

Large scale tunnel and bridge construction project construction essay



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Temporary Works are considered any temporary construction used to construct highway, bridge and tunnel related structures but are not incorporated into the final structure. Temporary works required for construction of permanent structures include: temporary detour bridge, Work Bridge, falsework, formwork, shoring, cofferdams and temporary retaining structures. Temporary Works shall be designed according to the guide design specifications for Temporary Works unless specified otherwise herein. Where failure of a temporary structure would have an impact on environmental protection, traffic, or public safety shall be designed and constructed using the criteria.

This report is to discuss the role of temporary works and equipment in large scale Tunnel and bridge construction project with an example of a large scale tunnel and bridge project, explain the impact of temporary works and equipment on the total cost of the project. The aim for this project is to Improve the knowledge and understanding on principles of designing and measurement of bridge and tunnel works in civil Engineering construction.

Introduction

Temporary work

Holmes, R (1995) stated that On many civil engineering projects the cost and design of temporary works forms a very high proportion of the total contract. Therefore care in design and planning is essential. Each temporary structure must be considered on its merits in relation to the importance of the contract and especially the consequences of failure. If under-design could lead to failure in operating conditions, then the cost of delay, together with loss the

saving in design. It is therefore important to design all structure to take the full in the erection of such structures in bad weather. Supervision in the erection, removal and maintenance of all these structures is paramount.

Where materials are used more than once, for example as in the case of falsework, they should be checked to ensure that they have not been weakened by their initial uses. Second-hand materials should be subject to careful scrutiny before being used in situations where the design was based on new materials.

Typical examples of temporary works are:

Ground support, eg cofferdams, timbering, underpinning and shoring.

Access bridges.

Gantries and scaffolding

Trackwork for cranes and trains

Dewatering systems

Specialised topics are dealt with in detail in subsequent chapters of the book.

Builders Plant or equipment

According to the Chudley and Greeno (2006) page 144 the builders plant ranging from small hand held power tools to larger pieces of plant such as mechanical excavators and tower cranes can be considered for use for one or more of the following reasons:-

Increase production

Reduction in overall construction costs.

Carry out activities which cannot be carried out by the traditional manual methods in the context of economics.

Eliminate heavy manual work thus reducing fatigue and as a consequence increasing productivity.

Replacing labour where there is a shortage of personnel with the necessary skills.

Maintain the high standards required particularly in the context of structural engineering works.

Bridge and Temporary Work

The bridge I choose for this topic is Juscelino Kubitschek Bridge, Brazil.

Juscelino Kubitschek was built in 2000-2002, Juscelino Kubitschek is a Arch bridge suspended deck. According to Holmes, R(2006), stated that “ Arch Bridge can support better loads-carrying member, the arch is in a state of compression throughout. This will make the design suited to materials which are weak in tension.” The Juscelino bridge

Foundation blocks, of dimensions 24 x 40 x 4m, were cast 1.5m below the water surface for architectural effect. Steel shuttering was installed and the water extracted before the concrete was poured in shallow layers, thus avoiding excessive thermal effects and cracking. 1.2m diameter piles were driven to depths in excess of 50m. Looking back to Figure 7, you will notice

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that the foundations are much deeper on the right hand side than on the left. The largely poor and extremely variable ground conditions meant that piles were driven until the desired capacity was reached, often exceeding the expected depths. Horizontal thrusts are transmitted into the foundations due to the rotation of the arches out of their normal plane. To accommodate these residual forces, the pile configuration has both vertical and inclined piles.

The inclined piers and arch starters were then constructed on the completed foundation blocks ready to accept the deck and prefabricated arch sections. The arch starters are comprised of a curved and tapered concrete hollow section, as shown in Figure 13.

Two types of deck construction have been used for the JK Bridge: the approach spans comprises of a profiled steel under tray and concrete slab; whereas the central 720m supported by the three arches is comprised of a steel under tray and orthotropic plate. Temporary piers were erected to support the central portions of the bridge whilst the deck was constructed (Figure 14).

Once the deck substructure had been completed, gigantic steel truss falsework was erected from this platform, with the temporary piers remaining in place below. A total of 1, 350 tons (approx. 1, 225 tonnes) of steel was used in auxiliary structures during the bridges construction. With the falsework in place, the prefabricated steel arch sectors could be lifted into place and welded (Figure 15). The final closing weld was welded completed

over night to limit internal strain within the arches due to daily temperature fluctuations.

The stays are made of galvanised steel strands, protected by a coat of wax and sheaths of high-density polyethane (HDPE). The stay head shown Figure 16 and is fixed, whilst the upper anchor point is turntable allowing for corrections to be made to the stay tensioning. [1]

The inclined cable configuration has been adopted to achieve a greater level of lateral restraint within the deck when subject to wind and transverse vehicular loading. The stays were installed in stages (Figures 17- 21) whilst the temporary supports were still in place, to avoid over stressing and damaging the arch. [8]

An array of 60 load cells and sensors were installed, along with surveying targets, to monitor the stresses and deformations within the bridge structure during its construction. Many of these devices remain in place today, collecting data to produce a “ Dynamic Signature” which is used to evaluate bridge performance over its service life, and to inform the maintenance programme. A large problem encountered during the construction process was the lack of local skilled labour and knowledge of steel construction. Brazil’s steel industry is relatively small, and the subsequent lack of use of the material has left the work force unskilled in steel construction techniques. The nation’s

designers also have limited knowledge and experience of working with steel, so the structural design for the arches was outsourced to Danish consultancy

COWI. Architect Alexandre Chan hopes that this iconic bridge will act to <https://assignbuster.com/large-scale-tunnel-and-bridge-construction-project-construction-essay/>

encourage a wider use of steel within designers, and ultimately stimulate the growth of Brazil's steel industry.

([http://people.bath.ac.](http://people.bath.ac.uk/cmb27/proceedings/papers/banthorpe_cm_JUSCELINO_KUBITSCHEK.pdf)

[uk/cmb27/proceedings/papers/banthorpe_cm_JUSCELINO_KUBITSCHEK.pdf](http://people.bath.ac.uk/cmb27/proceedings/papers/banthorpe_cm_JUSCELINO_KUBITSCHEK.pdf))

Gotthard Base Tunnel and temporary work

3. 0 Role of Temporary Works in Tunnel Construction Project.

Tunnel Boring Machine (TBM)

A tunnel boring machine (TBM), which is shown in Figure 3. 1, is a machine used to excavate tunnels with a circular cross section through a variety of soil and rock strata. TBM is a one of temporary works of Tunnel Construction Project. They can bore through hard rock, sand, and almost anything in between. Tunnel diameters can range from a metre (done with micro-TBMs) to almost 16 metres to date. Tunnels of less than a metre or so in diameter are typically done using trenchless construction methods or horizontal directional drilling rather than TBMs.

Tunnel boring machines are used as an alternative to drilling and blasting (D&B) methods in rock and conventional 'hand mining' in soil. A TBM has the advantages of limiting the disturbance to the surrounding ground and producing a smooth tunnel wall. This significantly reduces the cost of lining the tunnel, and makes them suitable to use in heavily urbanized areas.

Another advantage includes relatively high degree of safety against flooding and ground collapse, as the TBM isolates the ground and groundwater from the tunnel proper. Contractors are becoming increasingly familiar with the

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use of EPB type TBMs in North American but, however, not in this range. The ability to excavate and install water tight precast concrete segments as the final tunnel lining in one pass is another advantage of this method.

The major disadvantage of this method is the high initial capital expenditure for the TBM and the long lead time to manufacture, ship, assemble and test the machine, plus the normal inefficiency related to the learning curve on startup. TBMs are expensive to construct, and can be difficult to transport. However, as modern tunnels become longer,

the cost of tunnel boring machines versus drill and blast is actually less. This is because tunneling with TBMs is much more efficient and results in a shorter project. Another disadvantage is the very large circular tunnel section required to accommodate the traffic lanes, shoulders and sightline, which for vehicular tunnels is not a very efficient use of space. This also lead to buoyancy issues and the required mitigation when minimum cover under the channel is employed. Also, there is a potential for the loss of line and grade given the very tight turn radius required and steep decline followed by incline to pass under the channel.

Temporary Control Room in Tunnel Project

All tunneling activities were monitored and controlled 24 hours a day by the Temporary Control Room, through mimic or video view of all mobile and fixed equipment, thanks to a powerful redundant control system able to centralize all numerical/radio/phone communication, vocal and optical alarms. The safety desk (PCS) connected by direct phone to all emergency services (firemen, ambulances, hospital, etc.). Fixed Equipment Desk (GTC)
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is including visual permanent control of power, ventilation and pumping, connected to 8000 sensors in tunnel and served by 2 calculators, 1 programmable controller and computer networks. Rail Traffic Desk (PCT) includes vocal communication with all vehicles and optical monitoring of all tunnel activities on a large mimic served by programmable controllers. A dedicated software allowed automatic management of itineraries, location and composition of convoys, tracks and catenaries reservations, and even rolling stock status. Temporary control room is high initial capital expenditure to manufacture, sip, assemble and test the machine, plus the normal inefficiency related to the learning curve on startup.

Temporary Power Supply

TBM needs a large power to excavate tunnels with a circular cross section through a variety of soil and rock strata. A large temporary power supply is provided during large scale Tunnel construction project. The high-voltage power supply of the site is in 90 kV through two 90/20 kV transformers of 36 MVA each. Medium-voltage distribution included nine specialized substations, with tunnel power supply of 20 kV and 3. 2 kV for lighting. An emergency diesel plant was dedicated to TBMs, ventilation, lighting and pumping systems. Temporary power supply is a high impact of cost toward the total cost of the project.

Conclusion

Bridge temporary work is totally different with Tunnel temporary work. The bridge temporary work is simple compare with the Tunnel temporary work.

Bridge temporary work is such as falsework, formwork and temporary
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retaining structure. Both of bridge temporary works method is low initial capital expenditure and the short lead time to construct. For Tunnel temporary work, the high technology construction is used during tunnel construction project. TBM is the high initial capital expenditure and the long lead time to manufacture, sip, assemble and test the machine, plus the normal inefficiency related to the learning curve on startup. Large scale tunnel construction projects spend high temporary work cost for control room and power supply. At conclusion, total cost of the bridge project is lower impact compare to the tunnel project.