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Sports floors. Overview, classification, requirements

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Abstract: *Sports floors. Overview, classification, requirements.* This article gives an overview of material and structural solutions for sports floors used in covered buildings. Multifunction systems for various sport disciplines (multi-sports) were analysed. Classification for load performance, shock absorption, vertical deformation and reaction to fire is presented. The presentation includes drawings of exemplary solutions of modern sports floors. Current technical requirements are also presented.

Keywords: sports floor, indoor surface for sport area, surface, grid, sheathing, material and structural solutions, load performance, reaction to fire, requirements.

INTRODUCTION

Modern sports floors are specialist solutions which combine protective function, i.e. the ability to relieve load from motor system during sports activities and reducing the risk of injury in case of fall, with the sports function which minimising energy consumption of an athlete during sports. Systems including sets of a proper choice of materials, structure and application technology are usually offered.

Most of the solutions are multifunction sports floors intended for more than one sport discipline, particularly team sports, including handball, basketball and volleyball, suitable at the same time for general physical exercise during physical education classes and other sports activities. They are referred to as *multi-sports* floors.

There is a broad range of sports floors currently available. Floors with wooden and synthetic surface, with or without grid are available. Material and structural solutions are critical for the technical and operating properties of individual floors and make them more or less suitable for a given group of users and sport discipline.

MATERIAL AND STRUCTURAL SOLUTIONS

One of the main criteria for choosing sports floors is the surface type. Wooden surfaces are made of special laminated boards, less commonly from solid flooring elements. Laminated boards for sports facilities differ from standard products primarily in the specific properties of the surface. These include sufficient friction, wear and rolling load resistance. Some laminated boards also feature special joining profiles. Solid flooring components used in sports flooring are usually standard slats, however they require finishing with varnish dedicated to sports facilities.

The most common synthetic products are rolled or poured floor coverings. Rolled, PVC or linoleum coverings can be single layer or composite products with a elastic (e.g. polyurethane foam) sheet. Multi-layer poured systems include filler, polyurethane screed and polyurethane varnish. They are applied directly on a rigid substrate, e.g. wood-based boards or a course of shock-absorbing mat.

Each of the surfaces mentioned can be used in structures with or without grid. As a standard, single or cross grids are made of softwood boards with 16-19 mm height and 50-100 mm width. Typical joist spacing is 400 – 500 mm. In some flooring systems with cross grids, the top joist spacing is reduced to 250 mm. The grids are occasionally made of wood-based products, e.g. LVL.

Under the joints a set of pads is placed, including wooden spacers and elastic polyurethane foam pads or SBR recycled granules. The thickness of the spacers is 16-19 mm and of the resilient ones 5-12 mm. Their length and width is 50-100 mm. The pads are placed in 400 – 500 mm centres. In floors with cross grids, they are placed at the intersection of the joist lattice or in the middle of the distance between them. Sets of pads are fixed to the grid with 35-38 mm long staples. In case of small local irregularities of the substrate, levelling pad or wedges are also used, e.g. PVC.

A sheathing of wood-based boards (e.g. particles boards P5 or OSB-3, 10 or 12 mm thick) is often placed on the grid and fixed with screws to the joists. The sheathing can be single or two-layered. Both wooden and synthetic surface can be made on the sheathing.

In some systems, incomplete grid is used, so called "blind floor", on which the sheathing is placed or wooden surface is mounted directly. They are made of e.g. 19 x 95 mm boards in 120 – 175 mm centres. Solutions are also known in which a surface of laminated boards is placed directly on the grid.

Floors without grid are installed directly on concrete substrate. The most common solutions include synthetic floors, either poured or rolled, placed on a layer of shock-absorbing mat. Much less common are floors with the wood-based board structure, usually plywood, placed on shock-absorbing mat. Standard synthetic surface is spread on the plywood.

CLASSIFICATION

Sports floors are classified for performance under load, shock absorption, vertical deformation and reaction to fire.

In view of the behaviour under load, area-elastic (Mj), point-elastic (P), combined-elastic (K) and mixed-elastic (Ms) floor categories can be listed. In the Mj type floors, after application of concentrated force, around the application point flexure area with ca. 500 mm radius is formed, referred to as the deformation trough (fig. 1a). Such floors have relatively hard surface and are quite inert in reaction, but react well in case of falls with multi-plane load (whole body) efficiently protecting the athlete. In P type floors, the radius of flexure area around the force application point is about 100 mm (fig. 1b). With relatively soft, deformable surface, the floors react quickly at relatively low load. They provide good protection when hit by e.g. elbow or knee, but are less effective in case of a whole body fall. Transport of loads on its surface can be difficult. K type floors combine the advantages of the surface and point resilient floors. After application of concentrated force they deform both in 100 mm and 500 mm radius (fig. 1 c). Mixed-elastic floors (fig. 1d) are close to the point-elastic ones, but they also comprise a synthetic component for local rigidity, which makes them both soft and resistant enough to e.g. rolling load and similar effects. The flexure area in the Ms floors has the radius between 100 and 500 mm (fig. 1 d).

Depending on the shock absorption and vertical deformation, four types of sports floors are distinguished. Classifications in this respect are shown in table 1 and 2.

Tab. 1 Sports floor classification for shock absorption

Type	Sports floor type			
	Mj	P	K	Ms
	Shock absorption *R*			
1	–	$25\% \le R < 35\%$	–	–
2	–	$35\% \le R < 45\%$	–	–
3	$40\% \le R < 55\%$	$45\% \le R$	$45\% \le R < 55\%$	$45\% \le R < 55\%$
4	$55\% \le R < 75\%$	–	$55\% \le R < 75\%$	$55\% \le R < 75\%$

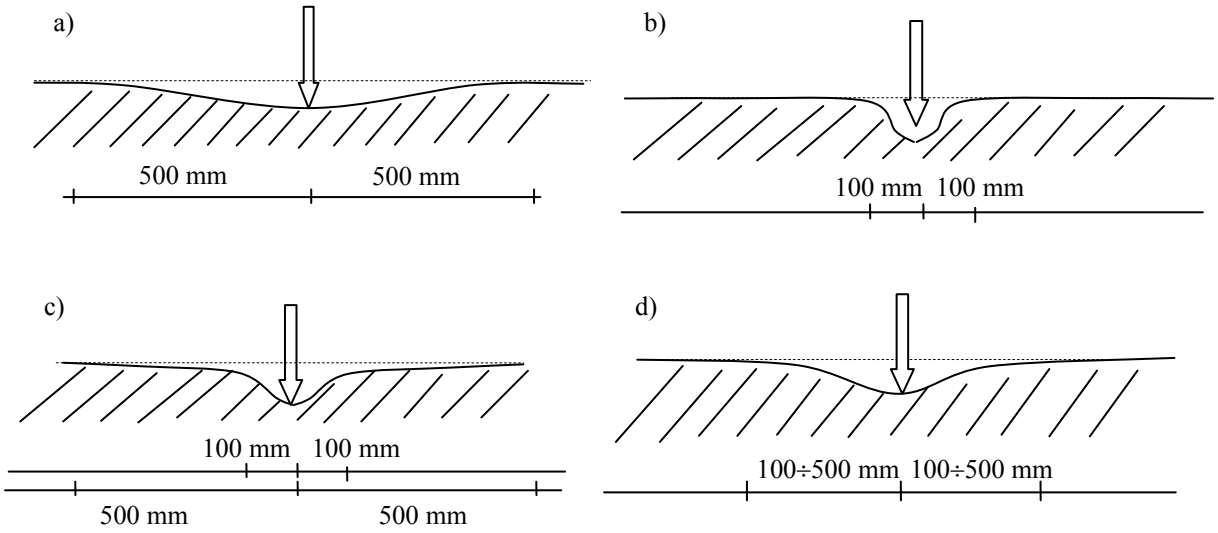

Fig. 1 Sports floor behaviour scheme under load
a) area-elastic floor (Mj), b) point –elastic floor (P), c) combined-elastic floor (K), d) mixed-elastic floor (Ms)

Tab. 2 Sports floor classification for vertical deformation

Type	**Sports floor type**			
	Mj	**P**	**K**	**Ms**
	Vertical deformation *D*			
1	–	$D \leq 2.0$ mm	–	–
2	–	$D \leq 3.0$ mm	–	–
3	1.8 mm $\leq D <$ 3.5 mm	$D \leq 3.5$ mm	1.8 mm $\leq D <$ 5.0 mm 0.5 mm $\leq D_p$* < 2.0 mm	$D \leq 3.5$ mm
4	2.3 mm $\leq D <$ 5.0 mm	–	2.3 mm $\leq D <$ 5.0 mm 0.5 mm $\leq D_p$* < 2.0 mm	$D \leq 3.5$ mm
* D_p – point resilient component flexure				

Sports floors are classified for reaction to fire according to PN−EN 13501−1. Such categories, together Table 3. Classification of floors for reaction to fire with specification resulting from the regulation [5] are presented in Table 3.

Tab. 3 Classification of floors for reaction to fire

Classification for reaction to fire	**Flammability specification**
$A1_{fl}$; $A2_{fl}$-s1; $A2_{fl}$-s2	Non-flammable
B_{fl}-s1; B_{fl}-s2; C_{fl}-s1; C_{fl}-s2	Flash resistant
D_{fl}-s1, D_{fl}-s2, E_{fl}, F_{fl}	Flammable
$A2_{fl}$-s2, B_{fl}-s2, C_{fl}-s2, D_{fl}-s2, E_{fl}, F_{fl}	Highly smoky

SAMPLE SOLUTIONS

Figures 2 –6 present chosen modern sports floor systems. The examples shown do not represent all currently available solutions.

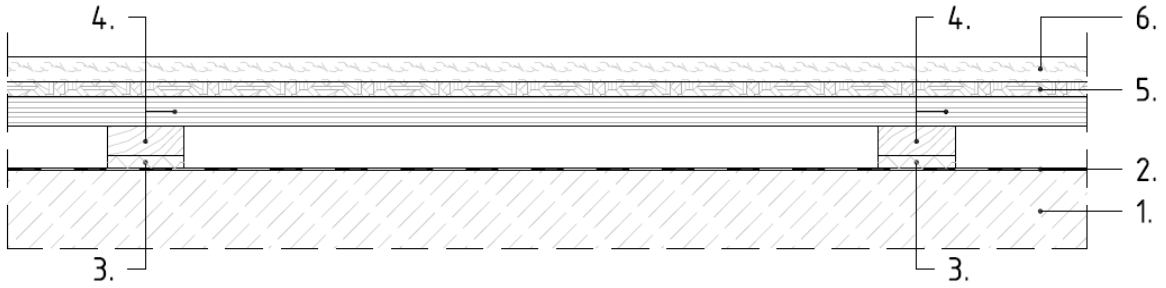

Fig. 2 Area-elastic floor on a grid with wooden surface
1 – concrete substrate, 2 – damp-proof course, 3 – elastic pads, 4 – joists in crossed configuration, 5 – wood-based board sheathing, 6 – laminated board surface

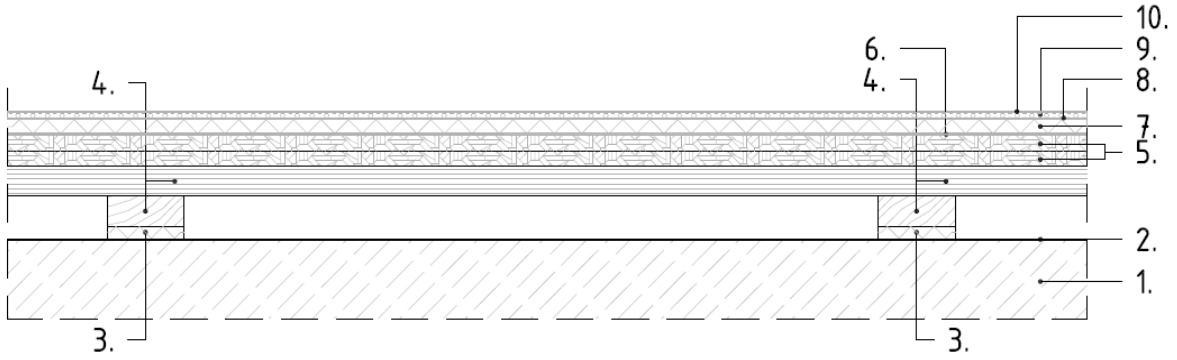

Fig. 3 Combined-elastic floor on a grid with synthetic poured surface
1 – concrete substrate, 2 – damp-proof course, 3 – elastic pads, 4 – joists in crossed configuration, 5 – wood-based board sheathing, 6 – adhesive, 7 – shock absorbing mat, 8 – filler, 9 – polyurethane screed, 10 – polyurethane varnish

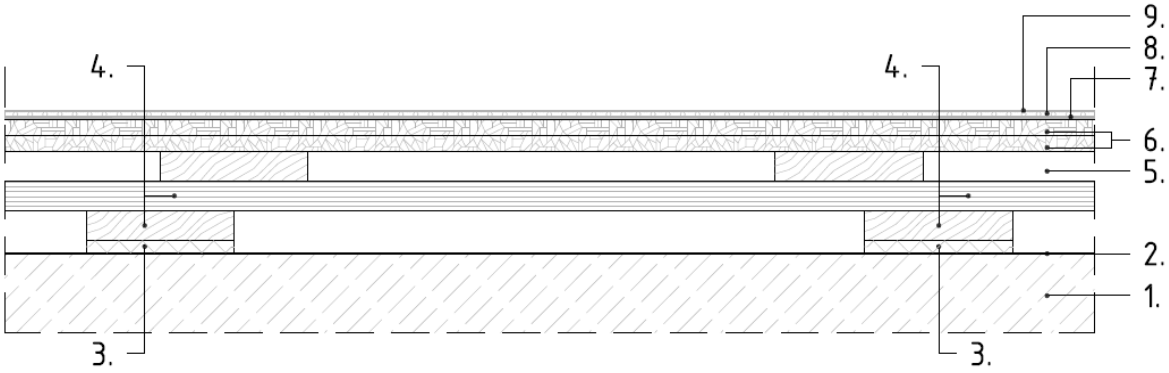

Fig. 4 Area-elastic floor on a grid with synthetic poured surface
1 – concrete substrate, 2 – damp-proof course, 3 – elastic pads, 4 – joists in crossed configuration, 5 – "blind floor", 6 – wood-based board sheathing, 7 – filler, 8 – polyurethane screed, 9 – polyurethane varnish

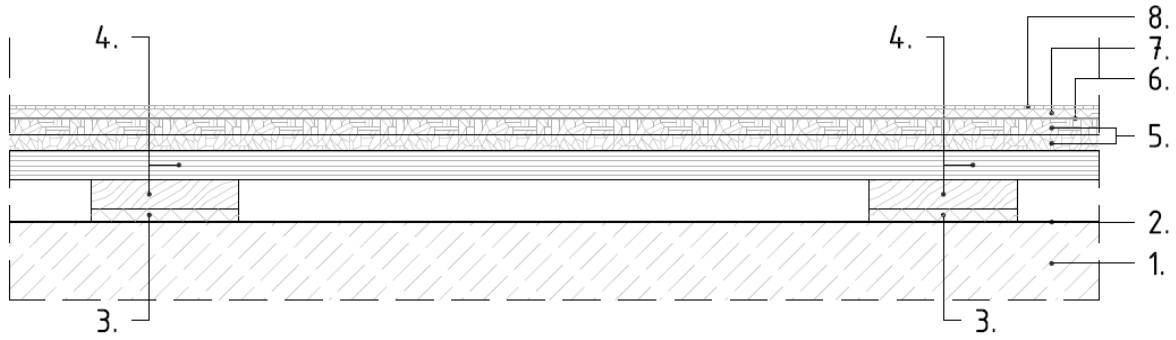

Fig. 5 Combined-elastic floor on a grid with synthetic rolled surface
1 – concrete substrate, 2 – damp-proof course, 3 – elastic pads, 4 – joists in crossed configuration, 5 – wood-based board sheathing, 6 – adhesive, 7 – shock absorbing mat, 8 – PVC covering

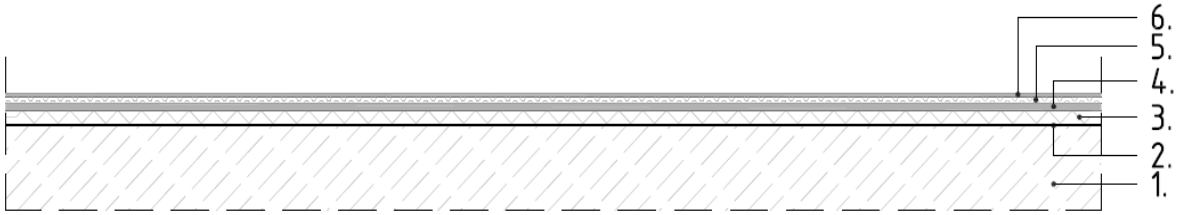

Fig. 6 Area-elastic floor without a grid with synthetic rolled surface
1 – concrete substrate, 2 – primer, 3 – shock absorbing mat, 4 – wood-based board sheathing, 5 – adhesive, 6 – PVC covering

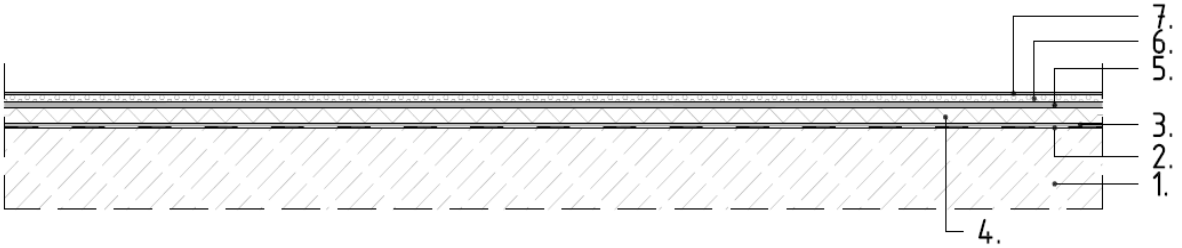

Fig. 7 Point-elastic floor without a grid with synthetic poured surface
1 – concrete substrate, 2 – primer, 3 – adhesive, 4 – shock absorbing mat, 5 – filler, 6 – polyurethane screed, 7 – polyurethane varnish

TECHNICAL REQUIREMENTS

Sports floors, regardless of the structure and material solutions should conform to the requirements set out in PN-EN 14904. They are listed in table 4. Main characteristics included in the initial type tests are highlighted with grey.

Tab. 4 Technical requirements for sports floors

Properties	Test methods	Requirements
Shock absorption	PN−EN 14808	average value: 25−75%[1)] no individual result should differ from the mean value by more than 5 units
Vertical deformation	PN−EN 14809	≤ 5 mm[1)]
Friction	PN−EN 13036−4	average value of the pendulum: 80−110 no individual result should differ from the mean value by more than 4 units
Vertical ball behaviour	PN−EN 12235	≥ 90% no individual result should differ from the mean value by more than 3 units

Table 4 - continued

Properties	Test methods	Requirements
Resistance to a rolling load	PN−EN 1569	resistance ≥ 1500 N indentation limit ≤ 0.5 mm
Resistance to wear	PN−EN ISO 5470−1	≤ 1000 mg – synthetic surfaces (H18 wheels, load 1000 g, 1000 cycles) ≤ 80 mg – painted and varnished surfaces (wheels CS10, load 500 g, 1000 cycles)
Reaction to fire	PN−EN 13501−1	class B_{fl}-s1, B_{fl}-s2, C_{fl}-s1, B_{fl}-$s2_l$, $A1_{fl}$, $A2_{fl}$-s1, $A2_{fl}$-s2 − sports floors in buildings with 50 occupants allowed at the same time ([5] § 260)
Formaldehyde emission	PN−EN 717−1	class E1 (emission ≤ 0.124 mg/m^3)
Pentachlorophenol content	PN−EN 14904, Annex C	≤ 5 ppm
Secular gloss	PN−EN ISO 2813 angle 85°	≤ 30% − mat surfaces ≤ 45 % − varnished surfaces
Resistance to indentation	PN−EN 1516	≤ 0.5 mm
Resistance to impact	PN−EN 1517	≤ 0.5 mm – wooden surfaces; no cracks, splits, delamination, permanent indentation – other surfaces

[1)] values recommended for individual floor types are listed in tables 1 and 2

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Streszczenie: *Podłogi sportowe. Przegląd, klasyfikacja, wymagania.* W artykule dokonano przeglądu rozwiązań materiałowych i konstrukcyjnych podłóg sportowych stosowanych w obiektach krytych. Analizie poddano systemy wielofunkcyjne, przeznaczone do uprawiania różnych dyscyplin, tzw. multisport. Przedstawiono klasyfikację z uwagi na zachowanie pod obciążeniem, amortyzację uderzenia, odkształcenie pionowe oraz reakcję na ogień. Dane zilustrowano rysunkami przykładowych rozwiązań współczesnych podłóg sportowych. Przedstawiono także aktualne wymagania techniczne.

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