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STRUCTURE DESIGN OF AN AMPHIBIOUS ICE-BROKEN VEHICLE

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Abstract: In the article, we introduce research of the ice run around world and related research and application of the ice-broken equipments. We present our design of amphibious ice-broken vehicle, and introduce the structure and its function in detailed.
Keywords: Ice-Broken Vehicle; Amphibious; Structure; Design.

1. Introduction

Now the research of ice runs are mostly performed in Canada and the United States and northern European countries. Canada's Albert University, United States army engineering division, cold and engineering and research institutions etc. make the research of the ice run cause, relief measures of the ice run, and a lot of experiments are conducted. The ice run research is mainly concerned on the below aspects: the ice run prediction and analysis; ice run model research; experiments of ice run ; the application of satellite remote sensing technology on ice run forecast; engineering measures of the ice run [1-3].

In 1973, Aleinikov applied the method of cutting ice to prevent ice jam and ice plug to prevent the adverse effects of the ice run on Siberian hydropower station. The river width is180 m, the cutting ice sheet in the river is performed one month before the break up date of the river [4]. And the equipments shown as Fig.1 and Fig.2 are adopted.

Finnish government and Mobimar company developed an amphibious ice-broken vehicle weighed eight 8ton with 168 Kw power, its circular saw can cut ice with thickness of 1.2 m, its speed is 0.5 km/h, within 8 hours it can accomplish the cutting task of 10 km long, 300 m

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wide ice sheet. Since the 1990s, it becomes the main method to prevent ice run in Finland [5-7], in 1996, it is applied in Finland nine rivers, and complete the task of cutting length 146 km. and the good effects are obtained.

Fig.1 Case 750 cutting machine

Fig. 2 Ditchwitch 1260 cutting machine

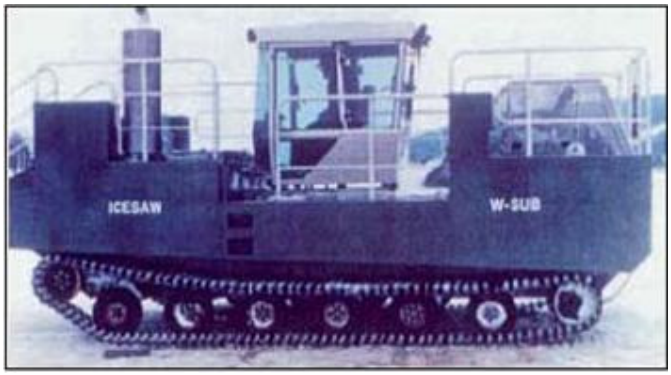

Fig.3 ICESAW amphibious ice-broken vehicle

In this paper, we introduce a design of an amphibious ice-Broken vehicle which can destroy the ice jam in the ice run. The working process of the ice-broken vehicle is as follows:

In the countercurrent direction, when we dug flow channel on the ice, the traction device of the vehicle are placed on ice, vehicle body parts are in water which can provide traction. When in downstream direction, water jet propulsion unit of the ice-broken vehicle can provide power to guarantee its traveling speed greater than or equal to 4m/s, when in the downstream direction we also can add the baffle in the vehicle in order to obtain greater water thrust; and the ice-broken also can produce waves to crush the ice.

2. Design of System

2.1 Design of Main Structure

The ice-broken vehicle body parts is made up of draft gear, ice saws, bladders, the airbag, the vehicle body, the robotic arm, the combination airbag and slide structure which are shown as Fig.4

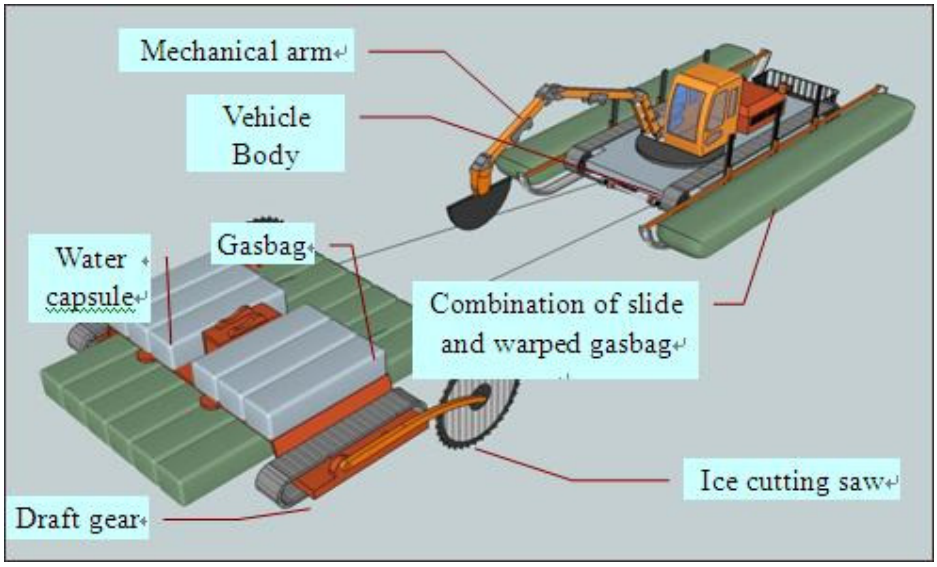

Fig.4 Main structure of the ice-broken vehicle

2.2 Body work

The bodywork is the structural support of ice-broken vehicle, it connects different parts of the vehicle, such as the power system, the robotic arm, combination of thruster operating, control room, sliding airbags combination, and the other auxiliary devices equipment and materials are also need to be carried.

The environment parameters of the vehicle are set as below: the waves were not more than 500mm, the flow rate is not greater than 3m/s.

Vehicle parameters are designed as follows, load capability is 8 tons, its weight 4 tons, the reserve buoyancy is about 2.4 tons. Long size is 6m, width is 3m, height is 3m, anteversion angle is 30 degrees, and caster angle is 60 degrees shown as Fig.5.

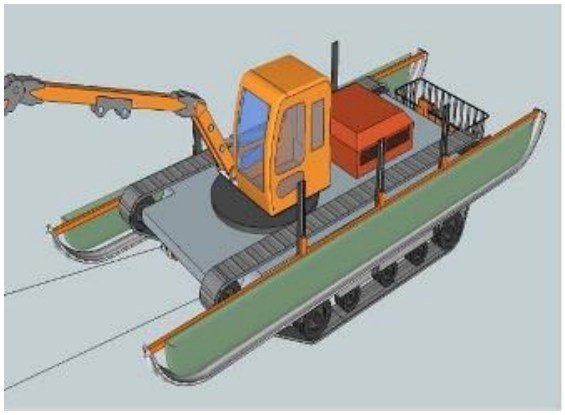

Fig.5 Diagram of body shape

Fig.6 Shape of water-jet

Power systems provide all the power for ice-broken vehicle, it provide the power to the components such as traction devices, ice cut saw group, waterjets, the robotic arm and other operating modules. In addition, the expected power of each device is designed in details.

2.3 **Operating of the thruster**

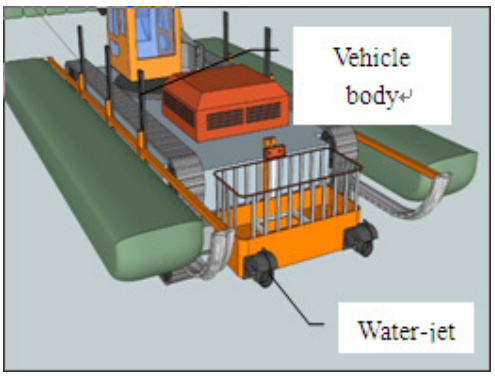

Fig.7 Installation diagram of slip parts and airbag

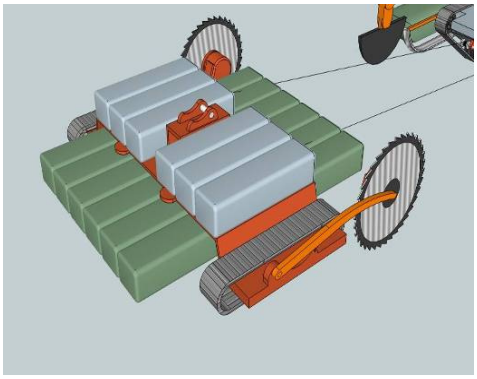

Fig.8 Schematic of traction device

Waterjets convert the power provided by the power system to the thrust force of the water, thus provide the power for the vehicle when it travels in the water. Its shape is shown as Fig. 6, its installation location is shown as Fig. 7.

2.4 Traction device

Main tasks of the draft gear are to provide traction for ice-broken operation vehicle; its power is provided by the power system. In order to ensure adequate grip force on the ice, we can adopt the method of water injection to increase vehicle weight; water injection is performed by the water jet propulsion; through water control valve of large diameter to achieve. The traction device is presented as in Fig.8.

The main parameters of the draft gear are set as below, traction is greater than 6 - 8 tons; obstacle crossing is greater than 1m; climbing angle is larger than 32 degrees; side slope is about 10 degrees.

2.5 Mechanical arm

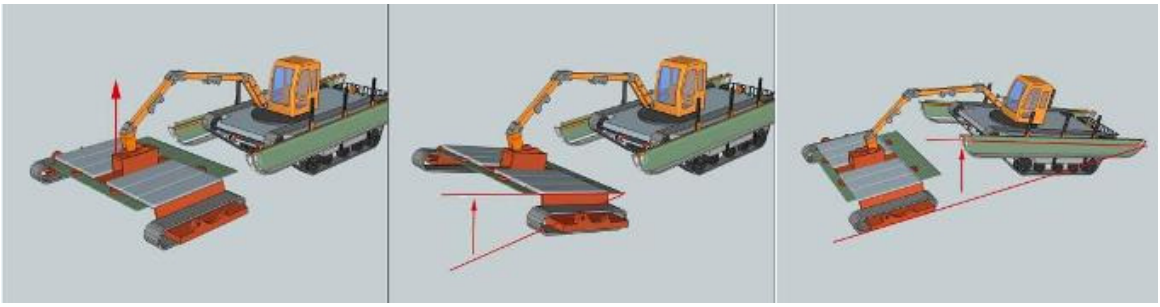

Fig.9 Schematic of Mechanical arm device

Main functions of the mechanical arm are as follows, It can provide the connection of traction part and the vehicle body; adjust the vehicle body posture, the auxiliary function in obstacle crossing; carry the operational part; part of the vehicle body gravity can be passed to the traction device thus increase grip traction on the ice, the working process as shown as Fig.9.

2.6 Auxiliary devices.

1. Auger and broken ax

As shown in the Fig.10, in order to weak the ice sheet. We can adopt the method of augering the hole on the ice, and the size and depth of the holes are different under different situations. Through this method, the efficiency of the ice-broken can be improved.

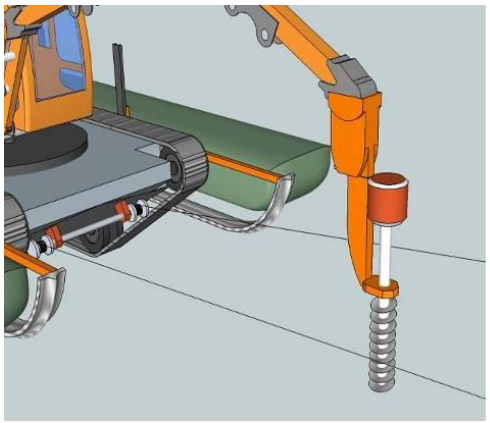

Fig.10 Diagram of auger outline and installation

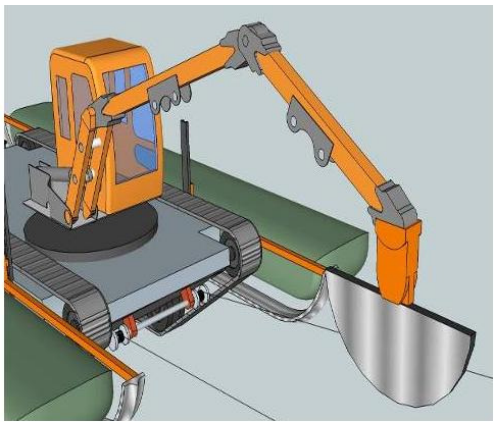

Fig.11 Diagram of broken ax

The main function of the crushing ax is to break the ice and get rid of obstacles. The crush ax and the auger can perform different function in the ice-broken process, and they can realize the interworking.

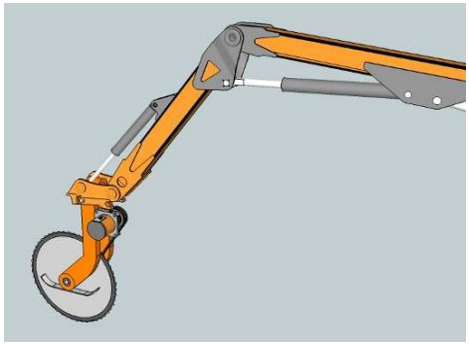

Fig.12 Cutting saws shape and installation diagram

2. Cut saws

Near the artificial structures such as bridges and culverts, the accumulation of ice may lead to the crushed ice jam. While in the process of getting rid of ice, in order to make part of ice as the buffer of impact from floating ice, it needs to keep the part of ice, the saw ice-broken method can protect artificial buildings and bridges. Therefore it should adopt the sawing method to implement controllable ice-crushing, Cutting saws is shown as Fig.12.

3. Working Process

The working process of the ice-broken vehicle are shown as Fig.13and Fig.14, first the we should make the working plan of ice-broken, according to the characteristics of the ice e.g., the width and depth of the ice ,and the strength of the ice as well. In the actual ice-broken process, different methods may be adopted in order to get the best effects of the ice-broken.

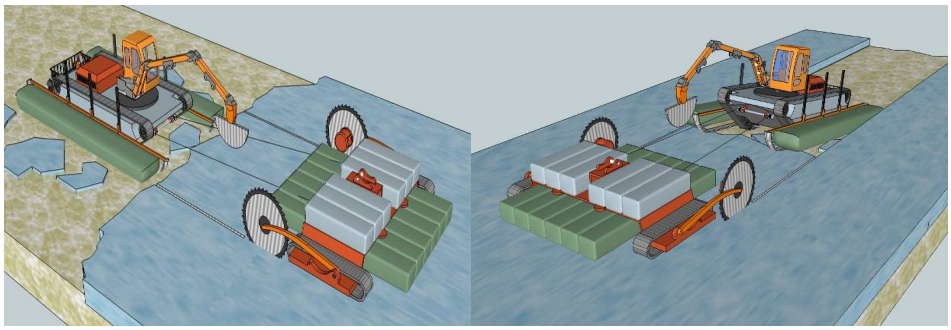

Fig.13 working process of the amphibious ice-broken vehicle

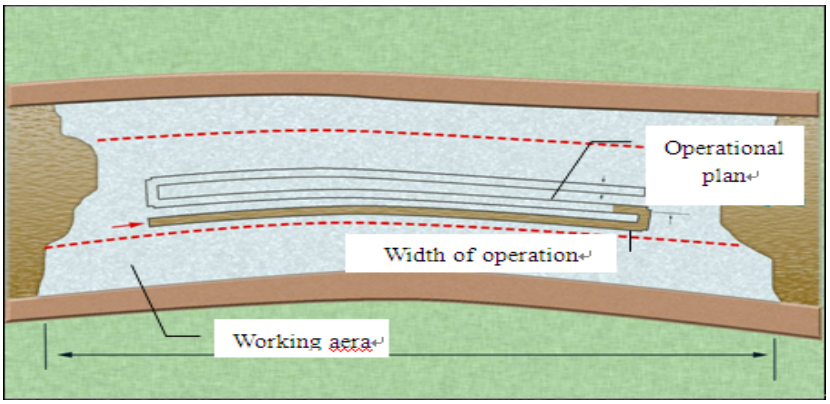

Fig.14 Diagram of the working process

4. Conclusion

In the paper, we present a design of the amphibious ice-broken vehicle, and give out the structure design in detailed; through the equipment we can deal with the ice run more initiatively, and can take the effective measurements to avoid the disasters produced by the ice run. It also has the reference value in the design of the amphibious ice-broken vehicle.

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