Calculation of Strength and Stiffness of Sports Equipment for Games in a Radial Basketball

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ABSTRACT. Discusses the main problems of strength of Sports Equipment for Games in a Radial Basketball. Based on structural analysis for stiffness, strength and stability of the proposed scheme two-piece installation that fixes all shortcomings noted by the developers. Formulated proposals for the modernization of sports equipment. Only after such studies, one can speak about the ways of its modernization. The main bearing element of the structure, defining the key performance indicators, is a stand. An analysis was conducted of its stiffness and strength.

Introduction. Radial basketball sports ball game, the presentation of which took place in December 2002 in St. Petersburg. For the first, time the rules of the game published in 2002. Playing on the Playground, made in the form of a circle 18 meters in diameter with three concentric circles bounding the zone for 3 seconds (R-3 m), two-point (e-6 m) and three-pointers (R-9 m)[1]. In the centre of the play area Desk with attached shields with baskets in the form of an equilateral triangle 9 (Fig.1).

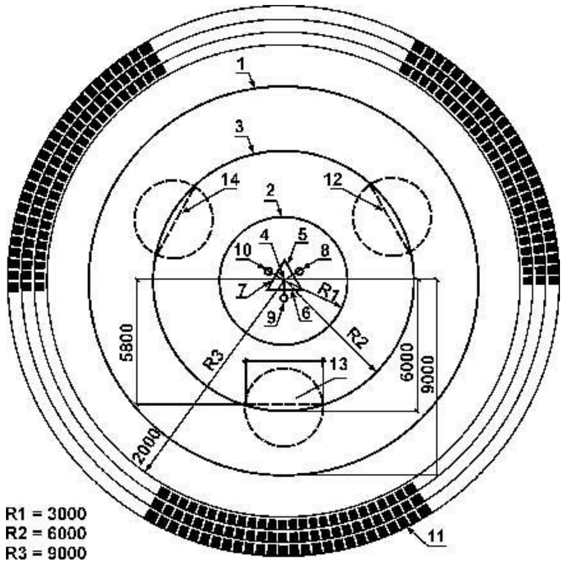

Fig. 1. The circuit court for radial basketball.

Device for playing basketball in the radial consists of a strut Assembly mounted on the base, made in the form of a circle. It fixes 3 of the shield with a basketball basket with the possibility of installation on the same or on different levels. The base of the strut is provided with a ball bearing fixed on its circumference, in the centre of the base console is installed, on which are strung hollow containers with caps and strut, which includes a clutch shiftable along it and fixation with metal retainers (Fig.2). The proposed utility model relates to sports equipment and can be used during sports games in a radial basketball [2].

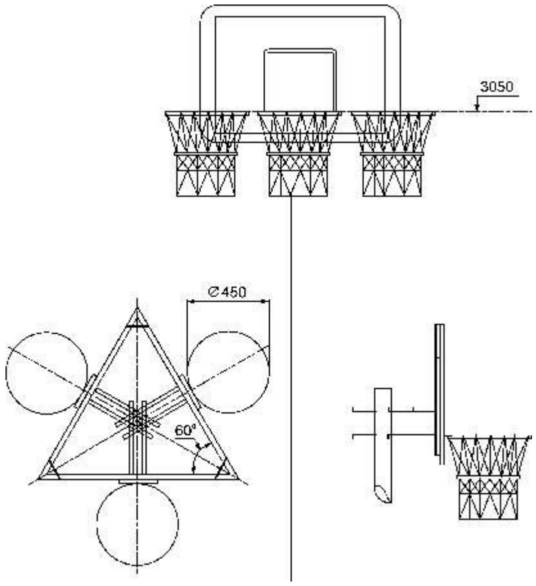

Fig. 2. Diagram of the shield with rings to play in a radial basketball.

The terms "load", "force", "force" are frequently used, even among experts far from the calculations on the stiffness and strength. Hence, the need for systemic presentation of these issues, especially the notion of "force" and "displacement" in mechanics and concepts "voltage" and "deformation" in the strength of materials and theory of elasticity are the main, primary concepts. Certainly the concept of "power", according to which "Value, which is a quantitative measure of the mechanical interaction of material bodies, is called force in mechanics" [1]. Strength is the magnitude of the vector. Its effect on the body is determined by:1) the numerical value or modulus of the force; 2) direction of force; 3) point of application of force. In resistance of materials, for ease of analysis, the concept of inner power (the power factor). Distinguish between longitudinal force N_z, the transverse forces Q_x and Q_y, the torque M_z, the bending moments M_x and M_y. The index when strength factors correspond to the coordinate axes with respect to which the relevant factor. The numerical value of inner strength is from the equilibrium condition, i.e. its value is equal to the sum of all external forces located on one side of the considered cross-section. Further, to simplify, as well as in elasticity theory, we assume that the equilibrium condition is satisfied, and the inner power factor is expressed as the external force.

Currently, when calculating the strength and stiffness that meet modern scientific and technical level, the popularity and widespread CAD/CAE (Computer Aided Designer/Computer Aided Engineering) system [2, 3]. Particularly fruitful was the use of specialized programs to assess stress–strain state (SSS) of technical systems based on this method, mechanical–mathematical modelling as finite element method (FEM). FEA – international standard for solving problems of solid mechanics by means of numerical algorithms. Suffice it to say that no bridge, no plane, etc. is not certified by international organizations if they are designed without the use of this method. In this study, we applied a widely used technique in the software package Solid Works/COSMOS Works – integrated program that includes the module solid modelling CAD and a module of finite element analysis CAE [4]. The main feature and advantage of this software is its orientation to the design of complex systems with a virtually unlimited number of items and their calculation on strength and rigidity, including under dynamic loads.

The results of the study. The aim of our study was to analyse the design for rigidity, strength and stability of the installation. Only after such studies, one can speak about the ways of its modernization. The main bearing element of the structure, defining the key performance indicators, is a stand.

The calculation of the strength and stiffness of cylindrical model. Fig. 3 shows the horizontal displacement of the end of the bar. To the right in Fig. 3 shows a histogram of the displacements of all points of the model. Module sensing results can be received and recorded in the Protocol analyse the result at any point in the model [5].Two points on the intersection of the pipe with the bar these movements (table. in fig. 3) is equal to UX=58, 3 mm and UX=59,16 mm.

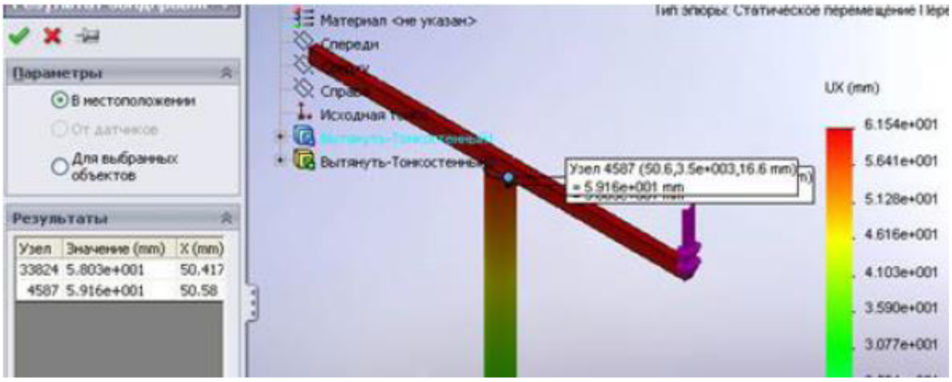

Fig. 3. The displacement field of the upper end of the stand.

In the same way it is possible to bring the voltage at any point in the system. The fig. 4 shows a field of von Mizes stress Mo the lower end of the strut, and Fig. 5 normal stress SY in the same area. A comparison of these stress fields confirms the assumption expressed above that in this problem the stresses SY are the major components in von Mizes stresses, SM, and further we will analyze only the stress SY.

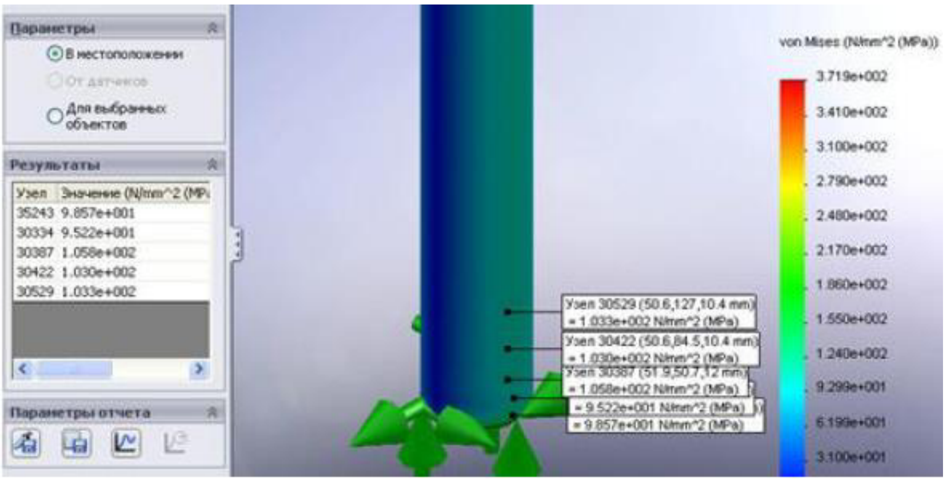

Fig. 4. A field of von Mizes stress SM at the lower end of the stand.

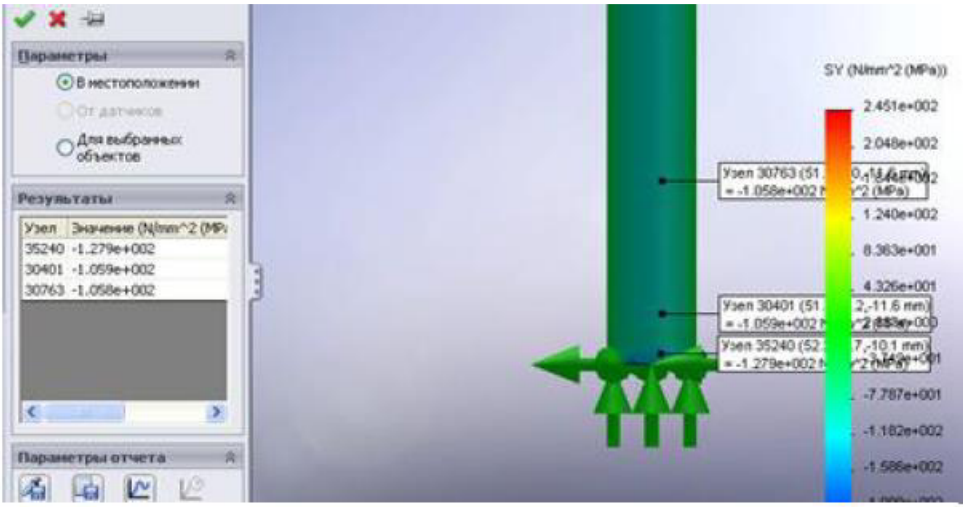

Fig. 5. Field normal stress SY at the lower end of the stand.

For completeness, in Fig. 6 shows the stress field SY at the upper end of the stand.

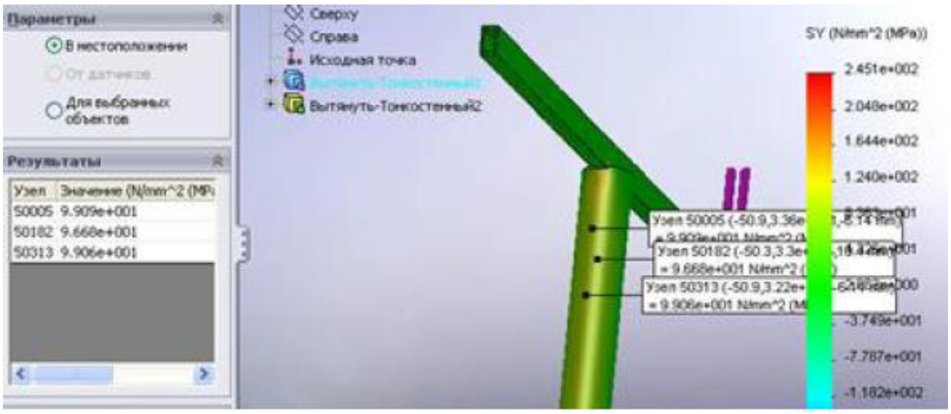

Fig. 6. The stress field SY at the upper end of the stand.

Analysis of the stress field shows:

1) The Results obtained using FEM, fixed voltage, taking into account their concentration. The program differential tension on the tensile (+) and compressive (–sign).

2) Results obtained using the finite element method and the results of the analytical solutions match very close.

3) Operating voltage in this problem is significantly below the allowable limit, i.e. the problem of strength for this structure is not decisive.

The calculations show that the results of analytical solution and finite element analysis are the same, which actually is a test solution to move on to more complex tasks.

Calculation for strength and rigidity two-piece stand.

Alternatively, stand design for play in the radial hoops with chains, consider a model in which the rack is made two-piece: the upper cylindrical part of length l=1500 mm and radius R=50 mm and a conical bottom part length l=2000 mm and base radius R=250 mm. Such constructive scheme follows the scheme with the chains, but visually looks "graceful". In Fig. 7 shows the total displacement field on the deformed model. In Fig. 8 shows the summary of travels with the results of sensing at the point of intersection with the cross member and at its end. Here, we present fields of total displacements UR, knowing that at the point of intersection with a cross these displacements UR and UX differ slightly. The obtained value of UR=19,98 mm is very close to the obtained above analytical way, the value Δc=17,67 mm and smaller than obtained in the cylindrical model (fig. 3) 3 times.

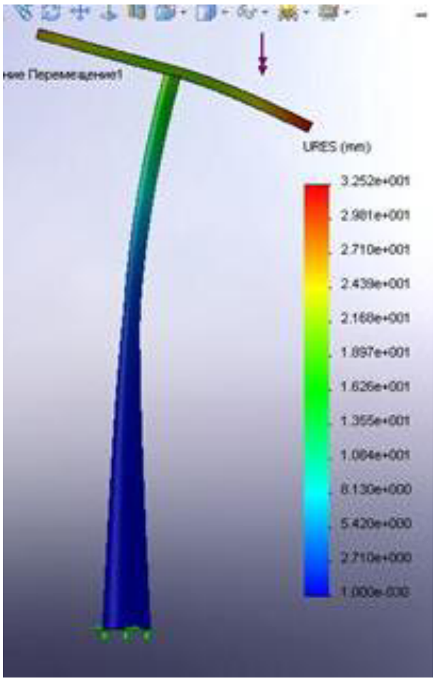

Fig. 7. The summary of movement

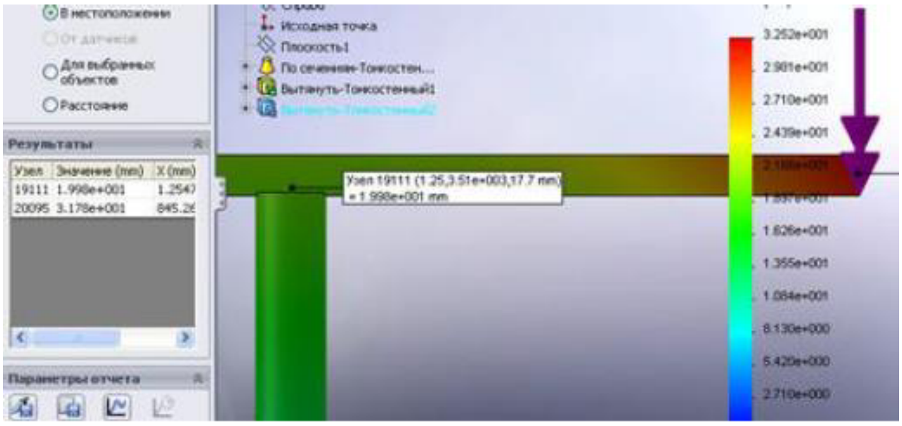

Fig. 8. The summary of the movements with the results of the sensing the point of intersection with the cross member and at its end.

Thus, with relatively simple constructive solution is obtained the desired result – reducing displacement of the end of the bar 3 times. Complete this section of the research, the analysis of stress values. In Fig. 9 shows a field of normal stress SY at the lower end of the strut, and Fig. 10 – at the upper end of the bar. Note that at the upper end of the counter voltage, with respect to the cylindrical model has not changed, and at the bottom decreased almost an order of magnitude, due to the increased moment resistance due to the increase of the radius of the base.

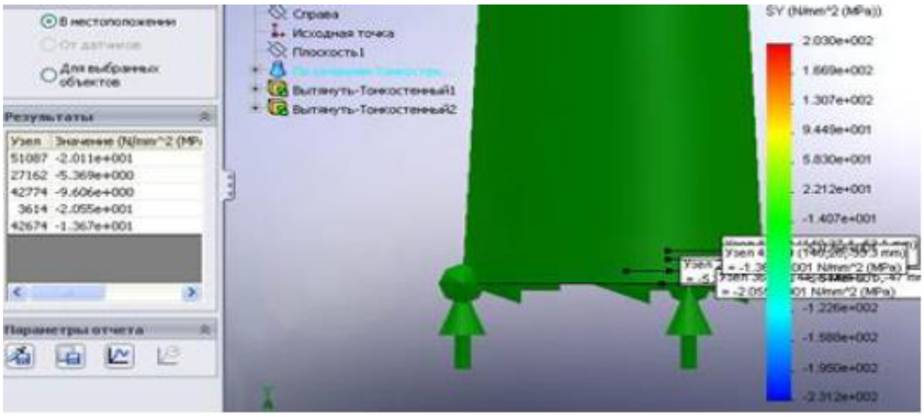

Fig. 9. Field normal stress SY at the lower end of the stand.

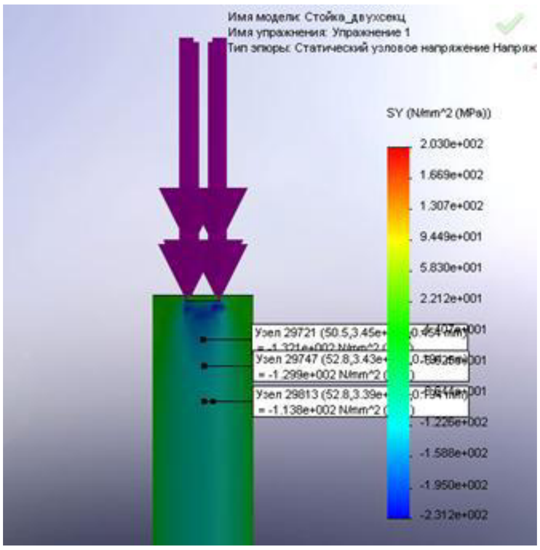

Fig. 10. Field normal stress SY at the upper end of the stand.

It is natural to check how affects the change, such as displacement, due to the changes of pipe wall thickness. In Fig. 11 shows the displacement field for the model, in which the thickness of the upper cylindrical part is increased to 6 mm.

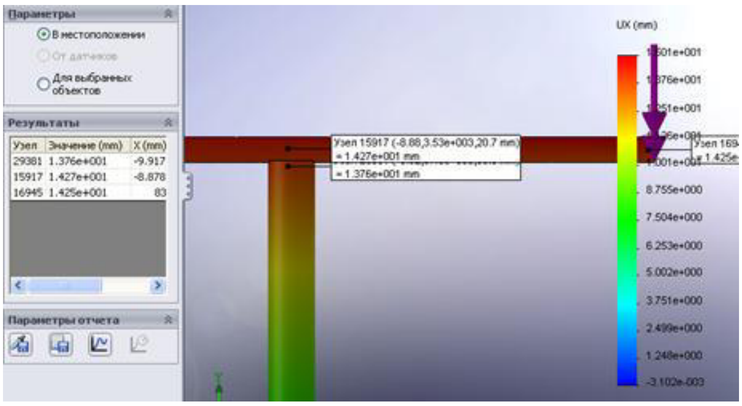

Fig. 11. The displacement field for the model thickness of cylindrical part is increased to 6 mm.

The obtained value of UR=13,76 mm is almost one and a half times less than that obtained earlier (fig. 8) the value UR=19,98 mm. Thus again it is shown that by using different design solutions to result in reduced displacement of the end of the bar. A preliminary analysis of stand design for play in the radial basketball shows that its stability is provided by a large weight. Therefore, the structural weight reduction will inevitably lead to the decline of sustainability. In the table of basic design parameters indicated that the balances have size 15•10•3 see In this case, the volume of the counterweight V=450 cm^3 and density ρ=7,85·10-3 kg/cm^3 the weight of one bar is equal to G=3,53 kg. Weight of the bars 18 G=63.5 kg, and the weight of the bars 30 G=106 kg. The Declared weight of the counterweight 200 kg is not obtained. At the same time the weight of 200 kg can be distributed rationally and stability of the installation will be provided constructively.

Summary. 1. Developed a methodology for estimating the basic parameters of the setup for the game in a radial basketball, by solid modelling and subsequent finite element analysis.

2. The proposed two-piece design scheme stands for the radial of basketball, which resolves nearly all shortcomings noted by the developers of the installation.

3. According to the experiment, operating experience and the above calculations, you should specify the main parameters of the installation: the horizontal movement of the upper end of the strut and the allowable weight "hangs" on the ring of the player. This will be the original data. Then all the installation parameters can be recalculated.

4. Base design of the installation must be specified after the adoption of the concept design and reception of the main carrier element.

5. When designing shields and rings can be used by existing development in the classic basketball.

6. Having a great weight, the design has some tolerance. Any improvements aimed at reducing weight will reduce the stability margin and to a possible injury.

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