

CASE STUDY ON CABLE ANCHORING AND GROUTING

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Abstract - The aim of the project is to design a cable anchoring according to IS 10270 _ 1982 and to install the cable anchors in the slope soil. This project gives details about the design principles, selection, load transference mechanism, corrosion protection measure for the anchors. In this anchoring work the anchors are classified into two types according to the usage they are Permanent anchors and Temporary anchors. Permanent anchor systems are generally considered to have a life of 75 to 100 years. But mostly the anchored systems are used for the temporary applications. The life of temporary earth support system is based on the time required to support the slopes while the permanent system are installed. This project covers the slope stabilization measure in the palanpur area by the use of the temporary anchoring system. Before the anchoring works are to be done in a location the soil situation in that area is to be important. The construction and the design works of the anchoring and grouting are explained as clear as possible in this project and their difficulties related to this work are also explained.

1. INTRODUCTION

The stability of slopes will get loss because of erosion, icing, or sand dunes. But human intervention or the ground slopes also affect the stability of the slopes in some areas. The natural causes in the slope disturb the equilibrium. The road construction, rail project and the extension of existing structures are mainly disturbing the slopes. In order to increase the rail transport in the Gujarat due to the lack of rail road the goods are not properly sent to time so in the palnpur location the new rail road are built in that area for the works. The stabilization of slopes for the construction of new rail road in the palanpur is not a big tough challenge to the engineers.

1.1 Soil condition

Alluvial sandy loam to sandy clay soils are found in the Kheda, Gandhinagar, Ahmadabad and Mehsana district and the western part of the Vadodara district. These soils are the most productive soils in the state and contains fairly good amount of potassium. So in this palanpur soil the construction of railway tracks is difficult. For this purpose the slope stabilization techniques are used. In this the cable anchoring method is the one of the most important technique followed in all of the areas. This method is done to avoid the slope in the Sandy soils. By the proper installation of the cable anchors the slopes in that area are avoided very effectively.

1.2 Cable anchors – an effective solution

To stabilize the bottom round the projected excavation zone, in rock the bar Anchor was used as an economical and economical technique. Cast-in-situ concrete piles were thought-about to support the anchors.

A Ground associatechor may be a structural component put in in soil or rock that's wont to transmit an applied tensile load into the bottom

1.3 Types of anchors

Depending on their service life, rock anchors may be

- Temporary
- Permanent

Depending on the application of stress, may be

- Passive
- Active or Post-Tensioned

Depending on cement grout injection, rock anchors may be that are currently used in U.S. practice.

- Straight shaft gravity-grouted ground anchors (Type A)
- Straight shaft pressure-grouted ground anchors (Type B)
- Post-grouted ground anchors (Type C)
- Under reamed anchor. (Type D)

Table -1: Types and methods

Type	Grouting methods
A	Gravity displacement
B	low pressure (typically $p_i < 1000 \text{ kN/m}^2$)
C	high pressure (typically $p_i > 2000 \text{ kN/m}^2$)
D	Under reaming operation.

2. METHODS

The different methods carried out for the installation of anchors

- ✓ Gravity walls
- ✓ Cantilever retaining walls
- ✓ Rock anchor
- ✓ Rock Bolts
- ✓ Rock Dowels
- ✓ Soil Nailing

3. MATERIALS REQUIRED FOR CONSTRUCTION OF AN ANCHOR

3.1 Grouting Materials

The materials used during grouting process are

➤ Cement

The cement shall be either ordinary Portland cement conforming to IS: 269-1976 or sulphate resistant cement conforming to IS: 6909-19737.

The use of high alumina cement complying with BS 915 should be restricted to temporary anchorages with a service life not exceeding 6 months and to anchorages used for testing ground holding capacity. As a prudent measure to minimize sulphide content, only cements complying with BS 12, BS 1370 or BS 4027 should be used for tendon bonding in permanent anchorages.



Fig.3.1 cement OPC 53 grade

➤ Admixtures

Admixtures should only be used if tests have shown that their use improves the properties of the grout,

- ✓ Improving workability or durability,
- ✓ Reducing bleed or shrinkage or
- ✓ Increasing rate of strength development.

Admixtures should be free from any product liable to damage the steel or the grout itself. For example, no admixture that contains in total more than 0.1 % (m/m) Expanding agents containing aluminium to give grout

expansion of up to 5 % may be used in accordance with the manufacturer's instructions. Wherever possible, admixtures should be used and tested in accordance with BS 5075.

➤ Cebex-100

Cebex 100 is an admixture for cementitious grouts where it reduces the W/C ratio. It is a combination of plasticizing agent and a gas producing expansion medium. The advantages includes

- ✓ Ensures low permeability
- ✓ Long term durability
- ✓ High fluidity with low water
- ✓ High early strength



Fig.3.2 cebex-100

3.2 FABRICATION MATERIALS

The materials used during fabrication process are

- Pre-stressing steel bar
- Centralizers
- Couplers and Hexagonal Nut

3.2.1 Pre-stressing steel bar

Single bar or most well-liked for brief and medium capability anchor. rib bars will either partly or totally given deformations. this needs a minimum hole size, however the final word carrying capability of the bar is probably going to be larger than plain bar. Common sizes out there are 25mm, 32 mm, 36mm, etc.

3.2.2 Centralizers

Centralizers ought to be provided on all sinews or encapsulations to confirm that the tendon or encapsulation is centred within the grout column. Centralizers ought to guarantee among the borehole a minimum grout cowl of ten millimetre to the sinew or encapsulation at the centralizer and will be provided at centres consistent with the angle of inclination of the

bottom anchorage and therefore the doable sag between points of support so as to produce a minimum grout cowl of five millimetre to the sinew or encapsulation. The planning of centralizers among encapsulations ought to guarantee a minimum five millimetre grout cowl wherever such cowl is deemed to be a physical protecting barrier.

For rock reinforcement systems employing a bar spun into rosin, a centralizer, wherever needed, could also be wont to retain the bar within the centre of the opening and to retain rosin within the fastened anchor section in up hole configurations. wherever this centralizer is additionally used as a spacer, it ought to guarantee among the borehole the minimum specified grout cowl.

3.2.3 Core sand mixer

The coresand mixed with araldite material which is to be applied to the bond length of the anchor and this mixture is to be fully around or cover the edge of the anchor. This mixture is applied for the stiffening purpose of the anchor. The anchor is to be used in the sandy soil so during the time of stressing the anchors get pulled out to the load applied. So by applying this in the bond length and edge the anchor get stiffened it will not be pulled out as much as easier.

3.3 STRESSING MATERIALS

Typical stressing equipment includes:

- (1) Hydraulic jack and pump;
- (2) Water proofing
- (3) Jack chair

3.3.1 Hydraulic Jack and Pump

A hydraulic jack and pump area unit accustomed apply load to the connective tissue either at the anchor head or at a pull head hooked up to the prestressing steel. The hydraulic jack should be capable of applying a coaxial load to the connective tissue. The load ought to be transferred to all or any of the prestressing components of the connective tissue.



Fig 3.3 hydraulic jack and pump

3.3.2 WATER PROOFING In order to avoid corrosion the permanent anchors are taken for the water proofing test. Under the correct pressure the test will be carried out and a

packer is placed at the fixed length of the anchor and then only the test will be conducted without any disturbance.

3.3.3 Jack chair

For bar anchors, a jack chair is placed over the anchor head and it rests on the bearing plate. The jack chair enables testing to be performed on bar anchors with the nut already in place and permits access to the nut during transfer of the lock-off load.



Fig 3.5 Jack chair

4. CONSTRUCTION SEQUENCE

During the construction of ground anchorages the operations may influence the capacity of the anchorage. The operations include the following sequence.

- Drilling with or without flushing,
- Tendon installation,
- Grouting system
- Stressing

The construction of ground anchorages should be carried out in such a manner that the validity of design assumptions is maintained. A method statement detailing all operations including plant information should be prepared prior to site anchorage work. The work should be under the supervision of experienced personnel.

4.1 DRILLING

Drilling methods normally involve a rotary, percussive or rotary-percussive mechanism and, occasionally, vibratory driving technique. Core drilling is rarely used for anchorage holes because of the high cost and the belief that the smoothness of the bore reduces the bond capacity. Drilling necessarily disturbs the ground. The method should be chosen relative to the ground conditions to cause either the minimum disturbance or the disturbance most beneficial to the anchorage capacity.

Care should be taken not to use high pressures with any flushing media, in order to minimize the risk of hydro fracture of the surrounding ground, particularly in built-up areas and where anchorages are installed at shallow depth. In this connection, a free passage within the borehole to the surface is desirable to prevent the build-up of excessive pressures in the surrounding strata. A free passage or open

return also permits the driller to monitor major changes in ground type from the drill cuttings or flush. Drilling through rock is carried out by using either rotary method with water flush or using pneumatic percussion method with air and/or water flush.



Fig 4.1 Drilling

The presence of gas mains, electric cables, water mains and other services that may be damaged and cause injuries need to be investigated before work commences. Anchor holes should be drilled at specified locations and tolerances as shown on the approved drawings. Drilling tolerances include length, orientation, and diameter. Common practice is to drill beyond the design length to permit better drill hole cleaning.

4.2 TENDON INSTALLATION

Immediately prior to installation the tendon should be carefully inspected for damage to components and corrosion. Punctures of protective layers should be repaired. The tendon should be lowered at a steady controlled rate. For heavy tendons weighing in excess of 200 kg, approximately, mechanical handling equipment should be employed, as manual operations can be difficult and hazardous. The use of a funnelled entry pipe at the top of a cased hole is recommended to avoid damage to the tendon as it is installed past the sharp edge of the top of the casing. On occasion, particularly at the start of a contract, the tendon should be withdrawn after the installation operation, in order to judge the efficiency of the centralizer and spacer units and also to observe damage, distortion or the presence of smear, e.g. in chalk or clay. Where significant distortion or smear is observed, improvements in relation to the fixing or design of the centralizers, or the borehole flushing method may be necessary.



Fig 4.2 Anchor fabrication

4.3 GROUTING

After the anchor is lowered, the fixed length of the anchor is grouted. Grouting is carried out under pressure by fixing a packer at the top of the fixed length or as necessary in accordance with the type of anchor. Normally thickest possible grouting is adopted for primary grouting. Adequate care is required so that the free length of the anchor remains free to elongate. On the top of the borehole, the cement grout should be correctly stopped in order to allow a good installation of the anchor head. When the injection is finished, the extra length of injection pipes must be cut off and removed.

Grout is injected through a pipe that is installed all the way to the toe of the anchor. The grouting to be continued till the grout overflows from the top of the hole consistently. After completion of grouting operation, temporary casing should be removed any used. After removal of casing, the grout shall be filled for the decreased volume of grout.

4.3.1 Test carried out while grouting

Following tests are conducted on grout mix:

1. **Flowability:** This is done using a Flow Cone apparatus. The time taken for the flow of pre-measured quantity of grout is noted which shall be in the range of 10 to 18 seconds.
2. **Shrinkage and bleeding test:** Grout mix is poured into a transparent beaker. Shrinkage and bleeding are measured and records maintained.
3. **Compressive Strength:** Fifteen numbers Grout cubes of 100x100x100mm shall be taken and the compressive strength checked after 7days, 14days, 18 days, 21 days & 28 days

The test results of the grout shall be checked with the following properties.

- ✓ Compressive strength should not less than 30MPa before stressing of anchor.
- ✓ Bleeding of grout should be maximum of 2% after 24 hrs. There should not be any bleeding.
- ✓ The Temperature of the grout shall be 10 to 30 degrees centigrade.

4.4 STRESSING

Ground anchor is load tested to verify its capacity. The load test is performed at the ground surface and consists of tensioning the pre-stressing steel element (i.e., strand or bar) and measuring load and movement. This is commonly known as stressing.

Stressing is carried out after 21 days of grouting by when, it attains the required strength. Depending on the different types of anchors used, details of the stressing jack vary. The anchor is stressed for about 10 % of the load and elongation measurements taken beyond this range. This takes care of any seating errors.

4.4.1 INSPECTION

Field data sheets which record the correct information regarding each particular operation are an essential part of anchorage works. Stressing records and analysis sheets should not only present the load/displacement results but also provide complete information on stressing equipment, monitoring system, tendon measurements, tendon properties, and grout strength records. The monitoring of anchor head displacement in the direction of the tendon axis due to structural movement may be difficult and require calculation or interpolation. Should anchor head displacement continue during load monitoring periods it should be recorded and due correction made for resulting load loss in the anchorage. The completion of the record sheet and graphical plot of load/displacement during a stressing operation allows on-going assessment of the anchorage performance.

5. CONCLUSIONS

From the various studies and the execution work carried out the following conclusion were arrived.

- ✓ To stabilize the big slopes the prestressed anchor is the best solution. To destabilize the soil forces some of the slope protection measures are inadequate they are placing wires or constructing retaining wall are not enough.
- ✓ The bond efficiency is mainly related with the size of the borehole which is selected. The number of strands and the steel density will get increased due

to the increase in the size of the hole by increasing these tendon bond will get failure.

- ✓ The life of the anchor is directly related with the GUTS (Guaranteed Ultimate Tensile Strength) because the working load is to be established with the help of the GUTS.
- ✓ If the Fiber Reinforced Polymer anchors should be examined for slope stabilization and also these type of anchor are best suited for slope stabilization no corrosion protection is required.
- ✓ Considering different criteria the anchor type is being selected and that should be more effective in the future

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