. Although this kind of resilience is excellent for falling on the floor, it may not necessarily be appropriate for handball. This floor will be "dead" and by pressing down the surface at one point the player will stand so firmly that he will eventually suffer joint damages. However this point-resilient floor will absorb the blow when falling on one's head and thus prevent injuries. This floor is appropriate for athletics, because track and field athletes are aware of their moving direction well in advance and will not need to abruptly stop running or change direction.

On the other hand a floor can be resilient over a certain area (area resilience). In this case a big part of the floor is moving up and down even though the area stepped on seems totally hard. This floor "gives way". However this also means that if one part of the floor gives way downwards another part of the floor moves upward.



This again is not appropriate for handball and in addition a floor with a hard surface will be hard all over.

A kind of combination of point and area resilience would be preferable.

Either the surface is made of a material which to a certain extent gives way by itself or a light point resilience and area resilience have to be combined.

A wooden sports floor will always be area resilient and as hard as the wood itself.

A synthetic sports floor may be given area resilience but additionally be made of a lightly point-resilient material so that we have a combination of the two properties. In principle, this is a floor appropriate for the handball game.

The standardisation DIN 18032 signifies that the area-resilient sports floor gives way but will not be deformed. Its characteristic is that in case of a point-resilient pressure a concentric and extensive hollow is generated at its surface that is substantially larger than the area of the surface which was actually put under pressure.

Standardizations and guidelines for the construction of sport halls and consequently also for sports floors have been the result of determined scientific investigation. The German standards (DIN) are in many ways the most developed guidelines. It is to be expected that in short time the GEN will adopt these guidelines without major changes to the content. The standardisation DIN-18032 covers the main technical requirements for sport halls.

The requirements in accordance with DIN 18032, part 2 are as follows:

Shock absorption	minimum 53%
Vertical standard deformation	minimum 2,3 mm
Width of deformation through	maximum 15%
Behaviour under a rolling load (axle load)	minimum 1500 N
Resistance to impact at 10°C	minimum 8 Nm
Indentation	maximum 0,5 mm
Ball rebound	minimum 90%
Sliding property	minimum 0,5 maximum 0,7

Of course there are many other properties handball players are interested in, such as texture of the surface, degree of hardness of the surface, absorption of moisture, light reflection, floor colour and its contrast to the colour of the lines.

The standardizations for the strength of the floor are not that interesting for the handball player. However, it has to be taken into consideration that the stronger the floor is the harder it will also be. Consequently we do not request for a stronger floor than required by the standards. Nevertheless the floor must be strong enough to comply with the different possibilities of utilisation.

A detailed analysis of the various technical requirements is beyond the scope of this publication. Should you nevertheless be interested in more detailed information please refer to the standard specifications sheet DIN 18032.

Of major interest for the handball player are points such as ball reflection and sliding property as well as all other properties mentioned earlier on.

**The ball must be reflected** from the floor with at least 90% (in relation to a basket ball on concrete floor). The handball players prefer a value around 92-95%. This value cannot be exceeded without the floor becoming too hard.

**Sliding property** should be 0.5 to 0.6, although the DIN standard says to 0.7 (0 is a hundred percent smooth, the value for good ice is between 0.01 and 0.02).

A sliding property of 1.0 signifies that for moving an object horizontally one needs exactly the same force as the actual weight of the object (only by applying glue or something similar can we exceed the value of 1.0).

Handball players prefer a relatively smooth floor, which may be surprising to read. It is necessary to be able to slide.

The floor supplier can guarantee a specific sliding property at the time of delivery only. For its further maintenance the cleaning of the floor is decisive, i.e. wrong cleaning can distort the sliding property. Unfortunately measuring instruments for the sliding property are not as common as for, e.g. light measuring. Actually a caretaker should also measure the sliding property of the floor after each cleaning.

In this context another relationship is to be mentioned. In principal the sliding property involves two objects and is normally measured with the help of a standardised weight perpendicular. The part of the player, however, which will come into contact with the floor, is the skin. This means that when sliding on the floor it is necessary that as little heat energy as possible is generated. A needle felt cover is therefore absolutely inappropriate for handball although it might be a good floor for other kinds of sport. The generation of heat is much too high and causes burns.

The playing rules for handball lay down that the players have to wear shoes during the game. Thus a major part of the sliding property is a question of the shoes. However, neither shoe manufacturers nor sport article sellers have shown as much interest in sliding property as floor manufacturers. Really the DIN 18032 should additionally include one or two sentences on sports shoes.

The aim is to produce a handball shoe type which has a higher sliding factor at the tip of the toes and under the heels (e.g. ice skating shoes) than under the ball of the foot. As well the pivot would need a special type for his numerous turns, and the defensive player again needs another type again. To overstate this a bit: every athlete should really have his or her special pair of shoes.

**The surface** has to be as less textured as possible for the handball game. The generation of heat during sliding as mentioned above is similarly relevant. Therefore a "smooth" floor is preferable except for one point: the increased light reflection and perhaps the subjective point of its look - which we do not want to treat in detail - should be improved. The floor may be as smooth as the lighting conditions allow, because dirt and residues of cleansing agents always find same space in pattern hollows. Thus it is absolutely imperative that the sliding property of the floor (non- slip) be smaller than the resting hollow of 0.5 mm as allowed according to DIN 18032.

**The surface must be so hard** as to guarantee the desired vertical ball bounce. Surface hardness is measured in Brinell and is 1.9 HB for pine, 3.4 HB for oak and 3.6 HB for press-dried beech wood. As for artificial material all possible grades of hardness can be produced. Surface hardness is also indirectly a factor for the "life- time" of a floor. A good sports floor has a "life time" of about 10-15 years. One should take into account that after use wood is environmentally less problematic to recycle than artificial material.

**Humidity absorption** is another factor to consider because during play it is unavoidable that the floor gets moist. Sweat and other fluids are lubricants which increase the slipperiness of the floor. For this purpose porous material may best prevent the floor from becoming too slippery.

Although **light reflection** is a factor of the lighting material, it must also be considered when installing the floor (and wall surface). In fact the floor must be so matt that light reflection is kept as low as possible.

At the same time, however, the floor must not absorb more light than is absolutely necessary, because in practice a floor has to emit a large amount of light. Bright and matt colours are preferable. The colours at the blue end of the colour spectrum return much more light than the colours at the red end of the spectrum. This can save you a lot of money during the lighting installation.

### **The mobile sports floor**

As has been mentioned in connection with the tennis floor, a mobile sports floor may be used under certain circumstances. However, a mobile sports floor can never make up for all the characteristics of the actual floor underneath. Nevertheless on a well-levelled base floor every kind of mobile sports floor may be used.

A mobile sports floor brings advantages when a change of surface is desired. The cover has its own colour, individual sliding properties, surface texture, surface hardness, humidity absorption and light reflection. In addition only the lines relevant to the kind of sport are printed on it, which is very important for television. In addition to the broadcasting companies it is also relevant for the athletes and the spectators, although in general the athletes very quickly get used to all the lines on the floor.

Another factor of humidity to consider is: condensation. Basically the amount of water vapour which can be absorbed by the air is highly dependent on the temperature. If the air humidity in the hall is 70% and the temperature lies at 20° C, theoretically the humidity just above the floor is also 70% if the floor temperature lies at 20° C. However in practice the case is often different. A floor temperature one degree lower than the air temperature may cause condensation on the floor, an effect which must be avoided by all means.

The air humidity in heated sports halls often only amounts to 55% -60%, which leaves adequate clearance. In non-heated halls, however, the situation is somewhat more difficult since air humidity may possibly climb to 90%.

In air-heating systems it is possible to control the air streams so that the heated air is first blown on the floor. In case this airing installation is also used for the exchange of used air without heating, the new, most probably humid air, is first blown on the floor which, when the floor is too cold, again causes condensation. Therefore the direction of the air stream has to be considered carefully.

Using a mobile sports floor on an ice rink presents difficulties with respect to condensation. On the under side of the mobile sports floor the temperature is approx. 0° C while the air temperature in the hall is about 20° C. This presents ideal conditions for condensation. In consideration of the athletes' interests, air humidity in a hall may be above 55%. As a consequence the surface temperature of the floor must be at least 12° C. This can only be achieved by isolation of the floor since the floor cannot be heated. In order to guarantee this the mobile sports floor must have a very low K value (a unit of measurement for the flow of heat - or cold - through a material over time). Nevertheless high outdoor temperatures and drenched spectators in rainy weather may still cause many problems.

## 2.2 Lighting Installation

Handball athletes do not really love daylight. Everybody speaks about light, even those who only know that light is the opposite of dark. Don't misunderstand this statement, a subjective attitude to the value of light is important, but a subjective attitude cannot be indicated in figures.

Even technicians prefer to kick an open door. Some time ago when the automatic light regulation of a camera was not as sophisticated as it is today, it was normal to measure the luminous intensity before shooting a picture. It was very important to measure the light reflected by the subject and not the general light conditions at the location. This particularly applied when shooting a backlit photo.

Similarly, in handball the light reflected by the players and the ball should really be measured because this is what we actually want to see. To this end the light reflected in each direction should be as similar as possible.

The luminous intensity ( $E = \Phi/A$ , while  $\Phi$  is the light stream in lumen (lm) and A stands for area) is measured in lux (lx). (The sun shines at 100,000 lx, during cloudy weather one can measure 10,000 lx, good street lighting has 10 lx, the full moon has 0.25 lx).

We may well say that the needs of the athletes (including the referees) are the most important factors to consider when deciding on light intensity. However the athletes' needs are relatively modest. A handball player can do with 50 lx, measured horizontally. This luminous intensity is in most cases reached with 200 lx, measured vertically.

The spectators need more light because they are not in the centre of the action. The farther away they are placed from the action the more light they need.

Furthermore television has additional needs. As a result of technical advances made in the past years, today, for the same pictures, less light is necessary than 10 years ago. Nevertheless it is recommended to consult television beforehand, because, e.g. the camera direction, horizontal reflection and the desired picture compositions are of great importance. Zoomed pictures taken from a greater distance require much more light. If today we have a vertical average luminous intensity of 500 lx, which enables us to guarantee a horizontal average luminous intensity of 250 lx or even better a half-cylindrical, horizontal average luminous intensity of 150 lx, the halls will be safe with a spectator number up to 4000. Most television companies will also be satisfied with this. However this does not signify that 500 lx must be achieved in order to be able to play handball.

The various standards have been calculated (under consideration of the technician) with values when lighting is new with an acceptable reduction of 30%. IHF officials inspecting the halls normally cannot know if the light installation is new, revised or old. Therefore they have been informed that for IHF events the luminous intensity at the time of inspection must be at least 350 lx over 75% of the playing field and at

least 300 lx above the sidelines and the corners of the playing field (measured vertically 1 m above the floor). This should be sufficient for a spectator number of 2000, but not for television needs.

Our needs concerning lighting cannot be clearly determined. A significant factor is the size of the hall and perhaps it is not our needs which count for a WC game but those of the TV companies. In any case we would like to determine that in a big hall seating, e.g. 10,000 spectators the luminous intensity must be at least 800 lx, measured vertically, in order to guarantee that the TV companies will not face difficulties.

However light involves much more than only luminous intensity. When talking about luminous intensity we always think of average values. Regularity of luminous intensity measured must be at least 0.5, even though satisfactory values can be reached with the lowest measurement. This point is particularly relevant in connection with TV companies, because they very often produce a higher luminous intensity in the direction of the picture to be taken when they want more light.

Light is not only a question of light sources. Reflection in the hall plays an important part too, and the athletes often have to directly look into light sources. At the places where the light sources have been mounted (normally on the ceiling) we want a good reflection in order to keep the contrast between the light sources and the roof as small as possible. Reflection on the ceiling must be at least 0.6 (better 0.8) - this is also advantageous for archers; but they need lower values for the walls in the direction of the targets, up to approx. 0.25, thus it is necessary to work with overhanging walls.

In contrast to the above, the light installations must be well protected in order to avoid any damage or breaks when hit by a ball. In addition athletes should be protected from being dazzled.

Furthermore big differences in the brightness of ceilings, walls and floors must be avoided. Although a two-colour floor (e.g. the playing area and the goal area) looks good at first sight it must be made sure that the difference in brightness is not too big; which implies that the colours should not differ too much. (It is possible to measure this factor with the light meter by measuring the (returned) light reflected from the floor)

Finally the temperature of the colour has to be considered. This factor is not only of importance for television; it is also a matter of immediate impression. We do not want to show our male or especially female heroes on the floor nor ourselves as spectators in an disadvantageous light. Therefore the Kelvin degree and the colour reflection index must be taken into consideration.

Emergency lighting, complying with the country-specific requirements, must be installed in every case.



## **2.3 Spectator Seating**

In principle no hall must be constructed without incorporating spectators' seating. The question of seating capacity cannot be answered here.

Normal seating for spectators should have a size of at least 50 cm: for journalists who have to work during the game the respective size should be increased to 60/75 cm. Space between the chairs (or benches), from one front edge to the other, must be 80/160 cm. The gradient between the rows should be 1:2.

The standing space for spectators may be designed in the form of steps 40 cm deep and 20cm high. Two spectators may be calculated per running meter.

Access is best organised from the back-side (back or top), whereas the emergency exit is better guaranteed over the playing area. It is recommended to build an access way every 10m.

Do not forget to provide free access for handicapped people in wheel chairs.

## **2.4 Heating and Ventilation System**

Possible heating systems are blowing of heated air, thermal radiation or installation of heat generators (radiators).

While in halls with a large spectator capacity a ventilation system is necessary, in bigger halls it is more sensible to use the system of blowing of heated air. It does not matter if handball is played with headwind or following wind. However this may be a factor for games like badminton.

Air renewal in the hall must be foreseen four times per hour with a performance of at least 50m<sup>3</sup> per hour and spectator. In heated halls it must be possible to regulate the temperature from 15 °C to 22 °C with an operating temperature of 18 °C, and in cooled halls from 18 °C to 24 °C.

The air speed at 20 °C shall have a maximum of 1m/s, whereas badminton players ask for only 0.2 m/s in the area where the shuttlecock flies.

The air in change and shower rooms should be renewed 10 to 12 times per hour. Fresh air must be blown into the change rooms and air should be sucked in showers and toilets

## **2.5 Acoustics**

It is very valuable to have a loudspeaker system available. Therefore the hall room should be improved acoustically by covering the inside of the walls. As a result the background noise should lie under 40 dB and the echo time for the frequency range from 250 to 4,000 Hz should not exceed 2 s.

## **2.6 Official Timekeeping and Scorekeeping**

A stoppable and restartable digital clock must be available and should be seen from the substitution benches, timekeeping table and from as many spectators as possible. Operation must be guaranteed from the timekeeping table. The clock shall run from 0 to 30. The use of an automatic acoustic signal has not only been allowed since 1993 but is very desirable.

## **3.1 Outdoor Handball**

As known handball can also be played outdoors - either all year round or at certain periods only (depending on weather conditions). Although this is not exactly "indoor handball" it is nevertheless a game which under good conditions comes close to indoor handball. This 7 - a-side handball is often played on grass, however, a different, firm ground would be more suitable.

Rain, wind and other weather influences cannot be avoided. As a result of these outdoor effects the ball will change its properties.

Based on above reasons, with regard to the effects of water, the use of a synthetic floor would be advantageous outdoors. Water must not be allowed to collect on the playing field. Therefore it is necessary to work with either a water-permeable or an inclined, tilted surface. In principle it would be possible to incline a playing field by 2.5 cm per 10 m falling from the centre line towards the two goals and resulting in the goals to be 5 cm lower than the centre line. On the other hand the effect of the wind could be such that the water will only run off one half of the playing field. If it is mostly raining in this direction it is therefore sensible to consider inclination of the entire playing field in this direction only (instead of from the centre towards the two sidelines or goal lines).

In case of heavy rainfall, however, neither the indicated inclination nor the use of a water-permeable surface will keep the water off the playing field.

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