

Research on Effects of Grounding Pressure Distribution of a Type of Seabed Tracked Vehicle on Traction Force

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ABSTRACT

The grounding pressure under the action of weight of the vehicle in water and the maximum grounding pressure under the supporting rolls were measured. 28 sensitive soil pressure transducers were evenly embedded in simulated soft seabed sediments 25cm below the crawlers. The results have shown that the measured values of grounding pressure are distributed in the form of hump curve. The maximum grounding pressure, 11.6kPa, occurred at about 3.7m point, which lay under 11th supporting roller. The effects of backward displacement of center of vehicle gravity and nonlinear distribution of grounding specific pressure of vehicle crawlers on the traction force of the vehicle were theoretically calculated. Optimization of grounding specific pressure distribution by varying numbers of support rollers as well as pitch of track plates was carried out to enhance adhesion performance and trafficability of deep seabed vehicle on soft sediments.

KEY WORDS: Soft sediments; Deep seabed tracked vehicle; Nominal grounding pressure; Average maximum grounding pressure; Traction performance

INTRODUCTION

Crawlers were made of a series of track plates connected with hinges. The hinges show flexibility so that the crawlers can adapt to the contour of the ground. However, the weight of the vehicle was transmitted to sediments via the supporting rollers to the crawlers. The supporting rollers cause concentrated load, which is called the maximum grounding pressure. The peak pressure occurring under track rollers was twice to thrice as high as nominal grounding pressure, or even higher, and the pressure between supporting rollers can be very low, or even close to zero. Thus, it was obviously inapplicable to use nominal grounding pressure to evaluate effects of vehicle on ground.

Tests of Schreiner (Schreiner, 1967) proved that vehicles with same nominal grounding pressure, but different pressure distributions have quite different trafficability performance on soft ground. According to Rowland (1972), average maximum grounding pressure (average value of the maximum pressure under all supporting rollers), is used to be a value for evaluation of trafficability of vehicle on soft sediments, instead of the nominal grounding pressure.

As we know there are two ways to obtain grounding pressure of the vehicle. One is the calculation of a mathematical model for theoretical prediction(Yang RY,1998; Ma RD et al., 2000) and the other is carrying out traveling tests(Rowland D,1972;Kogure K,1976). The former were numerical solutions for the equations of shearing force and bending moment of track plates. The later was tested by the soil pressure transducers embedded in soil. However, this predictive mathematical model related only to load on supporting rolls, track plate pitch, tension of hinges, driving force, traveling speed and time, it was independent of characteristics of physical mechanics of sediments, especially those of soft seabed sediments. The grounding pressure of the vehicle in the theoretical prediction therefore had a certain limit with respect to deep seabed soft sediments.

In this paper, the authors measured the grounding pressures with soil pressure transducers embedded in simulated soft sediments under a tracked vehicle, which was made by Ocean Mining Research Department of Changsha Institute of Mining Research. The average maximum grounding pressure was calculated and the function of grounding pressure distribution was obtained. Effects of grounding pressure on traction performance and trafficability of the vehicle were studied. Accordingly, measures of improvement were taken to optimize the design structure of the vehicle. The purpose of the study is to improve traction performance and trafficability of the vehicle on soft deep seabed sediment, perfect the design of the vehicle and help us develop a new type of tracked vehicle.

TESTS FOR MEASUREMENTS OF STATIC GROUNDING PRESSURE

Simulated Seabed Soft Sediments

Based on physical mechanics of soft deep seabed sediments in China's Pioneer Area in the Clarion-Clipperton Zone in the Pacific Ocean(Gao, 2001;Li, 2001; Yang et al., 2000), the soft deep seabed sediments were made up of clay and sludge type soil, in which the clay content was from 36.6% to 83.12%, and its inner friction angle was from 4.5 to 11.6 degrees and its shear strength 15cm below soil surface was from 3 to 6 kPa up to 12 kPa at a depth of 25cm. Consequently, the simulated soft seabed sediments for the tests conducted were made up of 50 percent of silt and 50 percent of sludge type soil, which was determined by many proportioning tests and shearing strength experiments in the past five years (Gao, 2007). The shear strength of simulated sediments had to be