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SELECTION OF A SPORTS FLOORING TYPE

WYBÓR WARIANTU WYKONANIA PODŁOGI SPORTOWEJ

Abstract

The article presents a classification of sports floors based on the type of deformations to which they are subjected and gives several examples of possible methods of their manufacture and installation. Three variants of sports flooring have been suggested for a selected sports venue and, subsequently, a multi-criteria comparative analysis has been carried out for the variants taking into account the following criteria: cost, installation time, suitability for various sports disciplines and other extra-sport purposes as well as the floor thickness.

Keywords: sports flooring, multi-criteria analysis

Streszczenie

W artykule zaprezentowano podział podłóg sportowych związany z rodzajem odkształceń, którym ulegają. Podano przykłady trzech wariantów podłogi sportowej i porównano je pod względem kosztu i czasu realizacji. Dla proponowanych wariantów przeprowadzono również wielokryterialną analizę porównawczą, uwzględniając przy tym: koszt i czas realizacji, możliwości zastosowania do różnych dyscyplin sportowych i celów pozasportowych oraz grubość podłogi.

Słowa kluczowe: podłogi sportowe, analiza wielokryterialna

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1. Introduction

The selection of the right sports flooring is a key factor in designing any sports hall since the degree to which it will serve its function properly depends mainly on the structure of the floor. A sports floor is a type of special purpose flooring that must accommodate the intensive and diverse movements of people practicing sport. Therefore it is designed and made with two fundamental objectives in view: comfort and safety of users, which, in consequence, will reduce the risk of injury. Additionally, it must provide the right surface finish effect (friction) and movement dynamics so as to ensure the highest possible level of performance.

The article presents the types of sports flooring which are in use contemporarily. Three possible variants of sports flooring have been suggested, their cost and installation times estimated, and the most suitable variant has been selected on the basis of the adopted criteria.

2. Classification of sports floors

The classification of sports flooring contained in standard [1] is based on the type of deformations to which they are subjected. Four types of sports floors may thus be differentiated:

– **Area-elastic floors**

Applying a point force causes deflection over a relatively large area around the point of application of the force [2]. This type of floors may be found in two structural variants: over a grid of joists or over a composite grid of plywood or particle board laid alternately [3]. These floors are characterized by a considerable height, yet, owing to their structure, they fully meet the requirements of professional sports people.

– **Point-elastic floors**

Applying a point force causes deflection only close to the point of application of the force [2]. Point-elastic floors are composed of two layers: the underlying elastic layer and the surface synthetic layer [4]. It may take the form of a thick sports floor cover with an underlying layer made of elastic foam [5]. The main feature of point-elastic floors is their relative thinness. Due to their soft surface, they are a good option for school gyms and recreational facilities.

– **Combi-elastic floors**

They combine area-elastic floors with a point-elastic surface [4]. The area of deformation is large in the load distribution layer. On the surface, however, it is limited precisely to the area directly under loading [2]. Combined systems are universal in their applications, as they are suitable for practicing professional sports without compromising safety. However, they also have the deficiencies of both area-elastic and point-elastic floors, such as considerable structural height or limited options of placing heavy sports equipment or spectator stands on them.

– **Mixed-elastic floors**

The area of deflection is small, but clearly extends beyond the point of application of the force. The floor deflection characteristics are between those of a point-elastic floor and an area-elastic floor [2]. It is a combination of a point-elastic floor with a surface stiffening component [4]. Due to the introduction of the surface stiffening component, the floor of this type does not induce muscle fatigue of its users, retaining at the same time a relatively soft surface. Moreover, such floors are low in height and lightweight.

3. Analysis of the selected variants of sports flooring

3.1. The suggested variants of sports flooring

Three possible variants of flooring have been suggested for the sports hall selected as an example, with the area of 526 m²:

– **Variant I – area-elastic sports floor**

Area-elastic floor over a grid of pine joists, 16 mm × 50 mm in cross-section, laid crisscross, with a subfloor of 16 mm thick pine boards nailed in an open-work fashion. The spacing of the lower layer of joists is every 50 cm, while of the upper one – every 31.5 cm. The surface made of polished oak parquet planks covered with three coatings of anti-slip paint.

– **Variant II – point-elastic sports floor**

Point-elastic floor of Omnisports REFERENCE sports flooring – 6.5 mm thick – glued directly to the base. Having been rolled out and glued, the floor covering is cut to fit and heat welded at joints.

– **Variant III – combi-elastic sports floor**

Combi-elastic floor over a grid of two layers of pine joists, 16 mm × 50 mm in cross-section, laid crisscross, with a subfloor of two layers made of 12 mm-thick waterproof coniferous plywood. The spacing of the lower layer of joists is every 50 cm, while of the upper one – every 31.5 cm. Epoxy surfacing poured on site over the underlayment of rubber granules laid over the subfloor.

3.2. The cost and time of installation

A detailed cost estimate according to [6], has been prepared for each variant. The following input data were used in the estimation process:

- man-hour fee – 14.34 PLN,
- materials purchase cost index – 6.40% of the materials cost,
- indirect cost index – 65.00% of the labor and equipment use cost,
- profit index – 10.90% of the labor, equipment use and indirect costs,
- prices of materials and equipment use – average market prices.

Next, the composition of working teams was determined and so were the times needed for installation of individual variants. The comparison of the estimated price components for each variant has been presented in Table 1.

Table 1

Comparison of the floor installation costs in individual variants. Source: the author

Variant	Labor [PLN]	Materials [PLN]	Equipment [PLN]	Indirect cost [PLN]	Profit [PLN]	Estimated net price [PLN]
Variant I	22,041.96	123,382.62	1,751.73	15,450.69	4,274.95	166,901.95
Variant II	5,410.70	67,744.59	165.14	3,628.06	1,003.89	77,952.38
Variant III	17,857.34	154,494.25	1,352.19	12,474.64	3,451.53	189,629.95

The variant of point-elastic floor is characterized by the lowest values of all the components: labor, materials and equipment use. The variant of area-elastic floor has the highest of all the compared labor and equipment use costs. The combi-elastic floor, on the other hand, requires the highest expenditure on materials. Since this component has the largest share in the estimated price, variant III of the floor is the most expensive.

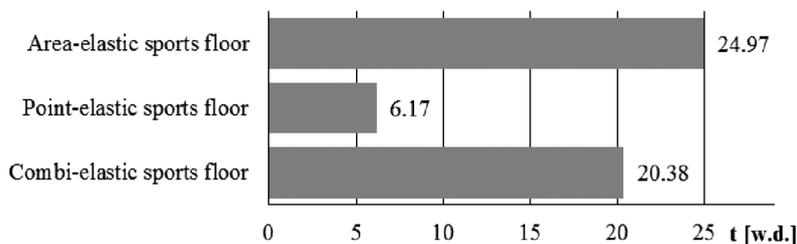


Fig. 1. Comparison of the installation times of the suggested sports flooring variants.
Source: the author

The shortest installation time, which is slightly more than 6 working days (8-hour working day), characterizes the point-elastic floor variant, whereas the area-elastic floor variant, requiring 28 working days, is the longest to assembly. Significant differences in the installation times of the individual floor variants result from the considerable difference in the number of layers in the structure of those variants. The point-elastic floor is basically one ready-made sports floor covering requiring solely to be glued to the base and heat welded at the joints. In contrast, the two remaining variants require installation of a joist grid, a subfloor and the surface. They are then definitely more labor consuming.

4. Multi-criteria comparative analysis

Multi-criteria analysis may be used to select, out of a set of analyzed variants, the best variant or a sub-set of variants which are “good enough.” It may also serve the purpose of arranging the variants from the best to the least advantageous. It is applicable when the decision-making process requires considering more than one criterion. In order to select the most advantageous variant of sports flooring, a multi-criteria comparative analysis has been carried out, in which the following four evaluation criteria were adopted:

- Criterion I – the cost of installation,
- Criterion II – the time of installation,
- Criterion III – functionality (for sports disciplines and extra-sport purposes),
- Criterion IV – the height of the floor structure.

The values of individual constituent measures are: the estimated net price and the times of installation presented in the previous chapter. The suitability of the individual variants for sports disciplines and extra-sport purposes has been graded arbitrarily on a six-grade scale, on the grounds of information included in [3]. The thickness has been determined measuring the layers from the base to the surface. Table 2 presents the values of individual constituent measures applied to the variants according to the adopted criteria of evaluation.

Table 2

Values of constituent measures applied to the variants according to the adopted criteria of evaluation. Source: the author

Criterion	Criterion character	Measure of the variant		
		Variant I	Variant II	Variant III
C I – the cost of installation	Inhibitor	166,901.95 PLN	77,952.38 PLN	189,629.95 PLN
C II – the time of installation	Inhibitor	24.97 w.d.	6.17 w.d.	20.38 w.d.
C III – functionality	Stimulus	5	2	4
C IV – thickness	Inhibitor	97 mm	6.5 mm	86 mm

The Neumann-Morgenstern coding has been applied in this paper, i.e. a constituent measure has been replaced by the ratio of the difference between this measure and the worst measure in a given criterion and the difference between the best and the worst measures in this criterion [7]. Table 3 presents the encoded measures of the variants according to the adopted criteria.

Table 3

Encoded measures of variants according to the adopted criteria of evaluation. Source: the author

Criterion	Criterion character	Measure of the variant		
		Variant I	Variant II	Variant III
C I – the cost of installation	Inhibitor	0.20	1.00	0.00
C II – the time of installation	Inhibitor	0.00	1.00	0.24
C III – functionality	Stimulus	1.00	0.00	0.67
C IV – thickness	Inhibitor	0.00	1.00	0.12

The following weighted indicators have been adopted: $v_1 = 0.3$; $v_2 = 0.1$; $v_3 = 0.5$; $v_4 = 0.1$; it has been decided that the most important criterion would be the suitability of the floor for sports disciplines and extra-sport purposes due to the special function performed by sports flooring.

The corrected summative indicator [7] has been applied for the purpose of a synthetic evaluation of the variants, calculated according to formula (1).

$$J_i = \sum_{j=1}^m (z_{ij} \cdot v_j) \quad (1)$$

where:

- z_{ij} – encoded measure of the i -th variant in relation to the j -th criterion,
- v_j – weight of the j -th criterion,
- m – number of criteria.

Summative indicators for the variants. Source: the author

Summative indicator	Variant I	Variant II	Variant III
J	0.56	0.50	0.37

As a result of the comparative analysis (Table 4), variant I – the area-elastic sports floor – must be considered the most advantageous in the light of the adopted criteria, since the summative indicator for this variant has the highest value $J_1 = 0.56$. Variant II – the point-elastic sports floor – has a slightly lower summative indicator value – $J_2 = 0.50$. The least advantageous variant, according to the adopted criteria, is variant III – the combi-elastic sports floor – $J_3 = 0.37$.

5. Conclusions

The suggested variants of sports floors differ considerably in cost and time of installation as well as in functionality and technical specifications. The multi-criteria comparative analysis has indicated the most advantageous variant in the light of the adopted criteria. However, selecting a sports flooring type, the investor should also consider other factors (which have been disregarded in the example), such as e.g. the prevailing sports discipline, the age of users or whether the sports practiced in the facility are amateur or professional. They will undoubtedly facilitate selection of the best option.

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