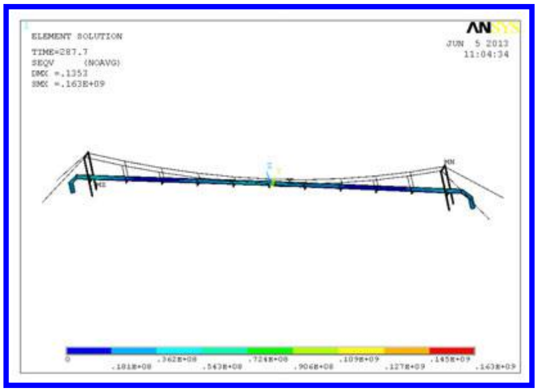

Figure 5 . Stress contour of suspension cable crossing pipeline

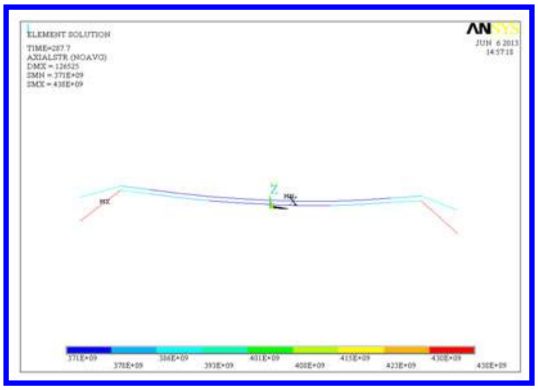

Figure 6. Stress contours of main cable and stayed cable

Stress distribution was extracted at the occurring of maximum displacement of pipeline. The effective stress contours of pipeline and support, and axial stress of main cable and stayed cable are shown in figure 5 and 6, respectively. It can be seen that: 1) under wind load, the maximum effectively stress of the pipeline and support are 63MPa and 163MPa，respectively. They are smaller than the characteristic yield strength of steel, i.e., 235MPa, which satisfies the strength requirement. 2) Under wind load, the maximum stress of the main cable and stayed cable are 386MPa and 438MPa, respectively. These values are smaller than the standard value of ultimate strength of steel strand, i.e., 1720MPa, which also satisfies the strength requirement.

CONCLUSIONS

Taking a suspension cable crossing pipeline in Wei-Hui project as the engineering practice, this paper applied wind field simulation software to simulate the wind speed for Wei-Hui crossing bridge. The wind speed was converted to wind load, which was imposed onto the finite element model of the suspension cable crossing pipeline to conduct wind vibration response analysis. The conclusions were drawn as follows:

1. Through the comparison of fluctuating wind power density spectra, simulated wind speed spectra were in good agreement with that of target power density function. It indicated that the wind field simulation software had high accuracy in this study.

2. The deflection span ratio of pipeline and main cable under wind load was smaller than the limited allowance value of Road Suspension Bridge Design Code . The displacement angle of support was also smaller than the allowance value among the steel structure elastic layers, which showed that the structure was safe under wind load.

3. Under wind load, the maximum stress of pipeline and the effective stress of main tower were smaller than the characteristic yield strength of steel. The maximum axial stress of main cable and stayed cable was also smaller than the standard value of ultimate strength of steel strand, which satisfied the strength requirement.

Through above conclusions it can be seen that this suspension cable crossing pipeline was safe under wind load with a basic wind pressure of 0.35kN/m2.

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Fiber Optic Cable Installation and Protection Method in Particular Areas in Oil (gas) Pipeline Project

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ABSTRACT

The fiber optic cable (FOC) is easily damaged in particular areas in the oil (gas) pipeline project. Owing to the same-trench buried method with pipeline, the installation and protection of FOC is always limited. The purpose of this article is to discuss the installation and protection method in these particular areas.

KEYWORDS

FOC; Installation; Protection; Particular Areas; Oil (gas) Pipeline Project

INTRODUCTION

The fiber optic transmission system can supply large capacity and high reliability channel for SCADA data, voice, security, office data of oil (gas) pipeline and it is widely used in the pipeline project. This article is mainly to discuss the installation and protection method of FOC in particular areas.

Frozen soil area. Currently, laying FOC (silicon-core duct) in same trench with oil(gas) pipeline has become a common method in domestic and international pipeline projects. So in the frozen soil area, the FOC has to face two particular situations: laying in same trench with oil(gas) pipeline and frozen soil.
There are two FOC laying types in the same trench used in oil(gas) pipeline project:

armored FOC directly buried type and "silicon pipe + FOC" laying type. The typical operation procedure for FOC laying in oil(gas) pipeline project is as follows: put oil (gas) pipeline into the trench→trench first backfill→pick a small ditch for FOC→put the armored FOC or silicon pipe in the small ditch→trench final backfilling→laying the FOC into silicon pipe by blowing(if "silicon pipe + FOC" laying type).

Telecommunication service operators always choose the directly buried method to lay the FOC in frozen soil area. But for oil (gas) pipeline project, the damages and injuries to FOC always are caused by the pipeline laying method.

In practice, the pipeline installation teams often hurt or seriously damage the FOC during the course of pipeline laying. According to the real examples of the already finished projects such as Linpu Line, Jizi line, Yonghuning imported crude oil pipeline, the great southwest Processed oil pipeline, the FOC directly buried in the same ditch, when it is broken by the pipeline operations, it can only be repaired by connecting with new joints. Such a way of reparation may not meet the quality requirements of the constructions. The defects include the poor project quality and the reparation fee can be very expensive. The method cannot lower down the investment.

The several pipeline operations may cause damages and hurts to the FOC:

The damages and hurts caused by the ditch operations. Due to the difficulties of supply and transportation of the pipeline bending joints, the continuous operation may not smoothly be achieved. In order to weld the joints of the pipeline in the ditch, the operators usually dig a big operating room at the joint place with the excavators. Such an operation may break or damage the armored FOC or silicon pipe nearby.

The hurt and damage caused by the backfill of the pipeline constructions. If the first backfills are not conducted correctly, the FOC will not be laid in correct positions, either. In that case, the FOC is exposed basically in the pipe ditches. As a result, the final backfill may easily hurt the armored FOC or silicon pipe.

Pipeline construction machinery operation damage to the fiber optic cable. According to the general belief, the construction of FOC is in a minor position of the integral construction. According to the construction of FOC, it is usually in very passive state during the cross operation with the pipeline constructions. In addition, as FOC is with low physical rigidity, when laid with pipes in the same ditches, the armored FOC or silicon pipe may frequently be broken during the machinery excavation operation due to irresponsible attitudes of the operators and the lack of supervision and protection by the operators compared to the large-scale machinery operation of the pipe construction.

The comparison of the adaptabilities of the two engineering plans. Controlling of the number of the connections, as well as ensuring the installation environment to meet the requirements of the specifications, it is most important for both laying of cable with the pipelines and laying the cables alone. By doing this, the constructors will be able to improve the integral quality level and the durability of the cables, which enjoys the top priority in pursuing the high qualities of the cable circuit projects.

As the laying of the cables in the same ditch with other pipelines is a method that may involve very complicated objective conditions, the method of laying the silicon core cable with the pipeline in the same ditch is similar to arranging a going through route along the pipelines. Blew in post period of time, the laying of FOC may be free from the aforementioned disturbance.

Moreover, with regard to the method of laying the pipe and blowing in the cables afterwards, the damages brought by the irregular constructions may be reflected in the silicon core cable lines, such damages can be discovered and mended during the blowing. In this way, the number of the connections can effectively be controlled and the attenuation indices of the fiber optic cable can also be ensured. In other words, by doing so, we manage to ensure the quality of the FOC.

Measure with the Frozen soil. In the seasonal frozen soil area, the FOC can be installed under the seasonal frozen soil to avoid being impacted. In ever frozen soil, silver sand can be laid above and below the FOC to reduce the impact.

High steep area. In high steep area, the FOC is always in tension stress state due to its own gravity, the environmental change may cause loss to the cable.

According to Chinese communication industry standard YD 5102-2010: Design Specifications for Telecommunication Cable Line Engineering, the fiber optical cable should use the "S" shaped laying when the slope is greater than 20 degrees and the slope length is more than 30m. But the FOC is buried in one trench with pipeline, and the ditch width is limited, so "S" shaped laying can't be used. When the slope is greater than 20 degrees, the FOC can be reserved every 30m for 2 plates, the plate radius is not less than 20 times of FOC diameter.

In high steep area，reservation number of FOC can be increased to reduce the weight influence of the cable due to tension, so as to effectively protect the cable from the tension and lower performance index.

Rock area. The biggest problem in rock area for FOC laying is that the soil is difficult to get, so the pipeline trench backfill is often accompanied by gravel or stone. Compared to pipeline, the FOC is much more easily damaged by gravel or stone, and it leads to a decline in the quality of FOC. For silicon pipe + FOC laying method in rock area, we have to excavate to search the damaged location of silicon pipe, then cut off a section of silicon pipe, and make use of the joint to connect the silicon pipe. After that, we can go on blowing the FOC into the silicon pipe. It is very difficult to repair the damaged points of silicon pipe one by one. For armored FOC directly buried method in rock area, we can only add fiber optic cable splice to deal with the damaged FOC point. But when the splice are added more and more, the FOC attenuation will become bigger and bigger, if the FOC attenuation exceed the standard, we even have to change a section of FOC cable to shorten the number of splice. In Shangxi-Beijing pipeline project, a long distance of FOC has been laid once more to change for the serious damaged armored FOC in rock area. So protection to FOC shall be considered to reduce the impact.

Picture 1. FOC laid in rock area

Combining with the actual situation of the project and design experience, silicon core pipe (fiber optic cable) protection in rock area is generally divided into the following 3 conditions:

The first backfill to trench is made use of soil. When the soil is not difficult to get near the construction site, the first backfill to pipeline trench is often made of soil, and then the silicon core pipe (fiber optic cable) can be protected by upper and lower stacking sandbags to avoid hurts and damages caused by the final backfill of the pipeline constructions.

Backfill with crushed stone. The China-Myanmar pipeline, as an example, in which the rock area along the Guizhou section is about 200 kilometers, and it is difficult to get soil near the construction site. Therefore, the rock got during the trench excavating is crushed by crushing equipment for backfill instead of soil. So, in order to save cost and reduce the construction difficulty, silicon core pipe (fiber optic cable) can be protected by upper and lower stacking bags which were filled with stone chips.

Pipeline protected by sandbags . When the pipeline is protected by sandbags, the operation procedure "trench first backfill" will not be implemented, so the silicon core pipe (fiber optic cable) shall be laid at the bottom of the trench and behind the sandbags which were used for protecting the pipeline, so as to avoid hurts and damages caused by the backfill of the pipeline constructions.

Rich water area.

In the rich water area, the underground water level is high, the soil is soft and the trench is muddy, so it is difficult to get a normal trench. The silicon core pipe (fiber optic cable) often get small bending when it is laid in such trench. The silicon core pipe (fiber optic cable) in the trench location is easily moved and not fixed, so it is difficult for cable blowing later.

In this rich water area, the underground water upwells into the trench quickly. If the pipeline is laid after a long trench excavation, the trench is always in seeper situation that the pipeline will float, and it is difficult to backfill and keep the pipe in the bottom of the trench.

In this rich water area, the pipeline laying often adopts sedimentation method. Settlement method means: After a section of the pipeline is welded on the ground, we can dig the trench directly beside or under the pipe, then the pipe will sink directly into the trench. To prevent pipeline drift caused by underground water, the trench backfill shall be finished immediately after the pipeline sinks into the bottom of the trench. In this way, excavation and backfilling work can be done continuously in nearby place, it is more efficiency.

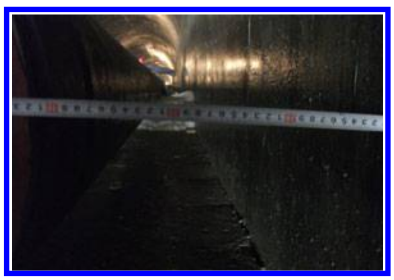
For this continuously pipeline settlement method, there is nearly no time for the silicon core pipe (fiber optic cable) to lay into the trench. To solve this problem and the other problems mentioned before such as: the silicon core pipe (fiber optic cable) often get small bending in the trench and the location of the silicon core pipe (fiber optic cable) in the trench is easily moved and not fixed, we consider to fasten the silicon core pipe (fiber optic cable) to the pipeline, and then the silicon core pipe (fiber optic cable) can be laid into the trench together with the pipeline.

Picture 2. Silicon core pipe fastened to pipeline in rich water area

But according to Chinese petroleum industry standard SY/T 4108-2012: Design and construction code of optical fiber cable(high-density polyethene silicore duct) laying in the same trench with oil(gas) Pipeline, the distance between the silicon core pipe (fiber optic cable) and the pipeline is required to be no less than 30 centimeters. The method fasten the silicon core pipe (fiber optic cable) to the pipeline has been tested in some projects, and no particular weakness has been appeared yet, so the distance requirement between the silicon core pipe (fiber optic cable) and the pipeline in the China petroleum industry standard SY/T 4108-2012 shall be changed for this difficult situation.

Tunnel.

In oil(gas) pipeline projects, steel pipe and HDPE pipe are always used to protect the FOC. It has been considered to lay the FOC beside the pipeline and make use of steel pipe to protect the cable in the tunnel as normal. But the tunnel in the oil(gas) pipeline projects is always very small to save the cost, and limited space is left for installation and protection of FOC. Such as this tunnel is shown in the pictures below:



Picture 3. Space between the pipeline and the tunnel on the right side

Picture 4. Space between the pipeline and the tunnel on the left side

As we can see in the pictures, the space left between the pipeline and the tunnel in the both side is only about 40 cm, and the FOC shall be installed after the pipeline to prevent damage to the FOC during the installation of pipeline. But the left space in the tunnel is too small for the protecting steel pipes' flitting, jointing and installing, so we changed to hang the FOC to the bracket on the wall at the high position and make use of silicon-core duct to protect the FOC. The silicon-core duct is lighter and easier to install.

CONCLUSION

The installation and protection method of FOC in particular areas have been discussed in this article. According to the engineering experience and field research, the installation and protection technical can develop thorough project practice.

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Behavior of Reinforced Thermoplastic Pipe (RTP) under Tension

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ABSTRACT

Recently, Reinforced Thermoplastic Pipe (RTP) is increasingly applied in the oil and gas industry. Since tensile behavior is a fundamental property of RTP, both theoretical method and numerical simulation are used within this paper to study the behavior of RTP under tension. In theoretical method, the model proposed by Knapp is modified and further applied to RTP, considering the interaction between pipe and wires as well as material nonlinearity. Equilibrium equations are derived based on the principle of stationary potential energy. Using Newton-Raphson method, the problem is solved by an iterative procedure. As for the finite element model, solid and truss elements are used to simulate the HDPE layer and wire respectively. Results from both methods are compared and an agreement between the theoretical method and numerical simulation is obtained. Both methods can offer valuable advice for RTP design and application.

KEYWORDS

Reinforced Thermoplastic Pipe; Tension; Theoretical Method; Finite Element Model

INTRODUCTION

Reinforced Thermoplastic Pipe (RTP) is a multi-layered composite pipe with contra-rotation helical reinforcement tapes. In a typical RTP construction, an even number of helical winding reinforcements is set between an inner layer and an outer layer. The reinforcement layers, providing high internal pressure resistance, consist of high tensile strength fibers embedded within the matrix. The inner layer provides a leak-proof capacity and corrosion resistance for the transported fluid. The outer layer