1. Bridge bearing

A **bridge bearing** is a component of a bridge which typically provides a resting surface between bridge piers and the bridge deck. The purpose of a bearing is to allow controlled movement and thereby reduce the stresses involved. Possible causes of movement are thermal expansion and contraction, creep, shrinkage, or fatigue due to the properties of the material used for the bearing. External sources of movement include the settlement of the ground below, thermal expansion, and seismic activity.[1] There are several different types of bridge bearings which are used depending on a number of different factors including the bridge span, loading conditions, and performance specifications.[2] The oldest form of bridge bearing is simply two plates resting on top of each other. A common form of modern bridge bearing is the elastomeric bridge bearing. Another type of bridge bearing is the mechanical bridge bearing. There are several types of mechanical bridge bearing, such as the pinned bearing, which in turn includes specific types such as the rocker bearing, and the roller bearing. Another type of mechanical bearing is the fixed bearing, which allows rotation, but not other forms of movement

Types of Bridge Bearings

Rocker Bearings

Rocker bearings have curved surfaces that allow rocking. As the bridge expands, the bearing rocks to allow movement in the horizontal direction. Rocker bearings are primarily made of steel. Rocker bearings tend to be used for highway bridges.[6]

Elastomeric Bearings

Elastomeric bridge bearings are the most popular type of bridge bearing used today. They are made of rubber and do not have any moving parts, because the rubber itself allows movement in the bridge. Elastomeric bearings can be made at a low cost, and do not need to be maintained, like other forms of bearings that have moving parts and are made of metal. Elastomeric bearings can be reinforced with steel to make them stronger if needed.[7]

Sliding Bearings

Sliding bearings have both a flat sliding surface to allow horizontal movement and a spherical surface to allow rotation. Although they used to be made of metal, sliding bearings now tend to be made of Teflon.[6]

Spherical Bearings

As the name suggests, spherical bearings are in the shape of a sphere. These bearings only allow rotation, and prevent movement in the horizontal and vertical directions.

2.Maintenance of bridge.

BRIDGE MAINTENANCE

Bridge construction and rehabilitation projects are complicated by the environmental sensitivities of working in riparian areas, including restricted work times to accommodate spawning periods of various aquatic species.

The majority of the steel bridges in the interstate highway system were constructed between 1950 and 1980; up until the mid 1970s, virtually all steel bridges were protected from corrosion by three to five thin coats of lead and chromate containing alkyd paints, creating dramatic complexity and cost increases for major and routine level bridge paint maintenance.([i]) Lead-based paint abatement and the related issues of environmental, worker, and public protection came to the forefront of the maintenance painting industry in the mid-1980s to early 1990s when regulations on hazardous waste disposal and lead exposure to workers were promulgated by EPA and the Occupational Safety and Health Administration. The changes wrought by these rules still shape the direction of maintenance painting in the bridge industry.([ii])

NHI has developed a training course, "Hazardous Bridge Coatings: Design & Management of Maintenance & Removal Operations - NHI Course # 13069" for FHWA and State bridge engineers in the area of bridge coatings maintenance and specification. This course includes guidance on coatings selection, surface preparation specification, and environmental and worker safety issues and covers some of the information in a number of the following sections.([iii])

In addition to coatings and coating removals, bridge maintenance activities include repairing bent or damaged steel beams, cracked or spalled concrete, damaged expansion joints, and bent or damaged railings. These activities can entail operation of support vehicles and equipment, pavement repair, welding and grinding operations, and associated pollutants. Environmental stewardship practices under paving, structural pavement failure (digouts), pavement grinding, and concrete slab and spall repairs may be pertinent for bridge repairs.

7.1. PREVENTATIVE BRIDGE MAINTENANCE PRACTICES

Preventative bridge maintenance avoids larger scale work in stream environments, and thus makes sense from the standpoint of stewardship of both natural and financial resources. Preventive maintenance is defined as a planned strategy of cost-effective treatments applied at the proper time to preserve and extend the useful life of a bridge.

Bridge maintenance encompasses:

- Cleaning activities, including annual water flush of all decks, drains, bearings, joints, pier caps, abutment seats, concrete rails, and parapets each spring.
- Preventive maintenance activities such as painting, coating and sealant applications and for routine, minor deck patching and railing repairs.
- Technical and specialized repairs, including jacking up the structures, crack repairs, epoxy injection, repairing or adjusting bearing systems, repair and sealing of expansion joints, repair or reinforcement of main structural members to include stringers, beams, piers, pier and pile cap, abutments and footings, underwater repairs, major deck repairs, and major applications of coatings and sealants.

- Stream channel maintenance including debris removal, stabilizing banks and correcting erosion problems.

Some of the bridge maintenance activities that provide the biggest benefit for the smallest level of investment generally include:

- Eliminating deck joints in old bridges
- Repairing or installing new expansion dams on bridge decks
- Repairing bridge decks
- Maintaining proper deck drainage
- Restoring or replacing bridge bearings
- Repairing or replacing bridge approach slabs
- Repairing bridge beam ends and beam bearing areas
- Bridge painting

Successful control of pollution from bridge maintenance and repair involves minimizing the potential sources of pollutants from the outset.

Maintaining Drainage from Bridge Decks

Effective bridge deck drainage is important because deck structure and reinforcing steel is susceptible to corrosion from deicing salts; moisture on bridge decks freezes before surface roadways, hydroplaning can occur more easily; and drainage occurs over environmentally sensitive areas. Bridge deck drainage is often less efficient than roadway sections because cross slopes are flatter, parapets collect large amounts of debris, and drainage inlets or typical bridge scuppers are less hydraulically efficient and more easily clogged by debris. Because of the difficulties in providing for and maintaining adequate deck drainage, the following practices should be used: ([xix])

- Gutter flow from roadways should be intercepted before it reaches a bridge.
- Zero gradients and sag vertical curves should be avoided on bridges.
- Runoff from bridge decks should be collected immediately after it flows onto the subsequent roadway sections where larger grates and inlet structures can be used.

Bridge Cleaning

Bridge cleaning consists of cleaning all bridge components that are susceptible to dirt, debris, bird dropping and deicing salts. Drainage systems and components subject to dirt or bird droppings accumulation need to be cleaned regularly by hand tools, air blasting or preferably water flushing.

- Dust or any material that could be inhaled should be avoided by the use of a proper respirator.

- Other components such as bare concrete decks, pier caps, abutment seats, bearing systems, non-sealed or open expansion joints, joint drainage troughs, head walls, wing walls, select beam flanges, truss joints etc. should receive a thorough water flush every spring (after applications of deicing salts have ceased) as a bare minimum.
- Personnel should become familiar with various types of bearing devices. Mechanical bearing devices should be lubricated after cleaning to prevent rusting and assist in their movement.
- Clearing of weeds, float debris, brush and overhanging limbs from the vicinity of the bridge should be performed according to best practices in channel maintenance.

7.2 AVOIDING AND MINIMIZING IMPACTS TO FISH AND WILDLIFE AND ENHANCING HABITAT

Scheduling Maintenance and Repair

There are times of the year when the effects of pollution from bridge maintenance and repair would cause the most damage and times when the damage would be minimal. The exact timing depends upon the site and the species involved.

- Schedule bridge maintenance to avoid egg incubation, juvenile rearing and downstream migration periods of fish.
- Call upon state DOT fish and wildlife specialists or local fish and wildlife agencies for assistance in scheduling to avoid aquatic impacts.

3.Tunnels: Types and Geological Investigation | Geology

In this article we will discuss about:- 1. Types of Tunnels 2. Geological Investigations for Tunnels 3. Geological Profile 4. Exploration during Construction 5. Soft Ground Tunneling.

Types of Tunnels:

Tunnels may be defined as underground routes or passages driven through the ground without disturbing the overlying soil or rock cover. Tunnels are driven for a variety of purposes and are classified accordingly.

Chief classes of tunnels are:

1. Traffic Tunnels,

2. Hydropower tunnels and

3. Public utility tunnels.

Tunnelling has been practiced on a large scale during last two centuries in all big countries for ensuring better and faster communications through roads and railways. At places such as in high mountains tunnelling becomes an absolute necessity for connecting two countries or two different places of the same country.

Metros which are symbolic of great progress achieved by advanced countries are a version of tunnelling and in fact may involve a good length of tunnels as their essential component. It (tunnelling) has been one of the most challenging jobs for the engineers.

Excavations below the ground for whatsoever purpose need very sound knowledge about the soil and rocks to be excavated on the one hand and keep the excavations so created (the tunnels) safe and stable at economically viable costs for the entire life of these projects on the other hand. Like buildings, roads, railways and many other construction jobs, tunnelling projects are included in the most important developmental activities of the big nations.

Geological information is an integral part of all the processes involved in preparing designs, executing excavations and construction of all types of tunnels.

1. Traffic Tunnels:

This group includes all tunnels which are excavated to divert the traffic load of whatsoever type from surface to subsurface routes for a short length with a view of facilitating the flow of traffic at a desired speed, maximum convenience and at minimum cost. The railway tunnels, the highway tunnels and the pedestrian tunnels are main sub groups of traffic tunnels. A few navigational tunnels also fall under this category.

A traffic tunnel is usually adopted as a convenient and cost-effective alternative to provide a direct transportation link between two places separated by such inconvenient obstacles as mountains, hills, water-bodies or even densely populated areas in the metropolitan cities.

Traffic tunnels may vary in length from a few meters to many kilometers and have been excavated in almost all major countries of the world. Reduction in distance which in turn saves considerable time and hence cost in travelling is the most common and important objective in driving tunnels compared to having surface traffic links.

Among the hundreds of traffic tunnels in different parts of the world, the following are just a few examples:

a. The Simplon Tunnel – It is a single-track railway tunnel, 19.370 km long and connects Brig in Switzerland with Chiasso in Itlay. Its construction started in 1895 and it was finally completed in 1921, thus taking more than 25 years for the job. The Simplon Tunnel passes through complex sequence of gneisses, limestones and shales under an average cover of 2 km in the Alps.

b. The Hokoriku Tunnel in Japan is a double track railway tunnel driven through sandstones and granites. It is 13.87 km in length.

c. The Mont Blanc Tunnel links France and Itlay and is a 12.6. km. long highway tunnel passing through complex rocks. It was completed in 1965.

Another tunnel starting in Italy and joining it with Switzerland is the St. Bernard Tunnel which is 6.60 km long.

d. The Jawahar Tunnel is a double tube highway tunnel on the National Highway in India and allows highway traffic even during extreme winters under the snow-clad Himalayan Mountains (Pir Panjal) at Banihal in Jammu and Kashmir, India. The tubes have lengths of 2430 meters and pass through panjal lavas, agglometeratic slates and Triassic limestones. It was completed in 1956, and has resulted in reducing the distance on the National Highway between Jammu and Srinagar to the tune of 20 kms.

2. The Hydropower Tunnels:

During twentieth century most of the tunnelling has been in connection with hydropower generation. Such tunnels are aptly called "hydropower" tunnels. In most cases these are driven through rocks for the purpose of conveying water under gravity from one point to another, as for example, to cross a hill. In such cases they are called discharge tunnels.

The other type of hydropower tunnels are those which feed water under great pressure to turbines and is distinguished as pressure tunnels. In India, till the end of 1989, more than 500 km of tunnelling had been done in hydropower projects. Some of the completed tunnels are around 15 m in diameter and 12-13 km in length. The Beas-Sutlej Link, Yamuna-II, Koyna and Balimela are few examples of hydropower tunnels.

3. The Public Utility Tunnels:

This group includes a variety of underground excavations made for specific purposes such as for disposal of urban waste (sewage tunnels), for carrying pipes, cables and supplies of oil, water etc. A recent development is construction of underground parking places and storage chambers to overcome space shortage in cosmopolitan cities.

Subways and tube railways also fall in the category of excavations but they are, in most cases, not tunnels in the strict sense because they are excavations made in the ground and then covered from the top. This method of placing the 'tubes' or 'tracks' is called cut and cover method and not tunnelling in which, top cover remains undisturbed and intact during the excavation.

Geologically speaking, only two classes of tunnels are recognized – tunnels driven through rocks (rock tunnelling) and tunnels driven through soil, loose sediments or saturated ground (soft-ground tunnelling).

Geological Investigations for Tunnels:

Objects:

Geological investigations are very essential in tunnelling projects.

These determine to a large extent solutions to following engineering problems connected with tunnelling:

(a) Selection of Tunnel Route (Alignment):

There might be available many alternate alignments that could connect two points through a tunnel. However, the final choice would be greatly dependent on the geological constitution along and around different alternatives: the alignment having least geologically negative factors would be the obvious choice.

(b) Selection of Excavation Method:

Tunnelling is a complicated process in any situation and involves huge costs which would multiply manifolds if proper planning is not exercised before starting the actual excavation. And the excavation methods are intimately linked with the type of rocks to be excavated. Choice of the right method will, therefore, be possible only when the nature of the rocks and the ground all along the alignment is fully known. This is one of the most important aim and object of geological investigations.

(c) Selection of Design for the Tunnel:

The ultimate dimensions and design parameters of a proposed tunnel are controlled, besides other factors, by geological constitution of the area along the alignment. Whether the tunnel is to be circular, D-Shaped, horse-shoe shaped or rectangular or combination of one or more of these outlines, is more often dictated by the geology of the alignment than by any other single factor.

Thus, in self-supporting and strong rocks, either, D-shape or horse-shoe shape may be conveniently adopted but these shapes would be practically unsuitable in soft ground or even in weak rocks with unequal lateral pressure. In those cases circular outline may be the first choice.

(d) Assessment of Cost and Stability:

These aspects of the tunnelling projects are also closely interlinked with the first three considerations. Since geological investigations will determine the line of actual excavation, the method of excavation and the dimensions of excavation as also the supporting system (lining) of the excavation, all estimates about the cost of the project would depend on the geological details.

Similarly tunnels passing through hard and massive rocks even when left unsupported may be regarded as stable. However, those passing through difficult grounds, although these might have been massively strengthened by secondary support system, might still collapse or bulge at places or even completely fail, if geological situation is not perceived properly.

(e) Assessment of Environmental Hazards:

The process of tunnelling, whether through rocks or through soft ground, and for whatsoever purpose, involves disturbing the environment of an area in more than one way. The tunnelling methods might involve vibrations induced through blasting or ground cutting and drilling, producing abnormal quantities of dust and last but not the least, interference with water supply system of the nearby areas.

A correct appreciation of geological set up of the area, especially where tunnel alignment happens to be close to the populated zones, would enable the engineer for planning and implementing plans aimed at minimizing the environmental hazards in a successful manner.

Methods:

The geological information required for tunnelling projects may not always be similar to that required for other civil engineering projects. As a matter of practice, the desired geological details for a tunnel project are obtained in three stages using specific methods in each stage. These stages are – preliminary surveys, conducted well before the actual planning of the project; detailed surveys which are conducted almost simultaneously with planning and concurrent explorations which are undertaken during the construction.

A. Preliminary Surveys:

These are conducted by the routine geological, geophysical and geochemical methods. In modern practice and for major tunnelling projects such fast techniques as aerial photography and seismic surveying are commonly adopted in combination with the routine surface methods.

Following geological characters are broadly established for the entire area in which the tunnel project is to be located as a result of preliminary surveys:

(a) The general topography of the area marking the highest and the lowest points, occurrence of valleys, depressions, bare and covered slopes, slide areas, and in hilly regions and cold climates, the snow-line.

(b) The lithology of the area, meaning thereby, the composition, attitude and thickness of rock formations which constitute the area.

(c) The hydrological conditions in the area, such as depth of water table, possibility of occurrence of major and minor aquifers of simple type and of artesian type and the likely hydrostatic heads along different possible routes or alignments.

(d) The structural condition of the rock, that is, extent and attitude of major structural features such as folding, faulting, unconformities, jointing and shearing planes, if developed. Existence of buried valleys is also established during the preliminary surveys.

In addition, such surveys would also reveal occurrence of reserves of rocks that could be beneficially used for construction programmes (lining etc.) in the tunnel project.

It is obvious that with the help of above information, the engineers could propose a number of alternative tunnel routes to connect the two places, and in most cases, even decide about the general run of the tunnel.

B. Detailed Surveys:

Once the general run of the tunnel has been decided, planning for its construction begins. Such plans require fairly accurate data about the rocks or the ground to be excavated for passing through.

Such data are obtained by:

(i) Bore-hole drilling, along proposed alignments and up to desired depths; the number of bore-holes may run into dozens, scores or even hundreds, depending upon the length of the tunnel; rock samples obtained from bore holes are analysed for their mechanical and geochemical properties in the laboratories;

(ii) Drilling exploratory shafts and adits, which allow direct approach to the desired tunnel for visual inspection in addition to the usual advantages of drilling;

(iii) Driving pilot tunnels, which are essentially exploratory in nature but could better be used as a main route if found suitable by subsequent enlargement.

The actual number of bore holes and shafts and adits and their depth and length are decided by the length and location of the proposed tunnel. For tunnels with little overburden, these may be driven close to the proposed tunnel. For very long and deep tunnels, economic considerations limit their number.

Information supplied by them has to be corroborated with that obtained by indirect methods such as seismic surveys. The shafts and adit borings are costly affairs but are very necessary. Often some of these could be merged with the main project subsequently as useful elements, such as for ventilation and allied purposes.

Sample of rocks obtained by direct methods from underground locations are tested in the laboratories for their:

(i) Mineralogical composition;

(ii) Strength values;

(iii) Modulus of elasticity;

(iv) Porosity and permeability and

(v) General chemical character.

Geological Profile of Tunnels:

When all the geological information gathered from preliminary and detailed surveys is plotted along a longitudinal section, the axis of the proposed tunnel being the section line, a geological profile is obtained. It is the most important geological record available with the project engineer and in fact his single most important guideline in the tunnel project.

Such a profile generally provides information regarding the following aspects of the proposed route:

(i) Location and depth of exploratory bore holes and shafts etc.

(ii) Types of rocks and their geochemical characters such as whether consolidated or unconsolidated, fissured and decayed or fresh;

(iii) Structure of rocks, that is, whether stratified, or massive, horizontal or inclined, and if inclined, degree and direction of inclination; folding and faulting with full details.

(iv) Hydrological conditions along the profile line; whether the line is above or below the water table and its relation to any aquifer that is likely to be intercepted;

(v) Ground temperature conditions, projected down to the tunnel axis based on calculations and observations.

Exploration during Construction of Tunnels:

Geological explorations in tunnelling projects do not end at the planning stage. These are carried out to supplement the information already available even during actual construction. Many important modifications in the construction programme may become necessary on the basis of such information. In fact investigations made by driving pilot tunnels form an integral part of tunnel driving process in long tunnels.

The necessity of exploration during construction arises from the fact that rocks are essentially heterogeneous and anisotropic materials that may show variations in properties in different directions and within short distances. Hence advance knowledge, as obtained by explorations and interpolations not directly involving the rocks to be attacked and excavated, is never perfect.

In principle, exploration during construction involves driving of small sized pilot-headings, openings of suitable lengths and similar methods ahead of the full section of the tunnel. In all these methods actual rock conditions are fully exposed for visual observation and direct testing for their petrological characters, structural arrangement and hydrological properties. This enables the project engineer to adopt the fittest method for excavation of the full section and for the safe and economical design of lining as and if required.

Soft Ground Tunneling:

Tunnelling in unconsolidated rocks or loose sediments or shales and clays, which require immediate support after excavation, is known as Soft Ground Tunnelling. It is comparatively complicated than tunnelling in solid rocks because of inherent structural weakness of the ground.

Geological Investigations:

In soft ground tunnelling, the emphasis of geological investigations is primarily on the following objects:

(i) Preparation of geological profile along the centre line of the proposed tunnel;

(ii) Thorough study of lithological characters and mode of origin of the sediments;

(iii) Precise establishment of groundwater regime and assessment of its possible effects on tunnel line.

The geological profile would give an idea of various types of soils that are to be encountered along the proposed tunnel. This profile would have a direct bearing upon the length of the line, design of tunnel, method of construction and type and extent of safety measures that would be needed.

Similarly, some sediment, e.g. those of glacial origin, is known to be dangerous for tunnelling. Geomorphological details associated with such deposits such as buried valleys must be ascertained in advance otherwise these would often be the cause of much serious trouble when tunnelling work force encounters them suddenly and unexpectedly.

Ground water conditions effect soft-ground tunnelling more than any other single factor. Many tunnelling hazards like failure of roofs, swelling or squeezing of ground etc. are all intimately related to groundwater conditions. Thus, hard, dry and compact clays might be quite safe and easy for excavation along tunnel line but when the same formations happen to be overlain by saturated sands and gravels, these might become the most plastic and difficult formations to tunnel.