Multipurpose Training Tool Development Branch of Artistic Gymnastics

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Abstract

The majority of sports organizations including gymnastics in Central Java Province still use school arenas which are quite small and not representative according to the rules of the Federation Internationale de Gymnastics (FIG). Meanwhile, athletes must train without the hindrance of external factors such as our facilities. Purpose of Study: To provide a solution that can be applied to a limited school area by conducting field analysis and designing a suitable model, especially for uneven rods in gymnastics. The material in this study is the school arena, the uneven bars. Observation and measurement are used to collect data, then analyze it using Computer Aided Design software. The data are presented as descriptive quantitative. Result: To facilitate uneven trunks it can be constructed using either a log or glass fiber with adjustable posts (lower: 1.61-1.70 meters; upper: 2.41-2.50 meters), and with grip properties such as tension: 13.64 Newton, displacement: 1.17 mm, strain: 4.428 m/m. Conclusion: The modified unmodified bar has been designed to optimize training sessions in a limited school area.

Keywords: *Sports technique, elite sports, gymnastics.*

Introduction

Sport is a human physical activity, now it has become a necessity of life. As an activity that involves large muscles, sport can be used as a tool in meeting economic needs, maintaining fitness and rehabilitation, as a means of recreation, education, and of course achievement. Sports can be grouped into three areas, namely; educational sports, recreational sports, and achievement sports[1]. However, there is about the scope of this sport, as stated in the excerpt of the paper Sport Science in Indonesia, namely; physical education, health sports, competitive sports (sports), recreational sports, and dance. Of the various types of artistic gymnastics equipment requires a good construction design, because the equipment is expected not to change the position of the tool so that the gymnast's movement technique during training and during competition does not change according to the assessment criteria[2]. For that in the use of training equipment for artistic gymnastics, requires the arrangement of mechanical installations is performance sports equipment, especially in gymnastics, both during training and for competition requires constant equipment conditions[3]. To help the calculation of constant equipment levels, one of them is by using CAD software (Computer Aided Design), because it is part of a multidisciplinary study between sports and engineering or what is called sports engineering. Likewise the need for sport engineering in artistic gymnastics based on the request of the Code of Points for various types of cutting-edge techniques[4]. The connotations of sport engineering are diverse, comprehensive and balanced. It is an extension of the latest techniques that must also adhere to this principle. To support the study of sports engineering in determining the conceptual design of building construction and sports equipment that can support the achievement of high-performance and sustainable sports facilities and infrastructure[5]. Based on the results of interviews with researchers with officials of the Central Java PersaniProv, of 35 existing Persani District and City Administrators, the use of gymnastic

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training facilities on single and multilevel bars in Central Java has not been effective, because based on average data the tools used are using modification tools. and it is not yet known the level of constancy in these tools using CAD (Computer Aeded Design). In addition, the main Persani organization in Central Java uses a school hall building as a gymnastic training place with a limited size of the school hall building, so that the arrangement of the facilities on single crossbar and multi-storey bars cannot be installed in the building because these tools use stakes to installation, so that it requires a large enough space, the parent organization Persani which uses modified equipment installed outside the room from 6 main organizations consisting of Grobogan, Karanganyar, Pati, Pemalang, Rembang and Temanggung districts[6].

The equipment modified by the 6 parent organizations of different shapes and sizes, both from material specifications and operational use of multilevel cross bars, cannot be adapted to the needs of athletes, while the 25 main gymnastics organizations in Central Java do not have single crossbar and multilevel cross bars. This results in not running the training program because the equipment is installed outside the room so that external factors are disturbed, one of which is the weather. On the other hand, the price of one of the standard FIG gymnastics products for the AAI brand on the single crossbar reaches $ 3,450 or around Rp. 48,300,000, -, while in the JannsenFritsen multilevel crossbar tool $ 6,216 or around Rp. 87,024,000, -. The price of the equipment is not included in the cost of shipping and taxes, so that the procurement of gym equipment for single crossbar and multilevel bar with standard specifications at the regional level cannot be fulfilled because the price of the equipment can be said to be expensive and cannot be installed in a limited space because it requires land. which is quite extensive. To solve this problem, the researcher feels the need to conduct development research so that existing problems can be immediately resolved and the results of research in the form of a model product development of a multipurpose training tool for artistic gymnastics in the form of a modified single-bar and multilevel crossbar without using a stake that can be used on Limited training space and can be used as an alternative to training by gymnastics athletes and for coaching the parent organization Persani in Central Java. Through the model of developing a multi-purpose training tool for artistic gymnastics on a single crossbar and a multilevel bar, this can provide solutions to overcome the efforts to improve skills in the aspects of motion related to the composition of requirements in assessment during competition, as well as the composition of requirements on single crossbar and multilevel bars referring to in Code of Points Artistic Gymnastics 2017-2020[7]. The development of a multipurpose training tool for artistic gymnastics on a single crossbar and a multilevel crossbar is hoped to be able to overcome the limitations of facilities and infrastructure to increase the level of effectiveness, efficiency and usefulness in the use and installation of artistic gymnastics equipment for motion training on single-bars and multilevel bars, assuming it can be used. installed in a space that is limited in size without the use of a rope staple and the level of constancy of the tool can be seen with CAD (Computer Aeded Design) software[7].

Based on the description above, the researcher needs to conduct research on the development of a multipurpose training tool for artistic gymnastics based on CAD (Computer Aeded Design) [8]. The hope is that the product development model for a multipurpose training tool for artistic gymnastics that researchers will develop can be owned by each parent organization Persani in Central Java. at a very affordable price because the tool is designed with two tools into one tool called the development of a multipurpose training tool for artistic gymnastics on a single crossbar and a multilevel bar. So that the parent organization can carry out an exercise program programmed and can be a boost for coaches, athletes and the parent organization of the gymnastics branch as a means of training and training activities in Central Java. The purpose of this development is to produce a product for the development of a multipurpose training tool for artistic gymnastics as an alternative as a means of exercise through several steps, namely:

1. Developing a multipurpose training tool for artistic gymnastics on a single bar and a multilevel bar as needed and can be used with minimal facilities.
2. Developing a multipurpose training tool for artistic gymnastics on single-bar and multi-tiered bars which are effective for installation in limited building spaces.
3. The results of the model for developing a multipurpose training tool for artistic gymnastics can be accepted by trainers and athletes in Central Java.

Method

Development research is research that aims to produce and develop a product in the form of a prototype. Research is to solve practical problems in gymnastics coaching in Central Java, the problems faced by athletes and coaches in implementing training programs, researchers are not for testing theories, testing hypotheses, or testing and perfecting products[11]. Research and development, usually called research-based development, is a type of research that is being increasingly used in solving practical problems in the world of research, especially educational research and learning. Research and development is a process used to develop or validate products used in learning education. Furthermore, it is stated that the research and development procedure basically consists of two main objectives, namely: (1) developing the product, and (2) testing the effectiveness of the product in achieving the goal. In this research, the development model used is a procedural development model, because this model is descriptive, which is a procedure that outlines the steps that must be followed in producing a product[12]. In each development can choose and find the most appropriate steps for research based on the conditions and constraints faced[13]. Define development research as a systematic assessment of design, development and learning programs, processes and products that must meet the criteria of validity, practicality and effectiveness[14]. The criteria "can show the added value of the three criteria. Research and development is a process used to develop or validate products used in education and learning. The development procedure carried out in designing, creating and evaluating (validation) in this study, using outcome measures adapted from Borg & Gall [15]

The trial was carried out to get responses and product revisions, so that the final product would be produced in the form of a development model for a multi-purpose training tool for artistic gymnastics on a single crossbar and a multilevel crossbar according to the needs of the athlete. The trials were carried out in small group trials and field trials. In this study, the trial design used was experimental design. Product development trials go through two stages, namely small group trials and field trials. The test subjects or respondents involved in this research are the parent organization PERSANI in Central Java which is divided into two stages consisting of small-scale trials and trials. field. The small-scale trials in this study included three parent organizations including Pati, Rembang and Grobogan districts with 12 athletes, with details of each district consisting of 4 athletes. While the large-scale trial covers 7 regions in Central Java. The data used in this study are qualitative data. Qualitative data obtained from interviews in the form of criticism, suggestions from gymnastics experts and resource persons orally and in writing as constructive input for product revision materials. The instruments used to collect data in this study were observations, interviews, questionnaires, field observations and documentation. Questionnaires are used to collect information in a systematic and targeted manner from experts and resource persons. Meanwhile, questionnaires and field observations were used to determine the feasibility and acceptability of the product. The validity of the data is an important thing in research, because it is a guarantee of confidence in solving the problems being studied[16]. To determine the validity (trustworthiness) of data, an examination technique is needed. The implementation of inspection techniques is based on a number of certain criteria. There are four criteria used, namely the degree of trust (credibility), transferability (transferability), dependability (dependability), and certain (comfirmability). In order for the data obtained to have a guarantee of trust, in this study the researcher used the criteria for the degree of trust (credibility). The author uses three data credibility checking techniques, namely triangulation, member checking, and peer discussion. Triangulation in credibility is defined as checking data from various ways, and various times. Thus there is triangulation of sources, triangulation of data collection techniques and triangulation of time. This research uses triangulation of sources and triangulation of data collection techniques[17]. Checking members by showing data or information, including the results of the researchers' interpretations that have been written in the format of field notes or interview transcripts to other information deemed necessary. Comments, reactions or additional information data were used to revise field notes or interview transcripts. The data analysis technique used is the percentage to analyze and the assessment of the developer's subject in assessing the feasibility, effectiveness and acceptability of the product to the development product. Respondents will be interpreted by the results they get, namely providing the results of tests that have been carried out. The data obtained through the testing activities were clarified, namely qualitative data. Qualitative data in the form of criticism of suggestions put forward by gymnastics experts and athletes are then collected for improvement.

Result and Discussion

Based on the results of the survey that has been carried out, in the use of single crossbar and multilevel gymnastic tools in Central Java, the model of the tool used is still using a stake as a training facility, so that the tool cannot be installed in the building because it requires a large enough area. The parent gymnastics organization in Central Java does not yet have a multipurpose training tool for artistic gymnastics on a single bar and a multilevel bar as a training facility that can be installed in a limited size building space. The trainer cannot carry out the training program on the single crossbar and multilevel bar in the rainy season, so the athlete cannot do exercises to improve the movement skills on the single-bar and multilevel crossbar effectiveness in carrying out training programs and utilizing hall space as training infrastructure, it can be said that logically the choice of development of a multi-purpose training tool for artistic gymnastics is made on single-bar and multilevel bars. Based on a glimpse of the conditions described in the previous chapter, it is hoped that the development of single-beam and multi-tiered bars can run better. Trainers and athletes do not only do exercises outside the building but can develop the exercise process to be more creative and innovative, so that they can accommodate the activities needed by artistic gymnastics athletes based on understanding the rules on the aspect of the composition of requirements in the code of points artistic gymnastics. Gymnastics new 2D models of single bars including end point movements[18]. 2D modeling of single crossbar apparatus in men's gymnastics is reviewed. Parameter estimation is described regarding two problems, first, to determine the measurement demands posed by parameter estimation, and second, to find the need for new parameter estimation due to different single bars in the review. It is then used to evaluate the adequacy of the FIG (Federation Internationale de Gymnastique) requirements for high competitive standards. The model structure is developed and justified, using two different sets of single bars. Static and kinematic measurements show very different stiffness, damping and inertia characteristics in the vertical and horizontal directions, which is due to the spatial non-fixation of the end points of the horizontal bars, as they attach to the vertical posts connected to the floor. Horizontally, the end-point motion was found to add 30% to the measured motion of the bending of the rod, while vertically, the end-point motion was hardly measurable at all. Hence the two directions are modeled differently. Horizontally, two damped linear springs connected in series are attached to the measurement data, whereas vertically only one spring is required, demanding a total of nine stiffness, damping and effective mass parameters for the model. It appears that only the parameter ratios are required to model the forced rod oscillations and that all nine parameters can be found from three parameter measurements, i.e. stiffness, and then curve fitting into a single cross bar self-oscillation in two directions to find the remaining. The parameter variation appears to be significant between the bars and finally, the adequacy of the FIG vertical stiffness requirements was found to be questionable.

The sports building design has a huge impact on top sports. This implies challenging tasks to meet performance requirements, including such as daylight/ lighting factors, air conditions. Such factors have an impact on athlete performance and are difficult to control in large sports halls; their control is even more difficult when the public/audience is in a hall and requires different climatic conditions. While mechanical installations are often required during competitions to ensure constant conditions, conveying mechanical installations during daily and recreational use of the venue challenges medium or long term sustainability. A computational form-seeking approach can support the achievement of high-performance and sustainable sports buildings. In this regard, this paper discusses the use of multi-objective and multidisciplinary design optimization. This paper presents the concept of multidisciplinary and multi-objective design optimization techniques to support the trade-off decision between several conflicting design objectives and interdisciplinary design methodologies, during the conceptual design of sports buildings[19]. From the various sources of literature review above, a model for developing a multipurpose training tool for artistic gymnastics can be developed as an alternative to exercise which can increase the level of effectiveness, efficiency and usefulness in motion training on single and multilevel bars, assuming it can be installed in space. which size is limited without using a rope staple. Of the various types of gymnastics available, the following is a specification for a single crossbar and a multilevel bar which will be used as a reference by researchers in this development research, including the following:

Single Cross: The single crossbar is one of the six numbers of tools in the sport of gymnastics in men's art. The regulations set by the International Federation of Gymnastics (FIG) rods are made of stainless steel 2.4m long and 28mm in diameter, while a single bar is 2.50

m high over a mat with a thickness of 20 cm and is held in position by two supports which are stabilized by four stakes [20]

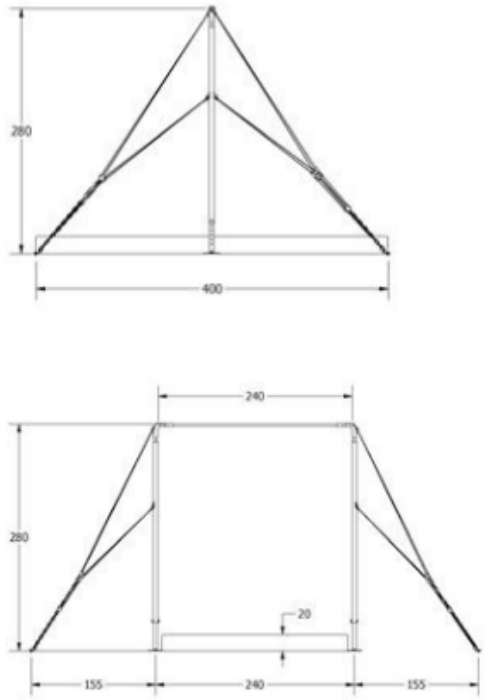

Figure 1. Single Cross

In a single crossbar, several types of motion aspects in the composition of requirements that refer to the code of points must be carried out by the gymnast which includes the giant swing, the skills of releasing, turning and changing direction, by using the momentum of the giant swing movement and sufficient height to be reached for dismounting.

Multilevel Cross: The multi-storey crossbar consists of two logs or fiberglass, each resting on a vertical support pole of different heights. The lower bar is 1.61 m to 1.70 m from the floor, while the upper beam is 2.41 m to 2 m., 50 m.

On a multilevel crossbar, the gymnast navigates two horizontal handles at different heights and a predetermined width, the gymnast performs swinging, turning, transitioning and releasing movements during the movement of the multilevel crossbar grip and ending with a dismount motion. The presentation of the exercise on a single crossbar and a multilevel bar must pay attention to the following matters: (1) The gymnast must start his training by doing kip which is an initial step performed by the gymnast. Motion assessment begins when the gymnast moves to kip on the handle of a single bar or a graduated bar. (2) The gymnast must enter the composition of requirements in the code of points artistic gymnastics which is carried out by the gymnast with full safety and with a high degree of aesthetic and technical mastery according to the ability of their respective athletes. It is hoped that this single and multilevel bar can also improve the movement skills of the tool. With the development of a multipurpose training tool for artistic gymnastics on a single crossbar and a multilevel bar, it is hoped that athletes, coaches and coaches will be more active in making various training models, so that through the development model of developing multipurpose training tools for artistic gymnastics on single bars and bars multilevel can be increased and can create various kinds of model development tools that can be used with minimal facilities and can improve the skills of athletes in accordance with the expected goals. The product model developed by the researcher as an alternative training facility in the form of a multipurpose training tool for artistic gymnastics is based on a needs analysis and existing equipment specifications, namely the AAI brand for single bars and the Gymnova brand for multilevel bars.

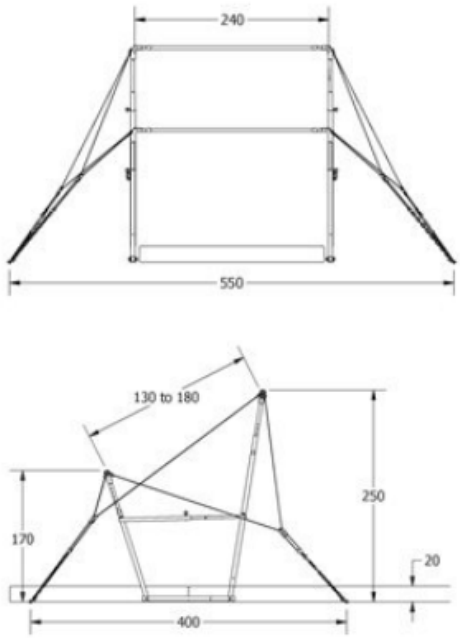

Figure 2. Multilevel Cross

The product specifications for the development of a multipurpose training tool for artistic gymnastics developed by researchers can be seen in the table below: Table 1. Specifications for the development of a multi-purpose training tool for artistic gymnastics on the single-bar and multilevel bars.

No.	Standard Tools	Tools developed
1		
2		

Figure 3. The design of the multilevel crossbeam tool

The image above is an initial design as a tool design that will be developed by the researcher, assuming the tool can be used for single crossbar and multilevel bars with an alternate use model, this is a design to accommodate the size of the hall which is limited in size, so that the design of the tool is designed to be used multipurpose and at the same time to overcome the limited size of the existing hall, with the specifications of the materials used as follows:

Figure 4. Design of the single crossbar tool

Table 6. Material Specifications for the Development of Multipurpose Training Tools for Artistic Gymnastics

No	Material	*Uneven Bars* Standard	*Uneven Bars* Developed
1	High support pole pipe diameter	5,5 cm	62 cm
2	Plate press thickness diameter	6 mm	6 mm
3	The length of the base construction of the press	1,2 m	2 m
4	The width of the basic construction plate press	-	2,54 m
5	Pipe quill diameter	4,3 cm	5 cm
6	Stabilizer Pipe	4,3 cm	
7	High bar height	2,45 up to 2,5 m	2,45 up to 2,5 m
8	Low bar height	1,5 m up to 1,70 m	1,5 m up to 1,70 m
9	Handle diameter of uneven bars	4,1 cm	4,1 cm
10	Stabilizer cable diameter	5,5 mm	Do not use stabilizer cables

With the development of a multipurpose training tool for artistic gymnastics on a single crossbar and a multilevel bar, athletes can do exercises when it rains, because these tools can be installed in buildings without using stakes which require a large area. Optimized kip performance on single bar. The characteristics of a simple goal-directed task, such as a grabbing hand gesture, have been well studied from the perspective of optimization principles. However, it remains unclear what characteristics or control mechanisms of these movements are shared with the movements more generally, (Yamasaki, Gotoh, & Xin, 2010). This paper focuses on gymnastic maneuvers on a single bar, referred to as a kip movement. The kip movements of the expert gymnasts are represented only by the three-link planar model, and attempt to be reproduced under three optimization criteria: the minimum angle criterion; reported minimum torque change criteria to describe multiple joint reach motion; and minimum effort criteria. Numerical analysis shows that 1. there is no criterion which considers that only the starting and ending points can reproduce the measured movements of the gymnast; however, 2. the minimum torque change criterion which assumes a starting and ending point, and the corresponding points can almost reproduce the measured motion, which is the best predictor of the three criteria with the way-point. The results may indicate that the reach of the hand and certain parts of the kip motion share a general characteristic roughly explained by the minimum torque change criterion.

Effect of optimization constraint on multilevel crossbar on dismount swing simulation in the research of Sheets AL and Hubbard M. Simulation of forward motion dynamics of multilevel crossbar on dismount swing preparation is optimized for observing errors in multilevel crossbar grip before dropping at dismount. Optimization constraints are classified as 1-anatomical/ physiological; limiting the maximum hand strength on the crossbar grip before dismount, maximum joint range of motion and torque, muscle activation/deactivation time and 2 geometrics; avoids low-bar contact, and requires minimum landing distance. The gymnast model includes the torso/head, arm, and two leg segments connected by a loop, compliant shoulders, and a frictionless ball-and-socket hip joint. Maximum shoulder and hip torque is measured as a function of joint angle and angular velocity. Movement is driven by maximum torsion scaling with a joint torsion activation function of time that approaches the mean activation of all muscles crossing the joint causing extension/flexion, or adduction/abduction. The force bar accelerates the center of mass while doing muscle work to flex/lengthen the joints, and increase the gymnast's mechanical energy. The optimal technique for generating angular momentum in the giant rear is accelerated before dismounting (Hiley & Yeadon, 2003). In men's artistic gymnastics numbers, the rear giant on a single bar is used to generate the angular momentum needed for the gymnast to dismount in a rotating manner. Mounting from where the gymnast is performing two cartwheels in a layout position (straight body) requires the greatest angular momentum. However, there appear to be two different techniques used by elite gymnasts when performing a giant circle of retarded before the two-round layout while dismounting. The "traditional" techniques have been replaced by those currently used

by the majority of elite gymnasts. To determine whether the scooped technique is better at generating angular momentum, a simulation model is used to optimize the angular momentum about the center of mass when released. The model was evaluated using data obtained from the video force analysis of an accelerated giant. Two optimals were found that are characteristic of the two giant circle techniques used by elite gymnasts. The traditional technique generates more angular momentum than the scoop technique although both techniques are capable of generating sufficient angular momentum for a layout of multiple dismount rotation. As a consequence, elite gymnast preference for scooped technique should be based on factors other than angular momentum production[21].

Determination of the dynamic elastic modulus of polymer materials under high strain loads using the Hopkinson technique (SHPB) of pressure on a stratified crossbar[22]. The associated factors, namely, the influence of the pressure imbalance in the specimen, the indentation of the stratified bar due to the specimen and the slope between the specimen and the stratified bar, are widely studied. The study of the crossbar material shows that for specimens the size of the specific elastic modulus and diameter of the size is very important for the degree of influence in this study. However, polymers with low modulus of elasticity can still be measured accurately regardless of the curvature shown. Numerical investigations of the tilt effect show that imperfect contact conditions greatly affect the accuracy of the measured modulus of elasticity. This problem can be fixed by the newly proposed vertical SHPB. This can significantly improve the contact conditions between the rod and the specimen and offer an acceptable accurate measurement of the dynamic elastic modulus of the polymer material. Measurement of dynamic force on a single bar using 3D motion capture[23]. The calibrated single-bar displacement is used as a measure for the force acting on the single bar itself during a dynamic gymnast look in artistic gymnastics. A single bar is loaded with a known force and the displacement is observed using the Vicon motion observation system. The calibration results are installed according to EulerBernoulli's beam theory. After calibration, the force can be directly measured by multiplying the displacement of a single bar with the specified fit parameter. This approach can also take into account the application of non-central force (two hands on the handle of a single bar) and the effect of single-bar inertia. The uncertainty in the measured strength was assessed plus an additional 1% for the unknown weight distribution between the hands.

Conclusion

With the development of a multipurpose training tool for artistic gymnastics on a single crossbar and a multilevel crossbar, athletes can exercise when it rains, because these tools can be installed in buildings without using stakes which require a large area. Optimization of kip performance on the bars single .. Numerical analysis shows that 1 there is no criterion which considers only the starting and ending points that can reproduce the measured movements of the gymnast; however, 2. the minimum torque change criterion which assumes a starting and ending point, and the corresponding points can almost reproduce the measured motion, which is the best predictor of the three criteria with the way-point. The results may indicate that the reach of the hand and certain parts of the kip motion share a general characteristic roughly explained by the minimum torque change criterion. Optimization constraints are classified as 1-anatomical/physiological; limiting the maximum hand strength on the crossbar grip before dismount, maximum joint range of motion and torque, muscle activation/deactivation time and 2 geometries; avoids low-bar contact, and requires minimum landing distance. The gymnast model includes the torso/head, arm, and two leg segments connected by a loop, compliant shoulders, and a frictionless ball-and-socket hip joint. Maximum shoulder and hip torque is measured as a function of joint angle and angular velocity. Movement is driven by maximum torsion scaling with a joint torsion activation function of time that approaches the mean activation of all muscles crossing the joint causing extension/flexion, or adduction/abduction. The force bar accelerates the center of mass while doing muscle work to flex/lengthen the joints, and increase the gymnast's mechanical energy. Therefore, the stratified bar constraints and forces inherently limit the performance by limiting the ability to carry out movement and reducing the energy of the system when releasing the grip on the multilevel bars. The calibration results are fitted according to EulerBernoulli's beam theory. After calibration, the force can be directly measured by multiplying the displacement of a single bar with the specified fit parameter. This approach can also take into account the application of non-central force (two hands on the handle of a single bar) and the effect of single-bar inertia. The uncertainty in the measured strength was

assessed plus an additional 1% for the unknown weight distribution between the hands.

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