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Wave Issues Relevant to the Operation and Maintenance of Seafloor Cables

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1. Introduction

Scientists and engineers working at the Naval Seafloor Cable Protection Office (NSCPO) design undersea fiber-optic and power cable systems while providing cable stabilization, cable route selection, shore landings, and cable deployment methods. Navy seafloor cable systems are found at fleet underwater training ranges and include sensor networks, communications and data links, and surveillance and monitoring systems. They are normally depicted on nautical charts so mariners can avoid them. Installation and maintenance is expensive and normally requires the use of Remotely Operated Vehicles, manned submersibles, and Cable Repair Ships.

Seafloor cables are typically laid along the bottom, but they can also be buried or trenched. Cables are sometimes buried to avoid being damaged by fishing gear or boat anchors. Seafloor cable locations are generally known within a radius of a few hundred meters and their heading is generally known within 20 degrees. Cable runs may be 5 to 40 km long in water depths from 25 meters to 5 kilometers. Range cables have a diameter from 1.6 to 3.2 cm with internal steel strength members. The cables are typically covered with either a black or white colored polyethylene jacket or occasionally, in shallow water, with a black jute wrapping. Some examples are illustrated in Fig. 1. Shallow water seafloor cables are especially prone to scour and burial, especially following severe weather. For this reason it is very important to understand wave height and direction distributions. The magnitude of general scour can be estimated from the annual extreme wave height.

Figure 1. Seafloor cables include telecommunication and power cables.

Underwater inspections provide valuable information to assess the seafloor cable condition and planning for scheduled maintenance or repair operations. Efforts are underway to explore the use of Unmanned Underwater Vehicles (UUVs) to locate, follow, and inspect seafloor cables. If they can provide quality controlled data, a significant savings can be made on the cost of cable inspections. This may be especially valuable for the execution of unscheduled maintenance.

Most operational UUVs have been designed for deep-sea work at depths where wave forces are not a factor. One concern in the use of UUVs for shallow water seafloor cable inspections is the effect of waves on the corresponding motions of the UUV, especially with respect to different wave frequencies and headings. This will be especially important along shallow water seafloor cable runs where there is a need for high-resolution close-up video. The UUV operating in shallow water will have to adapt to an ever changing environment. It will have to remain on course, avoid obstacles, and track seafloor cables that may have been buried by the effects of waves and currents.

2. Conclusions

The NSCPO uses available environmental data to make objective science-based decisions. Observed data are used in the calculation of environmental loads acting on seafloor cables and other underwater structures [1]. The environmental loads are caused by phenomena such as waves and currents and their interactions, especially with the seafloor (e.g. sand, gravel and rocky bottoms). Wave information from buoys and models is especially important, e.g., to forecast scour and burial. Wave information is also useful to plan for the recovery and repair of seafloor cables.

NSCPO needs to identify UUV technologies that support the collection of shallow water seafloor data and cable conditions. The ideal platform would include synthetic aperture sonar, a multi-beam echo sounder, optical cameras, and lighting. Wave information would be essential to identify conditions when the UUVs could be used for cable inspections that include photographs and video that documents the seafloor cables from various angles. A viable UUV technology will become important to service ocean renewable energy technologies that rely on submarine electrical cables to bring generated electricity to shore.

References

[1] Thompson, D. and D.J. Beasley (Ed.), Handbook for Marine Geotechnical Engineering, SP-2209-OCN, Naval Facilities Engineering Command, Washington Navy Yard, D.C., 2012.