DELIVERY OF A SCIENTIFIC OCEAN OBSERVATION ENGINEERING PROJECT

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Abstract: Scientific ocean observation technology plays an important role in safeguarding maritime rights and interests, developing marine resources, warning marine disasters, protecting the marine environment, strengthening national defense construction and seeking new development space. Due to its low cost and flexibility, scientific underwater sensor networks have gradually become an important part of ocean observation technology. In November 2017, Hengtong Marine Cable Systems successfully deployed an underwater sensor network as the project's general contractor. In this paper, some examples of route measurement, route planning, detector connection schemes, offshore construction and onshore construction are provided to show how to complete a project of underwater sensor networks.

1. SUBMARINE OPTICAL CABLE LAYING PROCESS AND LANDING PROTECTION

Project overview

The construction site is in the waters of Wanning, Hainan. Construction includes submarine optical cable construction and land optical cable construction. The submarine optical cable is 2.1km and the land optical cable is 1.5km. The construction of the land optical cable and the Submarine optical cable was laid by Hengtong Marine Cable Systems.

Figure 1: Submarine optical cable laying instruction map

Figure 2: Land optical cable laying instruction map

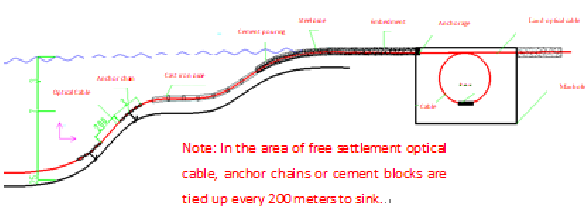
Route survey

Before the construction, the survey of the submarine optical cable route is carried out, and the safe and reliable sea line landing point and route are selected to determine the economical and reasonable Submarine optical cable laying technical plan to ensure the safety, stability and reliability of the submarine optical cable communication.

The construction site selects the sea area near the coastal detection station, and the monitoring station serves as the onshore monitoring base station. There is a fishing port near the inspection station. To avoid the fishing port, the cable route and landing point were selected away from the hazards of anchoring and fishing areas, while onshore, the land optical cable is buried continuously along the 1.5km route to a depth of 1.2m

The submarine optical cable is laid 2 km from the sea-facing shore. The armoured cable was surface laid, with slack control, from the sensor towards the beach landing point. The submarine optical cable is anchored in position by means of cement blocks: the cement block attached every 200 meters to the cable, and articulated cast iron pipes are attached on the shore end landing. The required cable system length including construction allowance was checked according to the bathymetric profile and engineered cable route to ensure that the optical cable is sufficiently long.

Drawing of Submarine Optical Cable Layout



Construction process

When the equipment is put into use, the deployment vessel uses its own crane to fix the wire rope connected to the detector with an automatic decoupling sling. Then, a nylon rope is attached to each of the two feet at the bottom of the detector to the hull connecting the optical cable. At about 30 meters, the artificial rope is installed. The purpose of the two ropes is to facilitate the crane to control the direction of the detector when it is lifted, and it will not damage the optical cable because of its twist.

The deployment vessel is maintained in position by a 4-point mooring system, that is, the two anchors in front of the ship, and the two anchors in the back, so that the deployment vessel moves slowly toward the shore end, the deck officers maintain a constant cable lead. The sensor is mounted on a large trawl resistant concrete base and during the deployment operation, the ship moves slowly along the extended route during the process of lowering the sensor & cement base to the seabed the cement block.

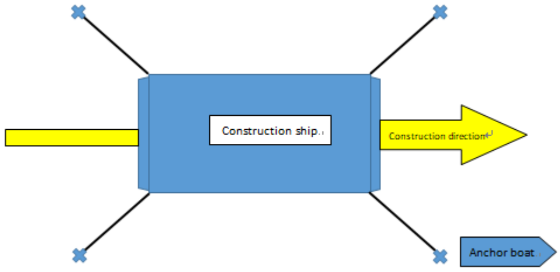


Figure 3: Top view of flat boat construction process

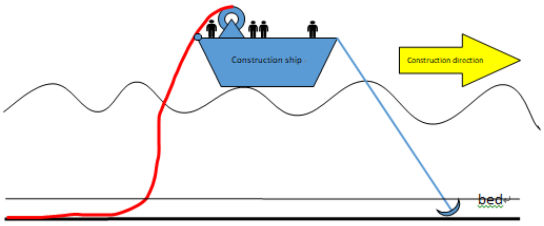


Figure 4: Flat boat laying process front view

During the laying process, two deck officers control the pay-off operation; one cable engineer controls the angle of the optical cable entering the water, by adjusting cable payout speed, vessel position and heading ship to adjust the direction.

Submarine optical cable landing

Because the water level is usually shallow on the coast, the construction ship cannot be docked when the optical cable is landed. Therefore, it is necessary to float the optical cable with a floating ball, pull the landing with a small boat, and then select the appropriate method for land laying according to the distance. When the subproject is landed, adjust the direction of the laying vessel to be parallel with the shore at a position of 400m from the shore. Discharge the optical cable from the optical cable drum, reserve enough optical cable length, attach the float ball, and pull it with the boat. The cable end is handed over to the beach team, who pulls the required length of cable ashore and straightens the offshore cable line, before applying a temporary beach anchor and feeding the cable into the Beach Man Hole (BMH). After the fiber optic optical cable is landed, optical performance testing is required to test the integrity of the optical cable.

Boarding land protection

The landing part of the fiber optic optical cable is laid by direct burial. The excavation depth is 1.2m and the width is 0.6m. The upper part of the optical cable is protected by Φ50 steel pipe. The optical cable between the rising and falling tides is protected by cast iron protection pipe. The submarine optical cable is connected to the manhole. The optical cable is protected with a professional iron pipe and enclosed with C15 grade concrete.

2. LAND OPTICAL CABLE LAYING PROCESS AND MANHOLE PRODUCTION

Land optical cable overview and laying process

The length of the land optical cable construction is 1.5km. The route of the project is laid by direct burial. The excavation depth is 1.2m and the width is 0.4m. Considering the soil quality of the construction area, it is used in the excavation process. Board-assisted construction, the optical cable is protected with 32PE pipe and before completely backfilling the trench warning tapes were placed above the cable route to prevent accidental damage by any future construction.

Manhole production

The manhole production process is as shown:

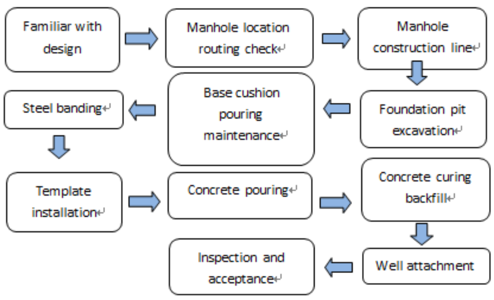


Figure 5: Manhole production flow chart

3. OPTICAL CABLE OPTICAL CABLE ENTERING WELL AND PROTECTION METHOD

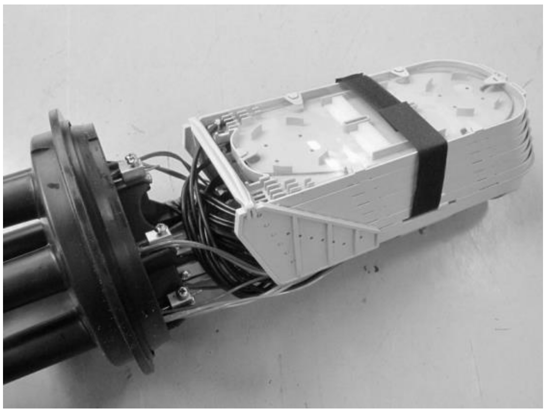
The optical cable is coiled into the BMH, and outside the BMH the cable is protected by a metal duct. The cable is anchored inside the BMH. This is to prevent the optical cable from being damaged due to external forces pulling the submarine cable off the beach.

After the fiber optic optical cable enters the manhole, the outer armor of the optical cable is completely stripped off, and the optical cable is suspended and fixed on the optical cable tray reserved in a sufficient length of spare cable in stored in the BMH to allow for beach jointing operations and any future repairs.

4. BEACH JOINT BOX INSTALLATION METHOD

Overview

The beach joint box allows direct, optical cabled, terminated or divergent connection of the optical cable. The sealed case provides waterproof protection without the need to fill the resin. Special accessories can be used for direct burial, pipe, manhole, overhead, pole and pedestal installation; and can be quickly inflated after completion of the connection.

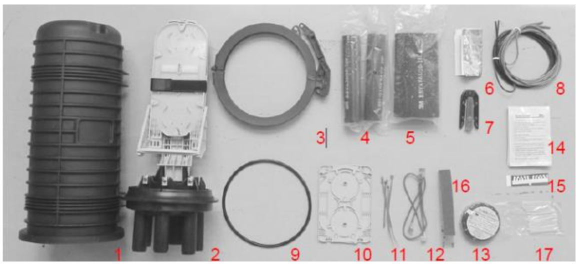


Specifications

Structure size and technical parameters:

- Six optical cable entry holes (five holes and one large waist hole)
- Minimum bending radius: R > 30mm
- Shell size (length × diameter): 510 × Φ 180 (mm)
- Shell weight (without any accessories): 2000 grams or so
- Waist hole: 10 - 32mm (supports 2 28mm optical cables to pull out cables at the same time)
- Small hole: 10 - 22mm
- Ambient temperature: -40 ° C - +70 ° C.
- Service life: 30 years.

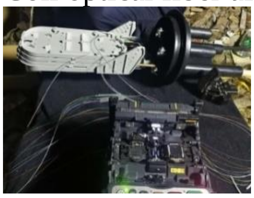
Kit



1	Cap on the connector box	2	Base and 2533 splicing tray	3	Locking clip	4	Heat shrinkable tube (small)
5	Heat shrinkable tube (large)	6	Insulating aluminum foil	7	Divergence card	8	Fiber-filled tube
9	Seal ring	10	2512 connecting tray (optional)	11	Optical cable tie	12	Ground protection line
13	80T tape	14	Optical cable cleaning paper	15	label	16	sandpaper
17	Optical fiber connection protection tube						

Installation steps

- Processing cable head;
- Remove the silicon gel and test it;
- Assemble the heat shrinkable tube;
- Cut the cable hole, extend the cable into it;
- Fixing cable with the steel wire;
- Put one end of the optical unit into the fiber disk and fix it with a strap;
- Protecting fibers with loose tube and intercepting appropriate length of fibers
- Start splicing and test;
- Coil optical fiber after qualified test;




- Fixed the fiber disk, tested again;
- Assemble the sealing ring and the cap;
- Thermal shrinkage sealing;
- Fix joint box in manhole;
- Joint box installation completed;
- Test and acceptance.

5. TESTING AND ACCEPTANCE

Test equipment (optical time domain reflectometer)

The optical time domain reflectometer (referred to as OTDR) is mainly used to test various indexes such as the length of the fiber in the submarine optical cable and the attenuation of the optical fiber, and has accurate fault location capability.

Model	FTB-730
Wavelength (nm)	1310±20/1490±10/1550±20/1625±10
Distance range (km)	1.25、2.5、5、10、20、40、80、160、260、400
Pulse width (ns)	5、10、30、50、100、275、500、1000、2500、10000、20000
Linearity (dB/dB)	±0.03
Loss threshold (dB)	0.01
Loss resolution (dB)	0.001
Sampling resolution (m)	0.04 to 5
Sampling point	Up to 256,000
measure time	User defined (up to 60 minutes)
Reflection coefficient (dB)	± 2

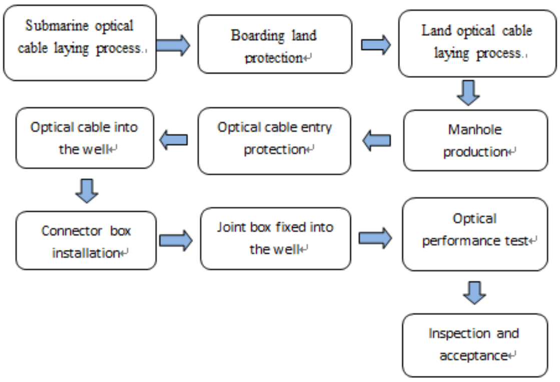
Test Results

The OTDR test results are as follows. The results show that the submarine optical cable is 2.1km and the length of the optical cable is 1.5km.

Submarine optical cable			Land optical cable		
Number	Fiber color	Length / m	Number	Fiber color	Length / m
1	White	2134	1	White	1548
2	red	2136	2	red	1545
3	black	2136	3	black	1551
4	yellow	2137	4	yellow	1548
5	purple	2136	5	purple	1548
6	blue	2134	6	blue	1549
7	Orange	2132	7	Orange	1546
8	green	2136	8	green	1548
9	Brown	2138	9	Brown	1547
10	gray	2132	10	gray	1548
11	Pink	2133	11	Pink	1548
12	Green	2137	12	Green	1549

6. CONCLUSION

The construction process of the optical cable project is as follows:



The land optical cable laying and manhole production can be carried out simultaneously or in advance during the optical cable laying process.

The scientific acoustic sensor project was delivered and handed over to the client after successful commissioning and testing of the sensor and cable system.

A full set of client documentation, including Daily Progress Reports (DPRs), Load and

Lay report, Onshore and offshore cable route charting and Route Position Lists (RPL) were delivered within budget and on time.

The Hengtong Marine Engineering Services team involved in onsite works was comprised of six staff, working 24 hours a day during marine operations and normal working days during onshore civil works.

7. REFERENCES

[1]Ying Chen, Canjun Yang, “Seabed Observation System”, Maritime Press, 2006
[2]Yincan Ye, “Submarine Optical Cable Engineering”, Maritime Press, 2015
[3]Hong Song, Caihao Huang, “Marine Technology Course”, Zhejiang University Press, 2012