report

Contributing to the International Community through Monozukuri

—Landmine Clearance for Restoring Land to Peace and Prosperity—

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The laying of landmines during the wars and civil conflicts of the 20th century has left somewhere between 60 and 110 million of these devices buried in the ground in different parts of the world (according to figures from a FY1998 U.S. Department of State report), and even now they result in injuries to around 20,000 people each year. It was against this background that Yamanashi Hitachi Construction Machinery Co., Ltd. established a project team to contribute to international peace through humanitarian aid, and in 1995 set about developing demining equipment based on functions from hydraulic excavators. This development got underway in earnest after the Japanese government signed the Ottawa Treaty in 1997. Currently 86 machines are being used for landmine clearance in nine different countries (as of April 2012), and the staff of Yamanashi Hitachi Construction Machinery are actively working to develop and supply demining equipment that is even more efficient and easy to use.

HUMANITARIAN INITIAL IMPETUS FOR DEVELOPMENT

ONE of the authors (Kiyoshi Amemiya of Yamanashi Hitachi Construction Machinery Co., Ltd.) made a sales trip to the Kingdom of Cambodia in 1994. During his stay, he was confronted with the suffering of people who had been injured by landmines, and this gave him the idea of using hydraulic excavators as the basis for developing an anti-personnel landmine removal machine. When he consulted staff from the Cambodian Mine Action Centre (CMAC), which is supported by the United Nations agency and the Cambodian government to undertake landmine clearance, he was told that the biggest problem was the clearance of reeds, bamboo, and other brush, and that this took up 70% of the time spent on landmine clearance. In response, he embarked on the development of a combined brush clearance and anti-personnel landmine removal machine that would be capable of dealing efficiently with this type of vegetation.

Although anti-personnel landmine removal machines were still subject to export controls at that time, Amemiya decided on humanitarian grounds to start the development anyway. Subsequently, development was spurred on by the Japanese government signing the Ottawa Treaty (officially known as the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction) in 1997, followed by the exclusion of anti-personnel landmine removal and detection machines from the "Three Principles on Arms Exports."

DIFFERENT TECHNIQUES DEPENDING ON MINEFIELD CONDITIONS

At that time, approximately 54% of the world's minefields were in the Middle East or North Africa, 21% in Asia, 18% in Central Africa, and 5% in Central or South America (see Fig. 1). The removal methods differ depending on circumstances in each region, including the soil type, how the mines have been laid, the types of mines, and the presence of other unexploded ordnance. Cambodia and other Southeast Asian nations have a high proportion of anti-personnel mines that can be difficult to locate because of the tendency for buried landmines to be carried to different positions during the rainy season. It is also common

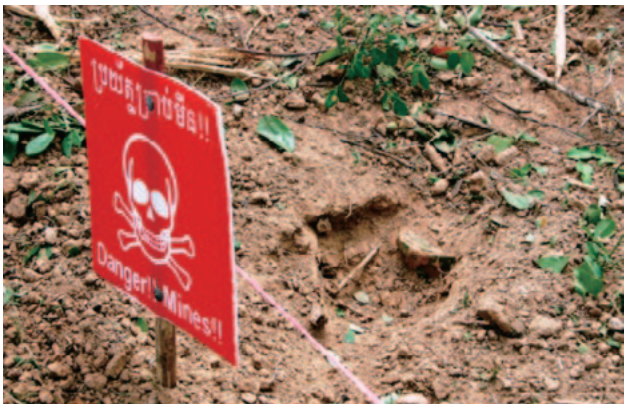

Fig. 1—Anti-personnel Mine Embedded in the Ground.

for minefields to be overgrown with grass or brush, which impedes the removal of anti-personnel mines. In contrast, while minefields in places like the Middle East or North Africa commonly have little vegetation that needs to be cleared first, they often contain large numbers of anti-tank mines and unexploded ordnance. Mines can be broadly divided into anti-tank mines (containing 6 to 10 kg of explosive) designed to damage tanks, and anti-personnel mines (containing 50 to 250 g of explosive) designed to injure human beings. Some minefields also contain unexploded ordnance. Amid all these different considerations, the major issue was the development of a cutter able to deal with the brush that grows on Southeast Asian minefields.

Fig. 2—Swing Type Anti-personnel Landmine Removal Machine Able to Deal with Brush Efficiently Using Rotary Cutter.

PRODUCT DEVELOPMENT

The two types of anti-personnel landmine removal machines in current use are the swing type based on hydraulic excavators and the newly developed self-propelled push flail type based on past research and development. The removal methods are the rotary cutter type and the more explosion-resistant flail hammer type.

Swing Type Anti-personnel Landmine Removal Machine

In surveys of Cambodian minefields since 1995, what the people on the ground have requested has been machinery capable of efficiently clearing brush prior to mine removal, a task that consumes 70% of the time required for demining. Products on the market at that time included a Canadian-made brushcutter and locally produced grass cutters, but none had the capacity to cut the type of brush found in Cambodia. Hitachi decided that it needed to develop its own combined brush clearance and anti-personnel landmine removal machine to overcome this problem, and that it was also necessary to be able to clean up the brush after cutting. With operator safety and machine durability obviously being the overriding requirements, the first prototype anti-personnel landmine removal machine based on a hydraulic excavator was completed in 1998.

Minefields in Cambodia have reverted to jungle, with daytime temperatures ranging from 50°C to 60°C. In addition to the potential for landmine explosion, cutting and removing this jungle brush by hand also puts people at risk of poisonous snakes and mosquito-borne diseases such as malaria and dengue fever.

Rotary cutter machines are one solution to this problem. The cutters rotate at high speed to pull out brush by its roots, and these same cutters can be used to explode any mines in the soil. An advantage of swing type machines based on hydraulic excavators is that they can cope with the different terrains in which landmines are buried. In addition to the hill-climbing capabilities of a hydraulic excavator, the end of the arm can follow the topography in situations such as steep or rugged terrain with severe undulations. The machine can also be used for digging by changing the attachment at the end of the arm to a bucket, for example. A swing-type combined brush clearance and anti-personnel landmine removal machine was supplied in 2000 following explosion resistance testing in Cambodia that confirmed the safety and explosion resistance of the cabin, the durability and explosion resistance of the rotary cutter, and the blade strength. This machine is still in active service (see Fig. 2).

Push flail type anti-personnel landmine removal machines, on the other hand, prove effective in locations such as deserts or where the land is flat.

Flail Hammer Type Demining Equipment

The way landmines are buried in minefields varies widely, and these fields often also contain unexploded ordnance and anti-tank mines. Because of the risk of encountering these, it is essential that equipment development place a priority on maintaining the safety of the operator and machine. With the aim of developing demining equipment with better explosion resistance, and with support from the New Energy and Industrial Technology Development Organization (NEDO), Hitachi started developing flail hammer type demining equipment in 2002 based on research and development conducted between 1995 and 2000.

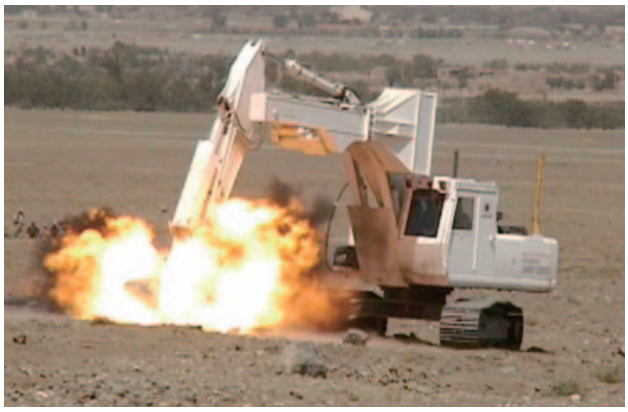

Fig. 3—Explosion Resistance Testing in the Islamic Republic of Afghanistan.

Machine in action

Level plate

Rippers

Curved central section of undercarriage

Fig. 4—Flail Hammer Type Demining Equipment.

Slide type elevated cab

Flail hammer and chain

Fig. 5—Slide Type Elevated Cab, and Hammer and Chain.

Unlike rotary cutter machines, flail hammer type demining equipment has a slimmer rotating shaft and works by rotating a chain with a hammer (weight) on the end at high speed to destroy the mines by blowing them up. The machines are more blast resistant because of the large number of gaps in the rotating flail.

This problematic explosion resistance testing was conducted in cooperation with the Japan Ministry of Defense. Hitachi also participated in practical trials in places such as the Islamic Republic of Afghanistan and Cambodia in cooperation with the Ministry of Foreign Affairs of Japan prior to the machine entering practical use in February 2007 (see Fig. 3). It is currently used in Cambodia and the Republic of Angola.

In 2006, Hitachi started developing new demining equipment that will be better suited to clearing flat land.

Equipped with a flail hammer at the front that covers a width of 3 m (twice that of the previous machine), the machine uses chains with 90 hammers attached to pummel the surface of the ground, and moves forward under its own power detonating mines as it goes. It is also fitted with nine large rippers at the rear of the machine that can plow the soil and help restore it to agricultural use. The machine provides an efficient way to clearing landmines with a capability of 1,700 m^2 per hour, which is more than 100 times faster than using manual labor.

The main features of the machine are as follows (see Fig. 4 and Fig. 5).

(1) Level plates (which function like sleds) fitted to the bottom of both flail hammer units provide an automatic control mechanism that can adjust the flail depth based on the terrain and detonates anti-personnel mines by reacting to uneven ground and keeping the excavation depth constant.

(2) Rippers are fitted to the rear of the machine to help rehabilitate the land for agricultural use.

(3) The undercarriage has a modular design that allows the crawler belt to be separated. This means that the crawler belt can be replaced on its own in the event of its being damaged by unexploded ordnance, an anti-tank mine, or some other large landmine.

(4) Even if the machine runs over a large landmine, the central part of the undercarriage is curved to deflect the blast wave and minimize damage.

(5) The cab is located at the rear of the machine to improve safety. Use of a slide type elevated cab also improves visibility.

(6) The shape and material of the hammers and chains were developed through repeated testing. To reduce maintenance costs, they are designed to allow refurbishment by local technicians.

LOCALLY BASED OPERATION AND MAINTENANCE

Before delivering machines, Yamanashi Hitachi Construction Machinery invites those involved,

Fig. 6—Maintenance Instruction in Progress.

Fig. 7—Presentation to Elementary School.

Fig. 8—International Exchange at Elementary School in the Republic of Mozambique.

including local operators, to Japan to receive between one and two months of training. A training range is available at Akeno-mura in Yamanashi where the company is located, and operational, technical, and classroom lessons are provided to ensure that the trainees have a thorough grasp of their job, including daily maintenance. Also, Hitachi staff travel from Japan to overseas sites to provide technical instruction at the time of delivery (see Fig. 6).

The machines are designed to be easy to use and maintain locally. For example, because visibility is obscured by dust thrown up at the front when used in desert regions, a cover is fitted over the flail hammer units to prevent scattering of debris. Features such as the split design used for the undercarriage referred to above were developed based on feedback from machine operators. This allows parts to be replaced efficiently if they are broken or damaged by landmines. The components most prone to damage include the flail hammers and chains, and these are designed in such a way that it only takes local workers one or two hours of work to refurbish them.

While training of local personnel presents some difficulties, the job is not complete until they can operate the machines on their own. It is necessary to be patient and repeat demonstrations over and over to ease their engrained fear of landmines and get them to accept that the demining equipment is safe. Our task is accomplished when the framework for local operation and maintenance has been established.

CSR ACTIVITIES

Through the development of demining equipment, Hitachi has been working actively to help eliminate the harm done by landmines in many countries around the world, to restore their land, and allow them to recover through their own efforts, seeing this as part of its corporate social responsibility (CSR).

While the development and supply of products is important, Hitachi also wants to express the value of life and the importance of understanding how other people feel by telling adults and children in Japan about the circumstances faced by the people who suffer from the world's minefields. To achieve this, Amemiya accepts around 70 to 80 invitations each year from schools and other social organizations to give presentations (see Fig. 7).

He also facilitates international exchanges between children, seeking to boost the morale of children living in the vicinity of minefields that are to be cleared by bringing them letters, pictures, and other artwork from children in Japan, and also by bringing letters and pictures from those children back to Japan (see Fig. 8).

SELF-RELIANCE AND INDEPENDENCE FOR LOCAL PEOPLE

Landmine clearing does not end when the mines are removed from the minefield. The actual benefits are realized when the land from which the mines

have been removed is reused for a school or farm, for example, so that the local people can become more independent and self-reliant. In the Republic of Nicaragua, land from which mines had been cleared is now used to grow oranges, producing 600,000 cases a year and about 1.5 million dollars in exports. Other crops included coffee and highland vegetables (see Fig. 9).

In Cambodia, two schools have been built on former minefields to provide the infrastructure for children's education. Working through a non-profit organization, "Good Earth Japan," Hitachi is also actively participating in measures that support self-reliance, including providing local people with agricultural education, the construction of wells and reservoirs, and the provision of roads. The company's aim is to do what it can to make an international contribution by restoring land to peace and prosperity so that children can play barefoot (see Fig. 10).

Fig. 9—Magazine Article on Cultivation of Coffee after Landmine Clearance in the Republic of Nicaragua.

Fig. 10—Kiyoshi Amemiya with Children in the Kingdom of Cambodia.

RESTORING LAND TO PEACE AND PROSPERITY

The personal motto of Kiyoshi Amemiya, one of the authors, is that, "engineers are challenged by monozukuri, and the root of technology can be found in monozukuri and hitozukuri—making good products is equal to making good people." The falling birthrate in Japan means that the number of working engineers with a command of their craft is steadily diminishing. Japanese corporations have always placed a high value on their personnel, fostering engineers and supplying technologies that are recognized around the world. Perhaps now is the time to once more be fostering the forgotten "spirit of craftsmanship."

Our aim for the future is to continue our efforts to make an international contribution by developing, supplying, and supporting demining equipment, so that land can be restored to prosperity and be a place where children can play happily. Nevertheless, civil war, terrorism, and other conflict continue to occur around the world. Hitachi will keep up its desire to bring about a peaceful world in which demining equipment is not needed.

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