

THE EVOLUTION AND THE CHARACTERISTICS OF WOODEN FLOORING FOR GYM AND SPORT COURTS

Olimpia-Minerva ȚURCAȘ (căs. DIACONU)

Transilvania University of Brasov, Faculty of Wood Engineering
Str. Universitatii nr. 1, 500068 Brasov, Romania
E-mail: minerva2013diaconu@gmail.com

Adriana FOTIN

Transilvania University of Brasov, Faculty of Wood Engineering
Str. Universitatii nr. 1, 500068 Brasov, Romania
Tel: 0040 268 419581, Fax: 0040 268 419581, E-mail: adrianafotin@yahoo.com@unitbv.ro

Abstract:

This paper presents the evolution of the sport flooring and the general aspects of the wooden surfaces. There are references to FIBA (International Basketball Federation) guidelines and requirements for building basketball facilities. Also, the current wooden structures on the market which are approved by the highest authorities in the field - FIBA, FFBB, IHF, WSF and WVBF - are presented. Finally, based on the principle of elasticity which is required for any sport flooring, several structures made from beech wood are being discussed. These proposed structures are characterized by their simpleness, ease of manufacturing and by the competitive price when compared to similar products on the market.

The proposed panels are tested according to the RGOCB 2016-2017 (General Organization Regulation of Basket Competitions) requirements.

Key words: sports flooring; wood flooring; sandwich structures; elasticity.

INTRODUCTION

It is well known that ball games were practiced even in antiquity and the old Greeks enjoyed very much the activities practiced under the name of "sphairstike" which included several complex games with the ball.

The first references about the ball games are found in Homer's poems and in the Legend of the Argonauts. The physicians of the time recommended these activities for developing skills and arms strengthening, having their own dedicated studies. Galenus wrote about the games that *"they bring health to the body, symmetry to the arms and virtue to the soul"* (Kirițescu 1964). The ball games were practiced in the *gymnasium*, in special rooms called *"sphairsteria"* under the supervision of a master called *"sphaeristichos"* (Kirițescu 1964).

Gymnasiums became more and more imposing and sophisticated constructions, they were created with their own architectural style, the free spaces between the buildings being planted with trees, pools, porticos, statues.

The first flooring for dancing and indoor sports was made of wood. It is supposed that the first variants of these floors appeared between 1870-1880 both in New Zealand and the United States of America. They became famous in the years 1920-1945 because of the large dance halls construction with large audiences. Since the Berlin Olympics in 1936, this type of flooring has been used successfully because it has been found to be very good for professional acrobatics.

The new concept based on the idea of having a concrete base layer with partially suspended floor has been adopted for athletes and dancers performances. Nowadays, sports and dance floors are quite similar, being different only by the level of performance (amateur, professional) of the two activities (Pardoseli Magazin 16/2013).

According to a well-established tradition, each European country has its own standardization system, the most common ones being the sports flooring norms in Germany, France, UK, Netherlands and the Scandinavian countries (Pardoseli Magazin 1/2010).

Meanwhile, a true sports flooring industry has been created and complying with the established standards. Thus, major sports competitions, national or international (when organized under the sponsorship of international federations), can only take place on dedicated, specially designed floorings.

The first regulation in this field was set up in Germany in 1960 (DIN 18032) and since 2001 it was changed in DIN 18032/2. This regulation stipulates special provisions for sports flooring considered also by the USA and Canada. Other conditions are imposed by the set of rules issued by FIBA (International Basketball Federation). The accreditation provided by this organization guarantees the quality of the environment on which the sport competitions take place, knowing that for example, basketball players need

a floor with special requirements because of their height and weight. The rules ensure the safety of the athletes and the conditions for their sport performance (Pardoseli Magazin 13/2012).

THE OBJECTIVE OF THE PAPER

This paper presents the historical evolution of sports floorings and some proposals for new wooden floor structures, as a result of own research carried out at Transilvania University in Brasov. The study was conducted in order to find improved solutions for the sports halls floorings.

GENERAL ASPECTS OF WOOD FLOORINGS

The evolution of the floors starts with the way of arranging the parquet strips and friezes and ends with the use of new wood species.

The transition from craft to industrial manufacturing occurred when technology developed and new products with better technical performance were designed. A dense parquet with significant hardness properties was obtained by applying pressure and new technologies such as "mosaic parquet" were developed for the capitalization of small-sized wood and the reduction of the assembly time.

The flooring industry is updated with all innovations in the materials field. For example, the deck is a relatively new invention (50-60 years) in the building materials market, having a remarkable evolution in terms of raw materials, starting with various wood species and ending with composites or totally synthetic materials. On the other hand, technology had also evolved, as in the case of click-fitting system.

A special category of wooden flooring is required for dance, ballet, aerobic gymnastics or any form of sport or movement. They are considered special ones, due to their behaviour in response to the type of activity that takes place on their surface (Cismaru et al. 2015).

The concern of sports floor specialists is to find the optimal balance between flexibility (not too soft / elastic - as it would involve additional effort from the user side) and stiffness (not too rigid - as it may cause injuries), but also to reduce as much as possible the unevenness of the subfloor to obtain the flat surface (Pardoseli Magazin 17/2013).

The sport floors developed mainly in terms of the support of the wooden panels, ranging from the most traditional systems to the most innovative ones and depending on the possibilities and levels of the desired performance for the sport activity.

Despite the innovative materials, wooden flooring systems for sports such as basketball, squash and dance remained unbeatable. For these kinds of floors the elastic properties were required for extended surfaces, not limited ones, so the wood continued to be preferred instead of rubber (kineticsport.ro).

The following elements/ conditions must be considered for the design and execution of sports floors (Cismaru et al. 2015):

- the nature of the activity carried out;
- body mass of the athletes;
- ensuring the athlete's protection;
- perception of comfort by the athlete;
- reliability of the structures;
- easy and fast maintenance;
- acceptable costs;
- the level of practice of different sports;
- the age of sport practicants.

Nowadays, sports halls are designed to have multiple uses (community activities, different cultural events), with several brands recognized worldwide (MONDO, BOEN, CONNOR, HARO, MEGASPORT, TARKETT), each trying to bring new elements to improve the properties of existing sports floors: shock absorption (Fig. 1, 2, 3), comfort and good acoustic insulation (Fig. 2), low risk of injuries (Fig. 3), resistance, friction, ball bouncing (Fig. 3), vertical deformation (Fig. 2 and 1), better return of energy to other systems (Fig. 1).

The sample products in Fig. 1-3 are *TARKETT Sports Floors* (www.tarkett.ro), and thanks to the excellent sports performance is the international choice for basketball and high level competitions, with the approval of the highest authorities - both national and international - FIBA, FFBB, IHF, WSF and WVBF.

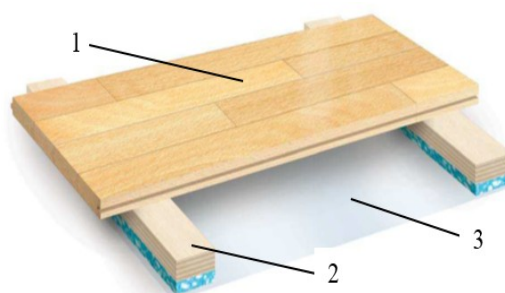


Fig. 1.
Reflex M Evolution sports floor
1 – wood sports floor (multilayer 22mm), 3 strips/Tongue and Groove; 2 – single joist system with PU foam included; 3 – Tarfilm.

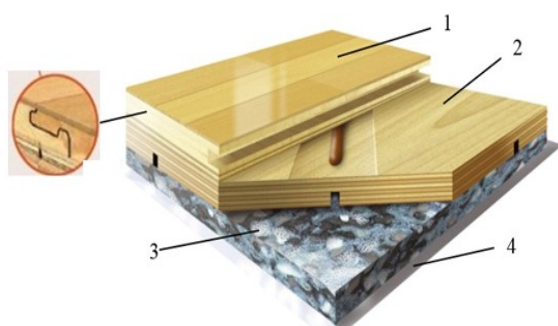


Fig. 2.
Multiflex M sports floor
1 - multilayer sports floor (14mm) 3 strips/2-lock; 2 – Tarflex; 3 – Tarfoam 1500; 4 – Tarfilm.

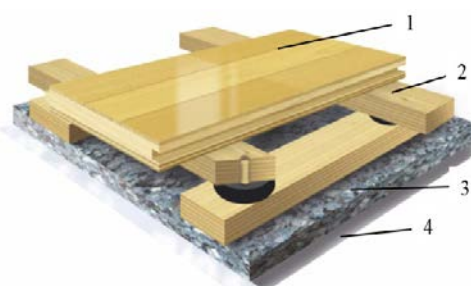


Fig. 3.
Proflex M sports floor
1 – wood sports floor (multilayer 22mm) 3 strips/Tongue and Groove; 2 – double joist system with elastomeric pads; 3 – Tarfoam 1200; 4 – Tarfilm

ACTUAL CHARACTERISTICS OF SPORTS HALLS AND REQUIREMENTS OF SPORTING FLOORS

Vincent Collet, coach of the French basketball team, believes that: „A fundamental aspect is slipperiness. A sports flooring must offer the perfect balance between grip and slide control to preserve energy and reduce the strain on muscles.” (www.tarkett.ro). He also mentioned that: „Shock absorption and energy release are the most important performance criteria to avoid injuries. In basketball, players change rhythm very frequently so it's tough on muscles and joints. That's why a double joist wood system is the solution best suited for basketball.” (www.tarkett.ro).

Depending on the competition line, the licensing of basketball courts and grounds is done according to the Federal Bureau's decision and the provisions of the Approval Regulation (RGOCB 2016-2017) and must meet the following requirements:

- rooms/halls to be tested and approved for the level of competitions they host;
- the sports halls where official basketball competitions of categories I and II are held will have wooden flooring of 28m in length and 15m in width;
- the height of the ceiling above the playing field must be at least 7m;
- the floor of the playing field must be at least 32.0m in length and at least 19.0m in width and the entire non-bumping surface in accordance with the FRB regulations (Chapter 15 of the Technical Basketball Equipment).

Table 1

Floor of playground

Level	Floor	
1 and 2	wood	fixed
		mobile
2 and 3	synthetic	fixed
		mobile

The floor area of the playing court, depending on the level of competition, must be done according to Table 1. Table 2 presents the requirements strictly applicable to the wood floors for 1st level.

Table 2

Level 1 - Requirements strictly applicable to the wooden floor (FIBA)

Crt. No.	Name of the request	Values	
		fixed floor	mobile floor
• Functional sports requirements:			
1	Impact Reduction (Shock Absorption) according to EN 14808	min.50%	min. 40%
2	Vertical deformation according to EN 14809	min. 2,3 mm max. 5,0 mm	min. 1,5 mm max. 5,0 mm
3	The vertical aspect of the ball (after impact with the floor) according to EN 12235 (basketball game)	min.93%	min. 93%
4	Sliding properties according to EN 14903	min.0,4 max. 0,7	min.0,4 max. 0,7
5	Sliding properties according to EN 13036 - 4 (dry condition)	min. 80 max. 110	min. 80 max. 110
• The requirements for the properties specified above must be fully met at each point in the test system.			
6	Deflection zone according to DIN V 18032-2 (2001-04);	average of the direction: max. 20%; single values up to 30%;	average of the direction: max. 20%; single values up to 30%;
• Uniformity requirements			
1	Impact mitigation	± 5% (absolutely) based on the average value	± 5% (absolutely) based on the average value
2	Vertical deformation	±0,7mm based on the average value	±0,7mm based on the average value
3	The vertical aspect of the ball	±3% (absolutely) based on the average value	±3% (absolut) based on the average value

The flooring delivered for installation is accompanied by technical documentation with the following content:

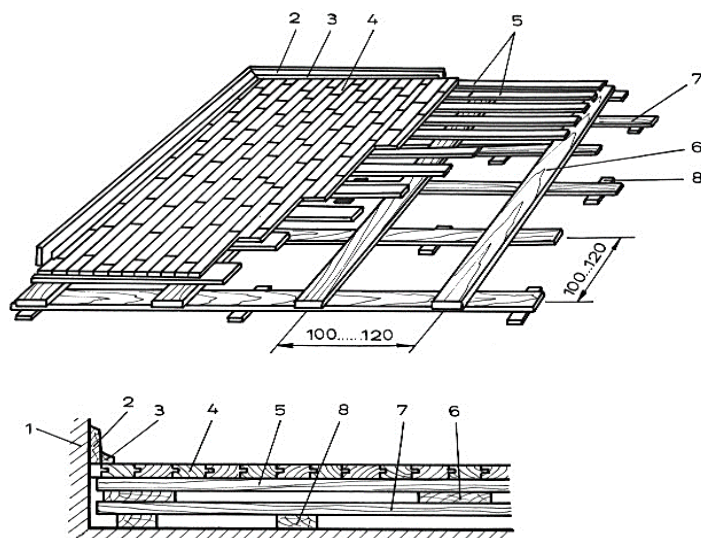
- results of the prototype test;
- a description of the assembly procedure;
- maintenance tips;
- the results of the inspection and approval of the use of the existing installation by authorized inspectors.

The floor of the playing court must be able to withstand the supporting structures of the panels, mobile or fixed ones, without diminishing the features required for the panel support structure (Technical Equipment of Basketball Game).

SOLUTIONS PROPOSED FOR SPORTING FLOORS

For an accurate design of wood floors dedicated to sport activities preliminary tests were carried out at Transilvania University of Brasov, namely bending test on specimens made of steamed beech wood of different thicknesses (g), (15, 20, 25, 30mm), widths (b) (30, 40, 50, 60mm) and lengths (L) (300, 350, 400, 450mm). The analysis of results indicated the behaviour of floor and conducted to the right choice in sizing of friezes for the floors to be tested. The parquet strips with sizes Lxbxg of 500x50x20mm have been choosed for the flooring. The floor friezes were arranged according to the English model.

Due to the specific activities taking place in the sports/dance halls, such as running, jumping, landing, plunging with impact on body ligaments, serious injuries may occurred if the flooring is not elastic. An elastic structure (Fig. 4) consists of elastic laths (6) resting on elastic planks (7) arranged perpendicular ones to the others. The structure thus obtained is supported by wooden legs (8). Afterwards the blind floor (5) is built and the parquet (4) is mounted (Cismaru 2006).



- 1 - the building wall;
- 2 - wall plinth;
- 3 - sill;
- 4 - field strips;
- 5 - blind floor composed of solid wood elements;
- 6 - elastic laths (I);
- 7 - elastic planks (II);
- 8 - supporting legs.

Considering the principle of elasticity, several constructive solutions for sports floors were designed to meet the requirements for good performance of sports activity (Fig. 5-11 and Table 3).

Fig. 4.

Recommended elastic floor structure specific to sports halls (Cismaru 2006).

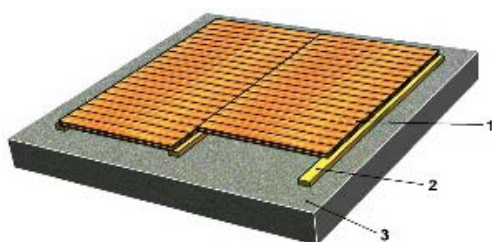


Fig. 5.

Structure A

1 - friezes of beech wood parquet; 2 - resinous beams; 3 - concrete support layer.

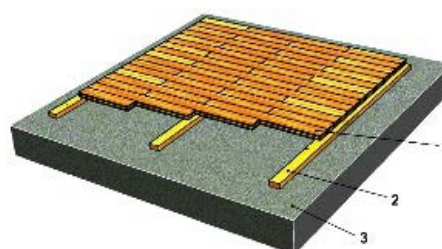


Fig. 6.

Structure B

1 - friezes of beech wood parquet; 2 - resinous beams; 3 - concrete support layer.



Fig. 7.

Structure C

1 - friezes of beech wood parquet; 2 - resinous beams; 3 - concrete support layer.

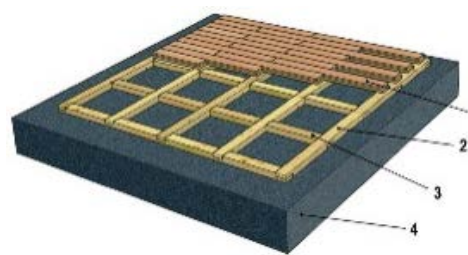


Fig. 8.

Structure D1_a

1 - friezes of beech wood parquet; 2 - resinous beams; 3 - sleeper from resinous timber; 4 - concrete support layer.

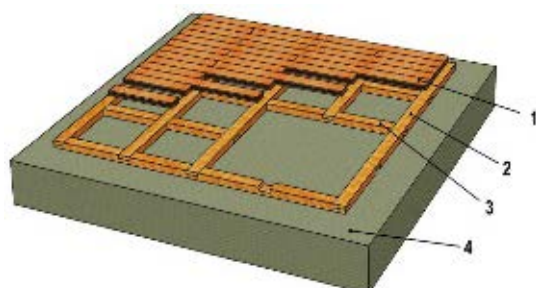


Fig. 9.

Structure D2_a

1 - friezes of beech wood parquet; 2 - resinous beams; 3 - sleeper from resinous timber; 4 - concrete support layer.

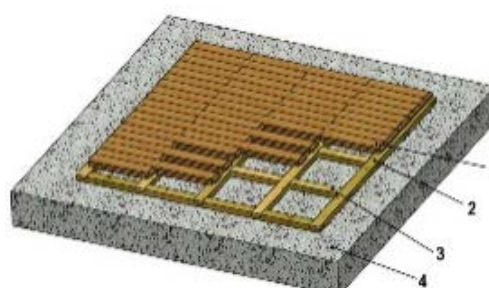


Fig. 10.

Structure D3_a

1 - friezes of beech wood parquet; 2 - resinous beams; 3 - sleeper from resinous timber; 4 - concrete support layer.

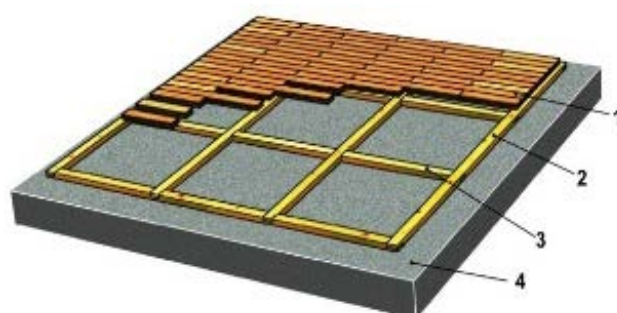


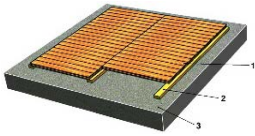
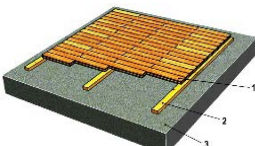
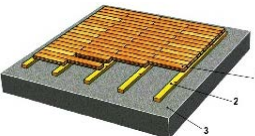
Fig. 11.

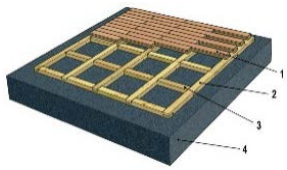
Structure E

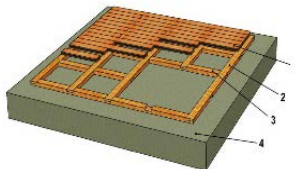
1 - friezes of beech wood parquet; 2 - resinous beams; 3 - sleeper from resinous timber; 4 - concrete support layer.

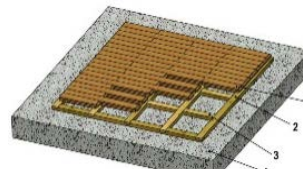
Table 3

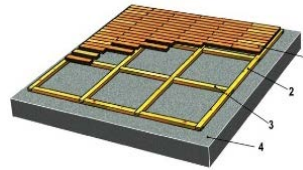
Constructive flooring variants

Structure A (1,00mx1,00m)							
frieze				beams			
thickness	width	length	total	thickness	width	length	
mm	mm	mm	pcs.	mm	mm	mm	pcs
20	50	500	40	20	40	1000	3
							
Structure B (1,00mx1,00m)							
frieze				beams			
thickness	width	length	total	thickness	width	length	
mm	mm	mm	pcs.	mm	mm	mm	pcs
20	50	500	30	20	40	1000	3
20	50	250	20				
							
Structure C (1,00mx1,00m)							
frieze				beams			
thickness	width	length	total	thickness	width	length	
mm	mm	mm	pcs.	mm	mm	mm	pcs
20	50	500	30	20	40	1000	5
20	50	250	20				
							

Structure D1_a (1,00mx1,00m)								
frieze				beams				
thickness	width	length	total	thickness	width	length		
mm	mm	mm	pcs.	mm	mm	mm	pcs.	
20	50	500	30	20	40	1000	5	
20	50	250	20	sleeper				
				20	40	1040	5	

Structure D2_a (1,00mx1,00m)								
frieze				beams				
thickness	width	length	total	thickness	width	length		
mm	mm	mm	pcs.	mm	mm	mm	pcs.	
15	50	500	30	20	40	1000	5	
15	50	250	20	sleeper				
				20	40	1040	5	

Structure D3_a (1,00m x1,00m)								
frieze				beams				
thickness	width	length	total	thickness	width	length		
mm	mm	mm	pcs.	mm	mm	mm	pcs.	
25	50	500	30	20	40	1000	5	
25	50	250	20	sleeper				
				20	40	1040	5	

Structure E (1,50m x1,50m)								
frieze				beams				
thickness	width	length	total	thickness	width	length		
mm	mm	mm	pcs.	mm	mm	mm	pcs.	
20	50	500	75	20	40	1500	4	
20	50	250	30	sleeper				
				20	40	1540	4	

The structures presented above are made from beech wood, which is the most spreaded wood species in our country. The structures are easy to manufacture and have lower prices compared to similar products on the market. Their performances have to be experimentally tested and are the subject of a future article.

CONCLUSIONS

The following conclusions emerged from the present study:

- wood flooring systems for sports such as basketball, squash and dance are preferred to rubber, because of the extended elastic properties of the entire built surface.
- today, sports halls are designed to have multiple uses (community activities, different cultural events) so that floors will need to be structurally designed and dimensioned to support mainly sport activities.
- new materials that can improve the function of wood flooring according to the destination of the space should also be taken into account.
- the type of movement practiced in the various sports are significant for the designed flooring in order to ensure the necessary comfort of the athletes for their performance in optimal conditions required by each type of sport activity.
- due to the requirements to be met in the field of wood flooring for sporting activities, research should take into account the variety of sport activities in order to create reliable structures with the lowest possible cost.
- the floor standard for basketball game, where the athletes are tall and the play is complex including running, jumping, and sudden changes in direction could be a reference one for testing, ensuring because of its complexity that the floor can be used for other sports, as well.

REFERENCES

Cismaru I (2006) Pardoseli din lemn – structuri, proiectare, execuție, fixare în construcții (Wood Floorings – Structures, Designing, Manufacturing, Fastening in Constructions), Editura Universității „Transilvania” Brașov pp.124-125, (in Romanian language).

Cismaru I, Filipașcu M, Țurcaș O, Fotin A (2015) Wooden flooring – between present and future, PRO LIGNO 11(2):39-50.

Kirițescu C (1964) Palestrica – o istorie universală a culturii fizice (Palestrica - a Universal History of Physical Culture), Editura Uniunii de Cultură Fizică și Sport, București, (in Romanian language).

Podele pentru sport (Flooring for sports) - Online at: <http://www.tarkett.ro/produse/podele-pentru-sport.1944.html>

RGOCB (2016-2017) General Rules for Organising Basketball Competitions 2016-2017. Online at: http://www.frbaschet.ro/documente/download/RGOC_2016-2017.pdf, pp.8-9.

Revista Pardoseli Magazin (Flooring Magazine) (2010) Pardoseli sportive poliuretanice indoor (Indoor polyurethane sports flooring). Online at: <http://www.pardoselimagazin.ro/images/docs/pardoseli01.pdf>, 1(feb):31-33.

Revista Pardoseli Magazin (Flooring Magazine) (2012) Două săli de sport spectaculoase - două pardoseli speciale (Two spectacular sports halls - two special floors). Online at: <http://www.pardoselimagazin.ro/images/docs/pardoseli13.pdf>, 13(oct/nov):50-55.

Revista Pardoseli Magazin (Flooring Magazine) (2013) Pardoseli pentru dansuri populare (Flooring for popular dances). Online at: <http://www.pardoselimagazin.ro/images/docs/pardoseli16.pdf>, 16(iun/aug):34-36.

Revista Pardoseli Magazin (Flooring Magazine) (2013) Pardoseli de sport pentru competiții (Sport floors for competitions). Online at: <http://www.pardoselimagazin.ro/images/docs/pardoseli17.pdf>, 17(sept/nov):38-41.

Suprafață sportivă lemn (Sporting wood surface). Online at: <http://kineticsport.ro/suprafete-sali-de-sport/suprafata-sportiva-lemn/>

Technical Equipment of Basketball Game within the Romanian Basketball Federation. Online at: <http://www.frbaschet.ro/documente/download/Echipamentul%20Tehnic%20a%20Jocului%20Baschet%20-%202014.pdf>