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COMPARATIVE ANALYSIS OF WRESTLING BRIDGE STATIC STRENGTH ENDURANCE

(Research note)

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Abstract

The objective of this study is to compare the predicted maximum sustainability force in position wrestling bridge and an experimental study data, and assess the applicability of the model in weight grades for both styles of sports wrestling. Subject of the study were 123 wrestlers, between 17 and 19 years old, free-style and Greco-Roman wrestling, selected from the representative teams of the country's leading sports clubs. The maximum force of sustainability in position wrestling bridge was registered for all persons. Tests used specially designed force platform. The external load on the bridge is carried by a belt across the chest of the wrestler, as applied effort is over the maximum, isometric and is directed at an angle about 60 degrees. Registered are also kinematics' parameters defining the configuration of the wrestling bridge. Experimentally it was found that the angles defining the wrestling bridge configuration, do not differ significantly in weight categories for both styles of wrestling and their average values are in degrees $\alpha = 73 \pm 3$, $\beta = 81 \pm 3$ *and* $\gamma = 48 \pm 4$. *To calculate the estimated maximum static force on the wrestling bridge it was used a simplified mechanical model. The comparison is shown as percentage difference between the two values. The difference between the calculated and experimental values for the two wrestling styles is less than 3%. This is a very good attestation of the estimated capabilities of the proposed model, considering that it comes to test results and outlines its applicability to all weight categories of free and classic wrestling style.*

Keywords: *biomechanics, sports wrestling, free-style and Greco-Roman wrestling, static stability, dynamo graphics platform, kinematics' parameters muscle strength, modeling, kinematics' parameters, kinesiology experiment, percentage*

INTRODUCTION

The development of sports wrestling is characterized by exceptional dynamics and noticeable dependence of the sport results on the science and rational understanding of teaching experience. Wrestling bouts are becoming more intense and saturated with numerous technical and positional variants of interaction between the wrestlers. The new competitive rules encourage more frequent use of the wrestling bridge as part of the most beautiful attacking bouts and as a universal means of protection and counterattack.

Although wrestling bridge is one of the most important components of classical and freestyle wrestling, it has not been enough studied. The main researches are focused on its role in combating, on the configurable parameters and methods of training, as equals with acrobatic exercises (Angelov (Ангелов), 2010). This is insufficient, since in the implementation of a large number of grips and protections, wrestling bridge is submitted to large force load, and practice shows that the efficiency of wrestling bridge depends too much on its force endurance. Wrestler in the wrestling bridge position has to overcome muscle effort and the pressure of the body of his opponent. Successful defense depends on the technical skill of the fighter caught in a critical situation and the stability of the wrestling bridge.

Considering the above facts and the importance of this sports technique, we decided to use two independent approaches for investigating the problem. We performed *experimental quantitative surveys* of the structure and functional strength limits in modeled situations of wrestling bridge. Registration was made by a specially designed equipment and methodology (Stanchev (Станчев), 1999).

In addition, we proposed adequate biomechanical and mathematical model to quantify the strength endurance of wrestling bridge, including calculation of the maximum static strength endurance of wrestling bridge at a certain configuration and external load of the bridge.

The objective of this study is to compare the results of the two approaches and assess the applicability of the model in weight grades for both styles of sports wrestling. The predicted maximum sustainability force in position wrestling bridge is compared to an experimental study data.

METHODS

Subject of the study were 123 wrestlers, between 17 and 19 years old, free-style and Greco-Roman wrestling, selected from the representative teams of the country's leading sports clubs. The maximum force of sustainability in position wrestling bridge was registered for all persons. Tests used specially designed force platform.

The external load on the bridge is carried by a belt across the chest of the wrestler, connected on the back with wire rope through a hole in the platform. The end of the rope is connected to a rod system for changing the applied force on the rope, which is measured by load cells transducer. Applied effort is over the maximum, isometric and is directed at an angle about 60 degrees.

Registered are also parameters defining the configuration of the wrestling bridge - height H, length $2L$, angle α between the axis of the lower leg and the horizontal axis, angle β between the axis of the lower leg, and thigh angle γ between the horizontal axis and tangent to the back. The wrestling bridge is schematically represented in Figure1. The scheme shows the configuration parameters, the competitor's weight force F_P, and load force F_Q. F_R force is the calculated resultant force by the action of F_P and F_Q, F_{Rx} and F_{Ry} are components of the resultant force, respectively in horizontal and vertical direction. The distance d is determined by the application point of the resultant force F_R, and the angle φ is determined by the direction of the action of external load.

Experimentally it was found that the angles α, β and γ, defining the wrestling bridge configuration, do not differ significantly in weight categories for both styles of wrestling and their average values are in degrees $\alpha = 73 \pm 3$, $\beta = 81 \pm 3$ and $\gamma = 48 \pm 4$.

Following this result, according to Arakchiyski (Аракчийски) (2013) it was used a simplified mechanical model of wrestling bridge shown in Figure 2.

This model allows us to calculate the force reactions in moving joints A, B, and C under certain configuration parameters H and $2L$, external load forces F_P and F_Q, the distance d and the angle φ of action of the resultant

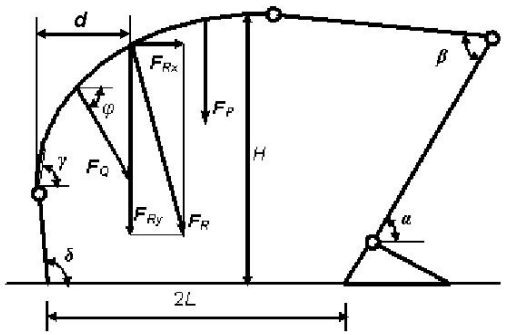

Figure 1. Scheme of the wrestling bridge configuration, including major joint nodes and parameters

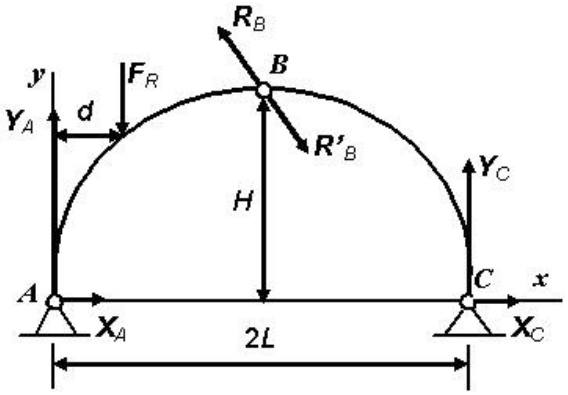

Figure 2. Mechanical model of "wrestling bridge" in the sagittal plane

external force. Thus we can reach important conclusions about the influence of the bridge parameters on its configuration sustainability.

To quantify the hinge force reactions is obtained the following equation

$$X_A = -X_C - F_{Rx} \tag{1}$$

$$X_C = -F_{Ry}\, d / 2H - F_{Rx} \tag{2}$$

$$Y_C = F_{Ry}\, d / 2L \tag{3}$$

$$Y_A = F_{Ry} - Y_C = (1 - d / 2L)\, F_{Ry} \tag{4}$$

The theoretical analysis of the equations elicits some typical relationships and dependencies between the force structure and the wrestling bridge configuration.

The force reactions of the supports in the horizontal direction X_A and X_C have opposite signs and are targeted in the direction away from the supports and destruction of the bridge. It is evident, that there is a collecting force that protects the bridge from a deformation, which is opposed to force reactions in the horizontal direction and spacing of the supports. The role of such a stabilizing force holding the bridge is played mainly by the powerful muscles of the torso and legs, in which case the mode of their muscle activity is isotonic and isometric.

The analysis of the equations shows the influence of the configuration parameters of the bridge H, $2L$, the distance d and the angle φ on the values of the support reaction forces.

Based on these relationships, the model is used to calculate the estimated maximum static force on the wrestling bridge, which was compared with experimental data.

RESULTS

The use of the model is related to the presence of certain data input.

For the purposes of this study, we use the experimentally obtained data for static torso strength

Table 1. Maximum static force of bridge wrestling sustainability – freestyle wrestling

Weight categories [kg]	Ftorso [kg]	Flegs [kg]	2L [m]	H [m]	Fs_{max} [kg]	Fs_{max} model [kg]	% difference Fs_{max}
48	140	148	.61	.33	79	79.4	.5
52	153	165	.58	.36	92	92.0	.0
57	157	171	.61	.37	97	94.6	-2.4
62	160	178	.63	.37	99	97.9	-1.1
68	165	183	.62	.39	101	102.1	1.1
74	167	182	.68	.39	98	99.3	1.3
82	185	196	.67	.42	110	110.5	.4
90	195	208	.72	.39	115	115.3	.2
100	190	207	.72	.40	115	114.1	-.8
to 130	204	230	.73	.41	125	127.8	2.2

Table 2. Maximum static force of bridge wrestling sustainability – classic style wrestling

Weight categories [kg]	Ftorso [kg]	Flegs [kg]	2L [m]	H [m]	Fs_{max} [kg]	Fs_{max} model [kg]	% difference Fs_{max}
48	142	150	.59	.35	80	80.7	.9
52	146	151	.60	.36	80	81.7	2.1
57	162	168	.63	.37	93	91.6	-1.5
62	169	174	.65	.38	95	95.1	.1
68	185	191	.64	.37	108	106.3	-1.6
74	188	193	.65	.38	109	107.6	-1.3
82	193	207	.71	.39	113	113.0	.0
90	195	202	.71	.40	112	111.1	-.8
100	205	232	.72	.41	125	127.5	2.0
to 130	208	225	.74	.39	121	122.9	1.6

Ftorso, static legs strength *Flegs*, the wrestling bridg length *2L* and wrestling bridge height *H*. The calculations assume values of $d = 2L / 4$ and $\varphi = 60$ °, which are most close to the experimental design. Calculated maximum static force of wrestling bridge sustainability of the model (*Fsmax model*) was compared with experimentally obtained maximum static force of wrestling bridge sustainability *Fsmax*.

The results obtained by weight category are shown in Table 1 for freestyle and Table 2 for classic style.

The comparison between the calculated and experimental value of the maximum static force of wrestling bridge sustainability for both styles is shown as percentage difference between the two values.

DISCUSSION AND CONCLUSIONS

Firstly, it is important to note that the difference between the calculated and experimental values for the two wrestling styles is less than 3%. This is a very good attestation of the estimated capabilities of the proposed model, considering that it comes to test results and outlines its applicability to all weight categories of free and classic wrestling style.

In actual testing of maximum static force of wrestling bridge sustainability, experimental results show that athletes in classical style wrestling have slightly better performance. The nature of freestyle wrestling implies greater "flexibility reserve" and less standardization of performance. The high sustainability of the bridge in classic wrestling derives from its frequent stereotypical use. Values calculated from the model reported that differentiation between styles through the smaller in absolute value maximum percentage differences in classic style to freestyle. But it should be noted that the wrestlers with very large "reserve" flexibility are physically weaker. As mentioned above, in modern wrestling all competitors have similar configurations on the wrestling bridge. Taking into account that the main parameter of the wrestling bridge is possible higher value of the endurance force, our study indicated that the small configuration variability leads to the conclusion that the stability of currently wrestling bridge mainly depends on the force parameters.

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