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Detection of Wet Condition for Underwater Local Dry Welding

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ABSTRACT

Local dry underwater welding is one of the key technologies for on site construction and maintenance of very large offshore floating structures(Mega-Float). Mechanical properties for wet welding is relatively poor compared to dry welding because of bad influence by surrounding water at the welding part. Local dry welding procedure by using of water curtain shield is one solution to improve mechanical properties. This technique is so simple to reduce much cost and working time, if complete dry condition is guaranteed during welding operation.

This paper describes a way to visualize two-dimensional wet condition using an infrared video camera with an optical bandpass filter for automatic detection of water on a plate to be welded. The water has absorption spectra in the infrared region at wave lengths 1450nm and 1940nm. An IR sensitive video camera (from 500 to 2000nm) combined with an optical bandpass filter (1450nm) was used to visualize the wet condition on steel plate. Wet region was recognized automatically by image processing.

KEY WORDS: Underwater welding, local dry welding, infrared image, image processing, VLFS, offshore joining

INTRODUCTION

Keen interest for utilization of offshore space and resources has been steadily growing up with improved offshore technology. A Mega-Float project was started in 1995 to develop techniques for a very large scale floating structure as a base for economical activities instead of land reclamation. A box type floating structure is considered to improve economical performance. Many box typed floating units are fabricated in the shipyards simultaneously, and they are joined at the offshore installation site. Welding is the most reasonable technique to join steel structures. The problem of offshore joining for Mega-Float structure is its enormous length of welding line, especially about the half length of them are located under water.

Underwater welding on a very long straight line is necessary in this case. Dry welding requires additional process to dry up whole welding area, and it spends much time and cost. Mechanized wet underwater welding technique is a key technology to improve its cost performance. Mechanical properties for wet welding is usually poor compared to dry welding because of bad influence by surrounding water at the welding part. A mechanized local dry welding process with water curtain nozzle was examined to improve mechanical properties and cost performance (Ogawa et al, 1997a). A suitable selection of shielding condition is very important for this technique. Usually, suitable shielding condition is selected by using of acrylic plate model. However, the behavior of water on the acrylic plate and the steel plate is different. And quantitative evaluation of wet condition was not made clear. Therefore, a trial to visualize wet condition by using of infrared video camera was carried out.

EXPERIMENTAL EQUIPMENT TO DETECT WET CONDITION

Figure 1 shows absorption spectra of water near infrared region from a technical letter by Hamamatsu photonics(1995). Water has absorption spectrum peaks at wavelength 1450nm and 1940nm. Then the image from wet part has weak spectra at these wavelengths compared to the image intensity from dry part.

Figure 2 shows an experimental set up to visualize wet condition. A vidicon(N2606-06) by Hamamatsu photonics was used. This vidicon is sensitive between 400nm and 2000nm as shown in Fig.3. An optical bandpass filter was used to emphasize the difference between dry and wet condition, which center wave length and -3dB band width were 1450nm and 30nm, respectively. Two tungsten bulbs were used as IR lights. Wet part on a rusty steel plate is sometimes discolored, and then human can recognize the surface condition. But a cause of discoloration is not unique, and we need some information and artificial knowledge to recognize the actual surface condition.

An image on dry steel plate, which had small wet part, was taken by this vidicon in order to develop the reasonable method and algorithm to recognize wet condition. Taken video image was transferred into computer by image grabber. The image size is 640 by 480 pixels, and each pixel has 8 bits brightness information. The computer analyzed the grabbed image data. Table 1 shows photo conditions of taken image data.