A Review on Zero Degree Horizontal Directional Drilling

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***Abstract*—Zero Degree Horizontal Directional Drilling (HDD) is a method of installing underground pipelines through trenchless methods. It involves the use of a directional drilling machine, and associated attachments, to accurately drill along the chosen bore path and back ream as per pipe specification. It differs from the actual Horizontal Directional Drilling since not taking the curvature or angle. After a detailed study of the soil investigations and site condition of the obstacles like Road, Nala and Railway the following installation method has been formulated to provide a successful installation of Pipeline across the obstacles using Zero Degree HDD.**

Keywords*— *HDD, Bore Path, Pipeline

I. Introduction

Zero Degree Horizontal Directional Drilling (HDD) is a method of installing underground pipelines through trenchless methods. It involves the use of a directional drilling machine, and associated attachments, to accurately drill along the chosen bore path and back ream as per pipe specification. It differs from the actual Horizontal Directional Drilling since not taking the curvature or angle. After a detailed study of the soil investigations and site condition of the obstacles like Road, Nalaand Railway the following installation method has been formulated to provide a successful installation of Pipeline across the obstacles using Zero Degree HDD.

The work should be go through the following procedures.

- Site inspection and survey
- Profile preparation
- Site preparation And Mobilization
- Rig machine setup.
- Piloting and Reaming.
- Preparation of pipe string.
- Clean pass And Pulling

II. Site inspection and Survey

A. Site Inspection

A site inspection of an area where work is proposed has to be done before the mobilization of rig. Site inspection will help to finalize the length as per site condition and water availability of the site for Drilling and together information for estimation and to complete the initial tasks. It can determine a precise location, Access, best orientation for the site and the location of obstacles. In order to ensure that the detailed inspection carried out is to conformity of actual site conditions, a detailed site survey is carried out. During this process, proper logistics inspection shall also be carried out to ensure easy access to equipment. Transportation of equipment is an important consideration as HDD equipment is large and heavy.

B. Site Survey

The soil condition as per site inspection, technical specifications and all other relevant data shall be studied in detail. Ground level survey should be done before the execution of Zero degree HDD. Elevation difference through the centre line should be surveyed from the site. The centre line for the zero degree HDD must be a straight line. The entry and exit must be in the centre line. The entry and exit points should be keep a minimum distance of twelve meter away from the side of the obstacle to avoid tie in problem. Maximum length of a zero degree HDD can be done is 72 meter and the depth of cover for railway crossing should be kept as minimum of 4 m, for Lined Canal/ Drain crossings depth of cover should be 2.5 m & for all roads/ highways cover should be 2m as minimum . Crossing details for each crossing shall be prepared and submitted for approval prior to start of each crossing.

III. Profile Preparation

The ground profiles, soil investigation report, technical specifications and all other relevant data shall be studied in detail and the necessary calculations shall be done to arrive at an optimum crossing profile ensuring the basic design requirements are satisfied. Each crossing drawing shall be submitted for approval of EIL-HO through EVDM portal prior to execution of crossing. Each drawing or document shall be in the same format as a normal HDD crossing indicating all crossing parameters.

IV. Site Preparation and Mobilization

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A. Approch to Site

Access to both side of the Road, Nala. Railway at the site of the crossing is to be made available through existing and the pipeline R.O.W.

B. Entry Side Preparation

Considering approach, availability of water and other accessories select one side of the obstacle as entry and other side as exit. The drilling Rig and other auxiliary equipment e.g. Mud tanks, Mud pump, Water pump, Water tank & Drill racks etc are to be located on entry side. A rectangular tie in pit is needed to be prepared. The depth of the pit should be depends upon the cover of pipe. The product pipe will be pulled up to the excavated Tie in pit for safe tie in. HDD rig will be placed 20 meter behind the tie in pit to

achieve zero degree. The pits should be properly barricaded and should follow all HSE norms. The site should have sufficient warning/ cautions boards around the pits and safeguard the site during the execution of crossings. In case of higher depth of tie in pit precautions should be taken against the high water table or collapse of pit or flooding of pit with bentonite.

C. *Exit Side Preparation*

Same as entry side preparation a rectangular tie in pit should be excavated in pipe side. Pipe side tie in pit will be maintained till reaming after that trench will be done as per string length and product pipe will be lowered before pulling in the trench to maintain zero degree. The length of trench will be as per length of string. The trench should be on the same line of the center line of drilling for the smooth pulling. In case of hard strata encountered in the trench additional depth shall be made for soft padding.

D. *Bentonite Storage and Pit*

An area within the dry hard stand is to be earmarked for storage of Bentonite next to the mud tanks. A pit shall be dug out outside the hardstand but close to same of sufficient capacity to accommodate the used slurry and the cutting mixture. This pit will be prepared after the Rig is on site. A Bentonite pit shall be dug up close to the hard stand at exit side for discharge of Bentonite slurry from the drill hole and at last all waste Bentonite will be dumped in other barren land and NOC will be provided by land owner.

E. *Mobilization*

The drilling equipment will be transported to the sites by road. Equipments used for HDD are

- Drilling Rig
- Power Pack Unit
- Mud Mixing Unit
- High Pressure Pumps
- Drill Pipes
- Cranes/Excavators/Pipe layers
- D.Gen.Sets.

V. Rig Machine Set-Up

In this crossing the drilling rig has to be set up behind the prepared tie in pit to achieve zero degree in tie in pit. The mixing and pumping installation are set up close to the Bentonite storage area and. Hoses and cables in between equipment will be installed either at perimeter of the work site. The rig shall be anchored with the help ofA steel frame footing in front of the rig and screwed and welded to the rig. Drilling tools/consumables shall be procured prior to start the work as per the requirements.

VI. Piloiting and Reaming

A. *Pilot Hole*

After mobilizing the equipment at drill location Rig shall be anchored at the specified angle as before start of pilot hole. The pilot hole shall by drill with a Horizontal Directional drilling rig, to enter the ground. The offset creates a steering bias in its direction and plane. Mechanical cutting action can be achieved by the bit attached to the offset drill string. The actual path of the pilot hole will be monitored by a state-of-art Digitracksystem. The actual path of the pilot hole is monitored during drilling by taking periodic readings of the inclination and azimuth of the leading edge. These readings, in conjunction with measurements of the distance drilled since the last survey, are used to calculate the horizontal and vertical co-ordinates along the pilot hole relative to the initial entry point on the surface and profile is plotted for the actual path being taken along the proposed alignment. Readings are taken at every joint. Horizontality of pilot hole shall be maintained during pilot hole.

B. *Reaming*

If the entry and exit side has a heavy elevation difference the rig can be set in pit at the entry side for obtaining zero degree. After the completion of pilot hole, depending on the drilled cuttings and actual soil encountered during the pilot hole, combinations of cutter and reamers will be used to enlarge the hole. It is proposed to use a 10", 14", and 18" Barrel Reamer to enlarge the hole. The hole opener or reamer will be fixed to the drill string on the pipe side and will be rotated and pulled through the pilot hole. The Barrel Reamer will cut through the hole with the cutting action of Bentonite pumped through the drill string and the teeth on the cutter body and the hole openers will be attached to clean the hole on the pipe side. Combination of Reamer/ hole opener will depend on actual site condition during drilling and may vary as per requirement. The diameter of the reamed hole should be 150% of the product pipe diameter. Figur 1 and Figure 2 represents the pulling and reaming stages.

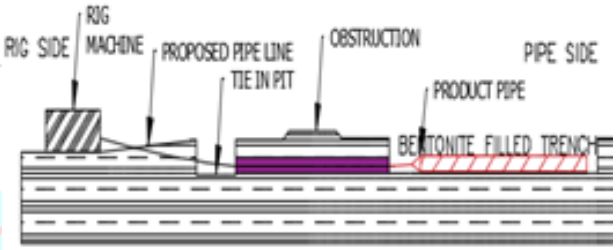

Fig. 1. During Pulling

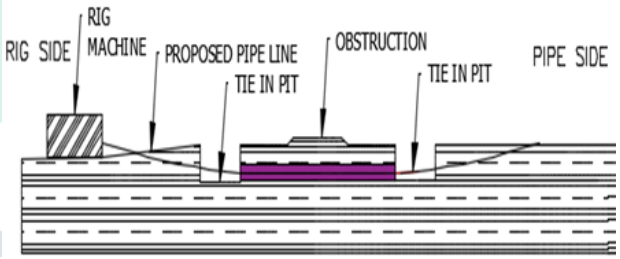

Fig. 2. During Reaming

VII. Preparation of Pipe

Mainline contractor shall keep the required string ready for Pull Back. Welding and coating has to be done in all respects as per Client specification. Also 40 mm duct pipe will be pulled along with the product pipe. As a precaution additional two duct pipes are also pulled in addition to the required two numbers. For pulling duct pipe Chinese Finger will be used along with the pulling head. 6" CS conduit pipe is not used in zero degree HDD since the pulling of the string is in a horizontal straight line and the length of crossing is comparatively less with normal HDD crossings. Taking account of the chances of damage we are providing additional two duct pipes as mentioned above .All joints must be coated with direx sleeve. A closure patch should be provided on the pulling side of the joints to avoid any damage to the coating. Pre- post hydro tests and gauging will not be done in zero degree since the number of joints in Zero degree HDD is comparatively less and the lack of curvature also redundant the need of Post- Pre hydro

tests, holyday test are need to be done before or during pulling.

VIII. Clean Pass and Pulling

Once the reaming passes are complete, a swivel will be attached to the pull head welded to the Product pipeline section to prevent torsional stress on the pipeline. Attached to the pull head shall be pulled together in the hole. Trench is to be made equal to the length of string. Trench will be filled with high viscosity Bentonite during pulling to avoid any damages to the coating during pulling. The drill pipe is aligned with the product pipe during pulling the product pipe string will be floating in Bentonite slurry. As the pipeline section is drawn towards the drill rig the pipeline section will be adequately moves in the pre-reamed hole. Bentonite will be pumped during pullback as the pipeline section is drawn towards the rig. Upon reaching rig side, the Barrel reamer and pull back swivel are removed and the pulling head will be cut from the pulled product pipe. After completion of pull back, section will be ready for tie in.

IX. Acceptance Criteria

After the pulling of product pipe the first pipe from the pulled string at the rig side shall be holiday checked for coating damage if any.

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