Research Status and Development Suggestions of High Mobility Multi-Functional Emergency Rescue Equipment

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Abstract. In this paper, the domestic and foreign research status of the emergency rescue equipment are analysed, combining with domestic existing typical development situation of emergency rescue. According to the contrastive analysis with overseas emergency rescue, the development bottleneck of China's emergency rescue equipment is presented, and emergency rescue equipment standard system in China is analyzed. After that, the high mobility multifunction emergency rescue equipment advance suggestions are proposed.

1. Introduction
China is in possession of frequent disasters such as fire, flood, snowstorm and earthquake. With the acceleration of urbanization, various types of sudden catastrophes have increased dramatically, and presented the characteristics of diversity and complexity, causing serious loss of life and property of the people [1]. Taking the year 2013 as an example, 69000 people died as a result of accidents and disasters in China, and the direct economic loss was 580.84 billion RMB, accounting for about 1% of GDP. Countries all over the world have paid great attention to the research and development of emergency rescue equipment while constantly improving the emergency rescue response mechanism. The level of emergency rescue equipment is one of the critical factors influencing the rescue effect. Comprehensive development of the world's developed countries emergency rescue equipment, especially some developed countries, the integration of all kinds of high-tech emergency rescue equipment emerge in endlessly. However, the technological level of disaster emergency rescue equipment in China is seriously lagging behind, with its single function, poor mobility, and low degree of specialization and a unified standard system of emergency rescue equipment has not yet been set up, which lead to the untimely and inefficient rescue and exacerbate the extent of the damage. At present, emergency rescue work including landslide clearing, road dredging, reinforced concrete breaking and cutting, rescue site cleaning and so on mainly depends on excavators, cranes and other construction machinery [2].

Engineering machinery plays a great role in the emergency rescue, but there are still some prominent problems: first, it has poor mobility. It is mainly transported by platform lorry, and it could not pass through the complex terrain in a narrow area; second, it has a single function. In order to carry out rescue, different machines are needed to work in turn, and various kinds of auxiliary equipment and personnel are also needed, which is easy to cause congestion, confusion, and low
rescue efficiency. Therefore, it is of great important and practically significant to carry out the research on the multifunctional emergency rescue equipment with high mobility and its standard system.

2. Research Status of Emergency Rescue Equipment

Foreign research on rescue technology and equipment starts at an early time. In the initial stage, most of the research results of typical engineering machinery and military engineering machinery are applied in the field of emergency rescue, and now a relatively complete emergency rescue equipment system has been established. The U.S. Sandia Lab has developed the Gemini-Scout rescue robot for coal mine rescue. In terms of mobility, the A770 multi-functional skip steer loader of American Bobcat Co. Ltd. has the functions of pivot steering and multi-functional operating device. The HMEE engineering vehicle of JCB Co. Ltd. for emergency rescue, with a maximum speed of 80km / h, has two sets of operational mechanism for digging and loading. By adopting the long stroke, adjustable coil spring, passive suspension technology of our company, passing ability of engineering vehicle of Benz Co. Ltd.is improved. In terms of multi-functions, Kaiser Co. Ltd. has promoted a variety of emergency rescue equipment, including demolition equipment and lifting equipment, with the function of quick change, which greatly improves the working efficiency. In the aspect of fire extinguishing with high efficiency, the main fire truck and fire truck with aerial ladder and high injection are designed and developed by American Hausche-Pierce Co. Ltd., which adopt special chassis, and have the functions of combined use of multi-type extinguishers, high injection, high fire extinguishing efficiency, various rescue functions and large flow rate of high injection volume. In term of a standard system, the International Organization for Standardization (ISO) and developed countries attaches great importance to the research on the standards of emergency rescue equipment. For example, the American Fire Protection Association, the British Standards Institute and the German Institute of Standardization all have released the related standard.

Although China starts the research of emergency rescue equipment relatively late, it has a rapid development in recent years and a series of researches have been carried out by related enterprises, universities and scientific research institutes. Shenyang institute of automation of the Chinese Academy of Sciences developed an earthquake rescue robot capable of searching debris surfaces and small gaps [4]. An earthquake rescue and relief robot developed by Jiangsu Bada Heavy Machinery co. LTD, is the world’s largest tonnage rescue robot, which can pick up 8t compact objects [5, 6]. Xuzhou construction machinery group Co. Ltd. has developed an ET110 walking excavator, with the functions of all-wheel drive, all-wheel steering, wheel leg composite and others so as to meet the various operation needs including excavation, lifting, crushing, drilling and other needs in mountain, woodland, wetland and other different terrains. It has been listed and installed by the troops. Our company has also successfully promoted multi-axle and heavy-duty chassis, with the functions of multi-axle steering, multi-bridge drive, oil and gas suspension, etc., which improve the vehicle's passing ability in complex terrain. In addition, its serialized and massive scale production has been realized. Our chassis types range from 5-axis to 9-axis, and its maximum driving speed is owned by 8km/h. A research group of Yanshan University has put forward the inertia control and suspension technology of vehicle, and developed the prototype model, which has improved ride comfort and control stability of the vehicle. The group in Jilin University also studied the chassis which can be self-adaptive to terrain, and improved the prototype model which has good cross-country performance. Rapid modular integration and flexible soft configuration technology of large-scale engineering equipment are studied in Tongji University as well, which has realized the rapid replacement of operational components and the reconfiguration of multi-task groups, and expanded the operational functions and improved the work efficiency. The key technologies including disaster information capture, early warning and rescue treatment are studied in China University of Mining and Technology, and the mine emergency rescue robot, firefighting drone and so on are developed to improve the ability to deal with unusual disasters. Xuzhou construction machinery group Co. Ltd has successfully developed a full series of 20 meters ~ 100 meters high lift fire engines, and its domestic market share exceeds 60%, which have become the largest production base of the high lift fire engines.
in China. Among our products, 80 meters high lift fire truck is the highest in the world, and 100 meters fire engine with high lifting platform is the first creation in China, reaching the international advanced level. As the fundamental unit of firefighting and emergency rescue equipment in China, Shanghai fire research institute of ministry of public security has revised many national / industry standards of firefighting industry, which has laid a foundation for the establishment of emergency rescue standard system in China. In addition, there are other domestic companies have carried out relevant research, such as Sany Heavy Industry Co. Ltd., Zoomlion Co. Ltd. and so on.

Construction machinery plays a huge role in the rescue and rescue, but there are still outstanding problems. First, mobile capability is poor, which is mainly transported by platform vehicles and cannot pass under the narrow and complex terrain. Second, the single function, the implementation of rescue needs different machinery rotating operations, need supporting machinery and equipment and personnel, easy to cause congestion and confusion, rescue efficiency low. In view of the above problems, it is urgent to develop special emergency rescue vehicles with high mobility, multi-function and high efficiency.

3. Research of standards system of emergency rescue equipment
To study the foreign emergency rescue equipment standard system and application, focus on the historical evolution of emergency rescue equipment technology and related standards of international standardization organization, American fire protection association and European Union standard technical committee, and determine the layout, application scope and key technical indicators of foreign advanced emergency rescue equipment standard. To study the development trend of overseas emergency rescue equipment technology and standards.

According to studying the related standards and application of domestic emergency rescue equipment, the data statistics method is adopted to study the pattern of natural disasters and sudden accidents in China, to master the requirements of emergency rescue equipment, key technologies and standard requirements for typical sudden disasters, such as fire, flood, earthquake, landslide, etc. and to study the development direction of the standard technology of emergency rescue equipment.

Based on the theories of system engineering, it studies and extracts the typical disaster pattern and the common abstract characteristics of emergency rescue equipment, defines the connotation and denotation of the standardization of emergency rescue equipment, identifies the existing decentralized emergency rescue standards, clarifies the missing standards and the cross and repeated relationship between those standards, and completes the confirmation of the status qua of standards and their differential analysis.

It is necessary to construct a standard system for high-mobility multi-functional emergency rescue equipment. Based on the standardization theories such as the integrity principle of standard system, the principle of combination of unified and differentiated treatment, the principle of relative stability and the principle of openness, the frame structure of the standard system is set up. Based on the risk assessment method and the analytic hierarchy process (AHP), it plans the hierarchy and branch of the framework of the standard system of emergency rescue, forms the standard system of emergency rescue, determines the elements of the system, and ensures the relevance, coordination and consistency among the elements of the system. The standard system includes basic standards, general technical standards, key equipment and apparatus standards and test inspection standards.

In term of the research on standard technology, the key point should be focused on the three dimensions of high mobility, multi-function and high efficiency. In view of the general technical standard, the emphasis is placed on the research of technical standard of modular design so as to standardize the installation of working arm, chassis and working device, as well as the quick interface size of rescue equipment, to meet the requirements of rapid exchange of various components and to realize the multi-functions of rescue equipment and apparatus.

In terms of standard technology research, it focuses on three dimensions of high mobility, multi-functionalization and high efficiency. According to the general technical standards, the study of modular design technical standards is mainly carried out to standardize the installation of working
arms, chassis and working devices, as well as the quick interface size of rescue equipment, to meet the requirements of quick exchange of various parts, and to realize the multi-function of rescue equipment and equipment. In view of the key equipment and equipment standards, the study on the rescue vehicle suspension technology, wheel/rail interchange technology, small site chassis technology, low-altitude delivery technology and other standards will be carried out to achieve high mobility of the rescue vehicle. The related standards, such as multi-agent fire extinguishing, multi-gun stereoscopic spraying, fast delivery and throwing of solid fire extinguishing materials, and high-lift fire extinguishing are carried out to realize the high efficiency of rescue. According to the test inspection standard, the research on test method and the evaluation method standard is mainly carried out to verify the conformity of the design indexes of rescue vehicle and equipment.

4. Development suggestions of emergency rescue equipment
Compared with foreign countries, China's emergency rescue equipment still has a large gap, which is mainly reflected in the lack of special chassis for high-mobility rescue vehicles, the lack of professional rescue equipment, the unsound standard system, and the high-end rescue equipment mainly relies on imports. With the acceleration of China's modernization process, various types of disasters and accidents occur frequently, and the emergency rescue situation is grim, and the demand for advanced emergency rescue vehicles keeps increasing. Therefore, it is urgent to carry out research on key technologies of high-mobility multi-functional emergency rescue vehicles, improve the mobility and efficiency of emergency rescue vehicles in China, realize multi-functionalization and establish a sound standard system. Need to multiple major workplace disaster accidents in China, the new demand for emergency rescue equipment and standard system, high around mobile multi-function emergency rescue equipment systemic and normative, carrying out a research into the multifunction emergency rescue equipment standard system, through the establishment of perfect standardization construction of China's emergency rescue equipment, improve the emergency rescue ability of our country.

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