The hysteresis loop of forces on the stretcher in a scull boat

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Abstract

Horizontal and vertical forces on the stretcher were measured during scull rowing. The hysteresis loop on coordinates of horizontal and vertical forces was made with these measured values. The pattern of the hysteresis loop is characteristic of the rowing performance synthetically. The hyteresis loop is useful for rowing training.

KEY WORDS: *rowing, scull boat, forces on the stretcher, hysteresis loop.*

Introduction

An awareness of the forces on the stretcher is a matter of great importance for rowing. In a rowing tank, these forces have been measured[1]. We measured these forces during rowing in a scull boat. With these obtained values, the hysteresis loop on coordinates of horizontal and vertical forces on the stretcher was made.

Equation

Ignoring the reaction force of the sliding seat and the force of air resistance, the following equation of forces in the direction of boat's movement can be written.

$$F_s(t) = F_h(t) - F_r(t)$$

where $F_s(t)$ is the force on the stretcher, $F_h(t)$ is the force of the oar-handle, and $F_r(t)$ is the force from the rower's body. The rowing performance is shown in the force on the stretcher.

Measurements and results

The rower was a 19 year-old female. Her body weight was 55.25kg. She had been rowing for 6 years. The stretcher was constructed with 4 load cells on the body of the boat. The output voltage of these load cells was amplified. Amplified voltages were converted with an A/D converter. Digital signals were connected to the 486 CPU (100MHz)board. Measurements were made at 30Hz. Obtained horizontal forces, vertical forces, and total forces for a single stroke are shown in Fig.1. The hysteresis loop for a single stroke is shown in Fig.2. In this figure, a stroke starts at catch point c and runs in the direction of the arrows on the curve, vector F shows the total force on the stretcher at one time, o denotes the origin, and θ denotes the angle of the vector to the vertical line.

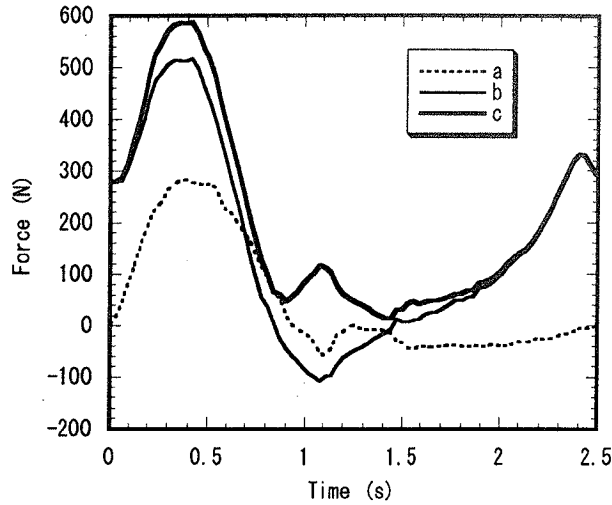*鹿屋体育大学 National Institute of Fitness and Sports in Kanoya, Kagoshima, Japan.

Fig.1. Forces on the stretcher. a,horizontal; b,vertical; c,total.
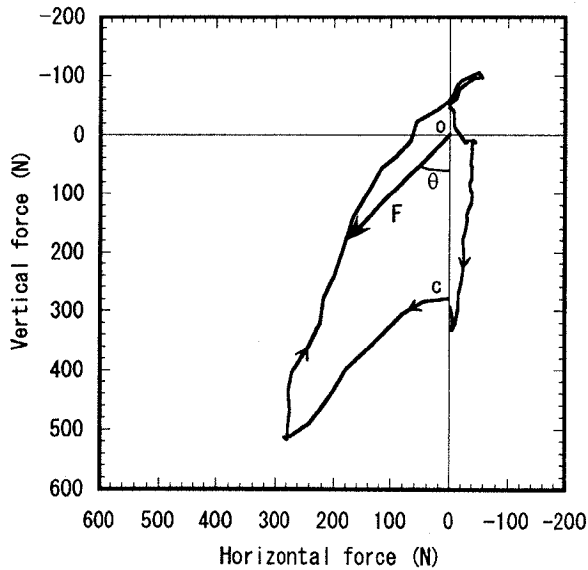

Fig.2. The hysteresis loop of forces on the stretcher.

Discussion and conclusion

The left side line of the horizontal axis of the hysteresis loop is in the drive phase and the right side line is in the recovery phase. We can read the line in detail at need.　In rowing, the boat speed depends effectively on the horizontal force on the stretcher.　The oar-handling, however, compels the

rower to generate the vertical force on the stretcher. The hysteresis loop shows the horizontal and vertical components clearly. The total force on the stretcher and the angle of this force to the vertical line at one time are obtained easily from this hysteresis loop. The hysteresis loop suggests the acceptable stretcher angle and the position of the shoes on the stretcher. The pattern of the hysteresis loop is characteristic of the rowing performance synthetically.

Horizontal and vertical forces on the stretcher were measured during scull rowing. The hysteresis loop on the coordinates of horizontal and vertical forces was made with these measured values. The hysteresis loop is useful for rowing training.

References

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スカルボート上のストレッチャーへの力のヒステリシスループ

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要約

　スカルボート上のストレッチャーへの水平および垂直方向の力が測定された。これらの測定値から、水平および垂直座標上に1ストロークのヒステリシスループを作成した。求められたヒステリシスループは漕動作の特性を総合的に表している。このヒステリシスループは漕法のトレーニングに有効である。

KEY WORDS: rowing, scull boat, forces to the stretcher, hysteresis loop.