UDC 51-77

Mathematics of sailing racing

***Zhou Meina**, student of gr. 51313124*
Belarusian National Technical University, Minsk, Belarus
Phd., associate professor Hundzina M.

Mathematical ideas and methods have become increasingly used in sports. The number of sports, directions and methods, and the number of researchers using these methods in their scientific and applied work, is rapidly increasing year by year. The use of mathematical models makes it possible to minimize the coaching practice of trial and error and makes it possible to conduct experiments not on the athlete himself, but on his mathematical model, calculating the most acceptable training and recovery modes. At the same time, athletic performance naturally increases, and the risk of overtraining and sports injuries decreases. This solves the problem of maintaining the athlete's health and athletic longevity.

We know a mathematical theory for the generation of forward drive force and sideway heeling force from the combined action of the sail and keel of a sailing boat under tacking against the wind.

Safety issues when ships are moving in conditions of wind and wave disturbances are very important and can have serious consequences. Failure to follow the recommendations and rules can lead to accidents, loss of life and material losses. Therefore, it is necessary to pay sufficient attention to stabilization methods that reduce fluctuations and reduce the risk of overturning. The constant influence of external factors such as wind, current, and sea waves on the movement of the vessel leads to the emergence of hydroaerodynamic forces and moments that form wind-wave disturbances. Wind and waves can affect the maneuverability of a vessel, especially when performing maneuvering operations such as turns and stops. One of the ways to study the effect of wind wave disturbances on ship dynamics is to take into account the relationships between wave parameters and power and moment characteristics in a mathematical model of ship motion.

Shallow water leads to an increase in disturbing forces and moment on long waves and a decrease on short ones. When moving in rough seas, forces and moments act on the vessel in the horizontal plane, which cause a deviation from the set trajectory, which leads to the need to make adjustments when setting the ship's course. The calculation of the vessel's speed, taking into account the waves, is calculated using the P.M. Khokhlov formula. With wind and waves, the vessel experiences additional resistance to its movement, which leads to a loss of speed and, as a result, to an increase in the duration of navigation. The universal Khokhlov formula is used to determine the numerical values of wind-wave losses of the vessel's speed:

$$V = V_0 – (0.745·h– 0.275·q_h·h) (1 -1.35\ 10^{-6}DV_0),$$

where *V* - the speed of the vessel in the swell;

V_0 - the speed of the vessel in still water;

h - wave height;

q_h - the heading angle of the wave, converted to radians;

D - displacement of the vessel, t (selected from the initial data).

Using the above method, only the combined wind-wave speed losses are calculated. At the same time, it is assumed that at a certain wind speed, the corresponding wave height is observed, and the wind direction coincides with the direction of the wave (steady wave).

The formula is used to calculate the speed of the vessel V for each section of the route. On tracing paper, taking into account the scale of the map, the length of these sections S is measured in miles. The duration of the voyage, or the actual running time of the voyage t, is determined by simply summing t.

After calculating the running time of the voyage t, the date (number, year, hours, minutes) of the vessel's arrival at the port of destination is determined, and the duration of the voyage is compared taking into account the calculations performed.

This formula takes into account the influence of not only waves, but also wind on the movement of the vessel. It can be useful in designing vessels operating in conditions of strong winds and rough seas. In general, the use of such calculation formulas makes it possible to assess the impact of wind-wave disturbances on the movement of the vessel and take measures to ensure its safety and efficiency. It is known that the highest achievable travel speed, km/h, can be found by the formula:

$$V=C/(0.454D/N)^{\wedge}0.5,$$

where D – vessel displacement, kg;

N – installed engine power;

C – a coefficient that has a different value depending on the types of contours. For small recreational non-motorized skimmers C=113. For single-edged gliders, C= 130. For three-point racing gliders C=152.