DYNAMOMETRIC MEASURING PROCEDURES FOR HORIZONTAL BAR AND UNEVEN BARS

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INTRODUCTION

Dynamometric measuring procedures for gymnastics apparatuses are applied to analyse sports technique, to determine load effects on female and male gymnasts and to optimise gymnastics apparatuses. In studies on sports technique dynamometric procedures are mostly applied in combination with kinemetric procedures, especially with photogrammetric procedures.

Dynamometers are developed for horizontal bar and uneven bars, which are integrated in measuring units (Figure 1). The dynamometers are installed to original gymnastic apparatuses. The lab-stadium (Bauer 1976) of the investigations should get over and the realistic conditions in training and competition are to consider, e. g. change of the gripping point on the bar, variable chain tension and stake position.

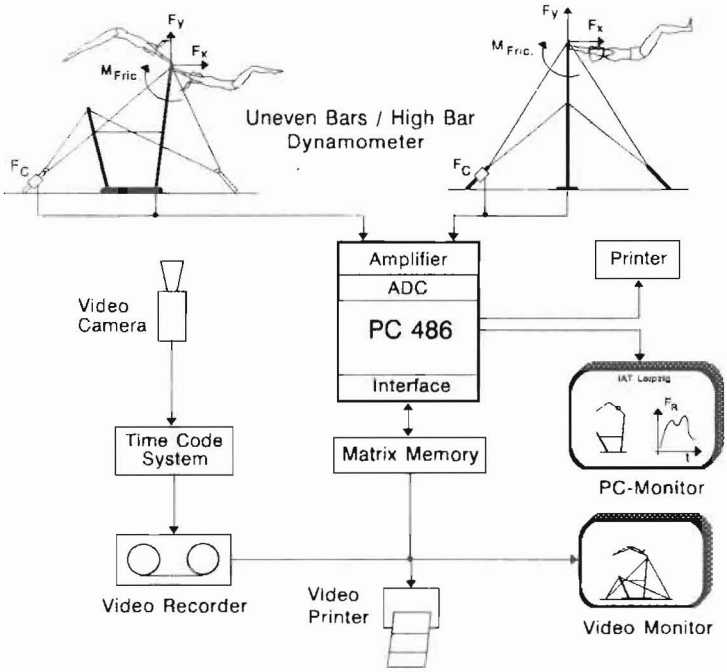

Figure 1: Measuring unit for uneven bars/horizontal bar

RESULTS

According to the principle of electric strain measurement reaction fores on horizontal bar and uneven bars are determined in vertical as well as in horizontal

direction. Using the same measuring principles the torque caused by hand friction was monitored. These measurements do not depend on the working point of the force, because the strain gauges are applied on both ends of the bar (Figure 2). The bearing of the bar is original.

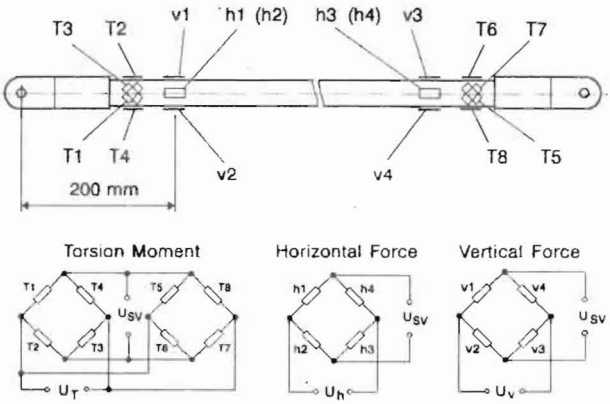

Figure 2: Arrangement of the strain gauges

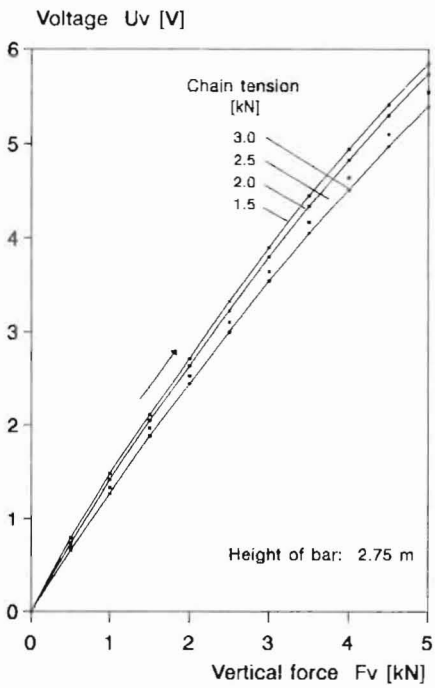

Figure 3: Calibration curves in vertical directions with increasing load and different chain tension

In this measuring system the measurement voltage U is influenced by guy strain strength F_c (chain tension). Therefore the guy strain strength must be known with its initial value. It is monitored by a tractive force transducer which is part of the guy wire. The calibration of the dynamometers are realized statically with a special device in vertical and horizontal direction. The calculated calibration curves (force as a function of measuring voltage) are non-linear in the upper loading range (Figure 3 exemplary with the calibration curves in vertical direction).

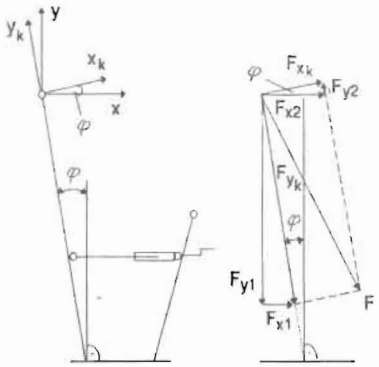

Figure 4: Components of force on the bar

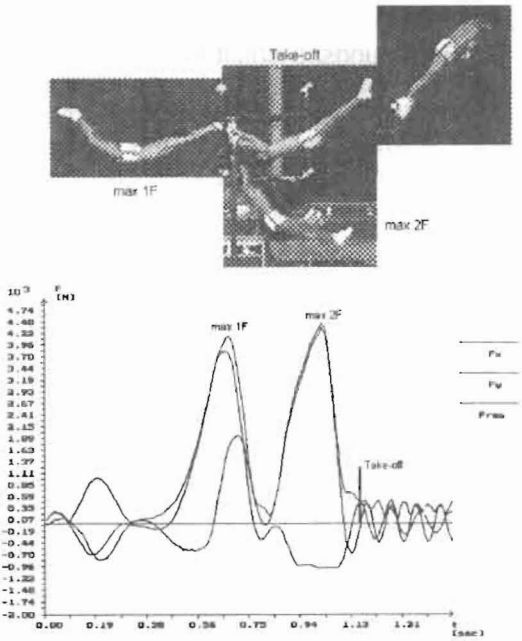

Figure 5: Dynamogram of a preparing giant swing backward to a double salto backward with 3 twist

CONCLUSIONS

Based on the principle of electric strain measurement and intruding an optimal number of strain ganges accurate dynamometers for the horizontal bar and the uneven bars have been developed. Different strain forces and non-linear calibration graphes have been taken into account. Both dynamomenters have been used already at World- an European championships with confirmation of the FIG and UEG (Knoll, Krug & Wagner 1993). The measurements unit with the dynamometers in connection with synchronised video recordings are suitabled excellent for the technique training including feedback information. This based on the fast provision of the information.

The measured reaction forces are the basic for the design engineer optimizing the gymnastic apparatuses. The reaction forces and the torques based on the hand friction are used for validation of the mathematical-physical models for simulation of the movements (Auspurg 1989, Arampatzis 1995, Knauf 1985). Compared with kinemetric procedures (details of the bar of 3D-procedures) the measurement of the dynamic of the horizontal or uneven bar is much more exact.

REFERENCES

Arampatzis, A. (1995). Mathematische Modellierung zur Überprüfung und Identifikation von Bewegungslösungen im Kunstturnen - angewandt auf die Riesenfelgen am Reck (Mathematical modelling for revisal and identificatin of the solution for movement taskes in gymnastics - used at the giant swings on the horizontal bar). Köln: Sport und Buch Strauß.

Auspurg, D. (1989). Modellierung und Simulation von vorbereitenden Bewegungsabschnitten und Elementen mit Flugphase an Reck und Stufenbarren als ein Beitrag für die Erarbeitung sporttechnischer Lösungsverfahren im Gerätturnen (Modelling and simulation of the preparing movements and elements with air-borne phase on the horizontal bar and uneven bars - a contribution for the acquiring of the techniques in gymnastics). Unpublished dissertation. Forschungsinstitut für Körperkultur und Sport, Leipzig.

Bauer, W.L. (1976). Einsatz von Dehnungsmeßstreifen zur Untersuchung von Lernvorgängen bei Turnübungen am Reck (The using of the strain gauges for the learning-process in gymnastics exercises on horizotal bar). Hottinger, Meßtechnische Briefe, 12(2).

Dimova, C., Jordanov, N., Tisinov, O. & Andonov, K. (1985). Videocompjuterna Sistema za Registracija i Analiz na gimnasticeski Upraznenija na Visilka (Video computer system for the recording and analyse of the gymnastic exercises on the horizontal bar). Vupr. fiz. Kult., 30(12), 11-19.

Hay, J.G., Putnam, C.A. & Wilson, B.D. (1979). Forces exerted during exercises on the uneven bars. Med. Sci. Sports, Madison (Wisc.), 11(2), 123-130.

Ilieva, S. & Dimova, C. (1988). Kompjuteren analiz na njakoi upraznenja na smesena usporedka (Computer analyse of several gymnastic execises on the uneven bars). Tren'orska Misul, 22(12), 11-14.

Jihong, B. (1990). A study of giant swing techniques on the uneven bars. Sports Sci., Beijing, 10(4), 58-62.

Knauf, M. (1986). Biomechanische Modellierung und Bewegungssimulation mit Hilfe von Gliederketten unter Berücksichtigung elastischer Widerlager - ein Beitrag zur Weiterentwicklung der Modellmethode in der Biomechanik (Biomechanical modelling and movement simulation using of chain limb links considering of the elastic support - a contribution of the further development of the model method in biomechanics). Unpublished habilitation, Forschungsinstitut für Körperkultur und Sport, Leipzig.

Knoll, K. (1995). Optimierung der Sporttechnik und Entwicklung von biomechanischen und ingenieurtechnischen Verfahren - dargestellt am Beispiel des Gerätturnens (optimization of the sport techniques and development of the biomechanical and engineering technique procedure - presented on the example of the gymnastics). Unpublished habilitation, Martin-Luther-Universität Halle-Wittenberg.

Knoll, K., Krug, J. & Wagner, R. (1993). Biomechanische Sofortanalysen am Reck und Stufenbarren (Immediate biomechanical analysis on the horizotal bar and uneven bars). Leistungssport, 23(4), 41-45.

Kopp, P.M. & Reid, J.G. (1980). A force and torque analysis of giant swings on the horizontal bar. Canad. Journal appl. Sport Sci., Windsor (Ontario), 5(2), 98-102.

Vasil'cuk, A.L., Dzafarov, M.A. & Zajdel', B.M. (1986). Ustrojstvo, registrirujuscee usilija, prilagaemnye k zerdjam brus'ev raznoj vysoty (Apparatus for the recording of the force on the uneven bars). Teorija i Praktika fiziceskoj Kul'tury, 46(6), 51-53.