PROJECT REPORT

(Project Semester January-July 2017)

"FOUR LANING OF HISAR-DABWALI SECTION(PACKAGE-I) UNDER NH-9 ON EPC MODE"

Submitted by

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(Deemed University)

9th January to 29th April, 2017

DECLARATION

I hereby declare that the project work entitled **"FOUR LANING OF HISAR-DABWALI SECTION(PACKAGE-I) UNDER NH-9 ON EPC MODE"** is an authentic record of my own work carried out at **"Gawar Construction Ltd., Hisar, Haryana"** as requirements of six months project semester training for the award of degree of B.E. (Civil Engineering), PEC University of Technology (Deemed University), Chandigarh under the guidance of **Mr. Devesh Kumar** and **Prof. Yatindra Kumar**, during **9th January 2017 to 29th April 2017.**

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Certified that the above statement made by the student is correct to the best of our knowledge and belief.

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1. SUMMARY

During the internship semester at Gawar Construction Ltd., Hisar, I was assigned my project primarily regarding the supervision of highways and structures activities in the "Four Laning of Hisar-Dabwali section from km. 170.00 to 227.00 (Package I) with paved shoulder in the state of Haryana of National Highway-9 under NHDP phase-IV B on **EPC** mode". For the development of nation's growth, National Highway Authority of India (NHAI) is encouraging Private Sector to take up major highway Projects based on PPP (Public Private Partnership) system.

Firstly, a comprehensive literature review of the road development in India from 19th century to present and the future prospects was done. Being assigned duties in the site on flyover, the methodology in site includes the survey works, site clearance, earthwork excavation, providing pile foundation, RE wall construction, superstructure with girders and deck, expansion joints, followed by construction of roads including subgrade, granular sub-base, wet mix macadam and dense bituminous macadam construction followed by laying of kerb and application of tack & prime coat, footpaths, road markings etc.

In this project, Survey work process and supervision of RE wall is shown as it is one of my major tasks performed there. Also, an analysis of environmental impacts on land, air, water, socio-economic and biological environment along with the mitigation measures was also accomplished. It is shown that how much construction activity will change the environmental and economic conditions.

2. INTRODUCTION

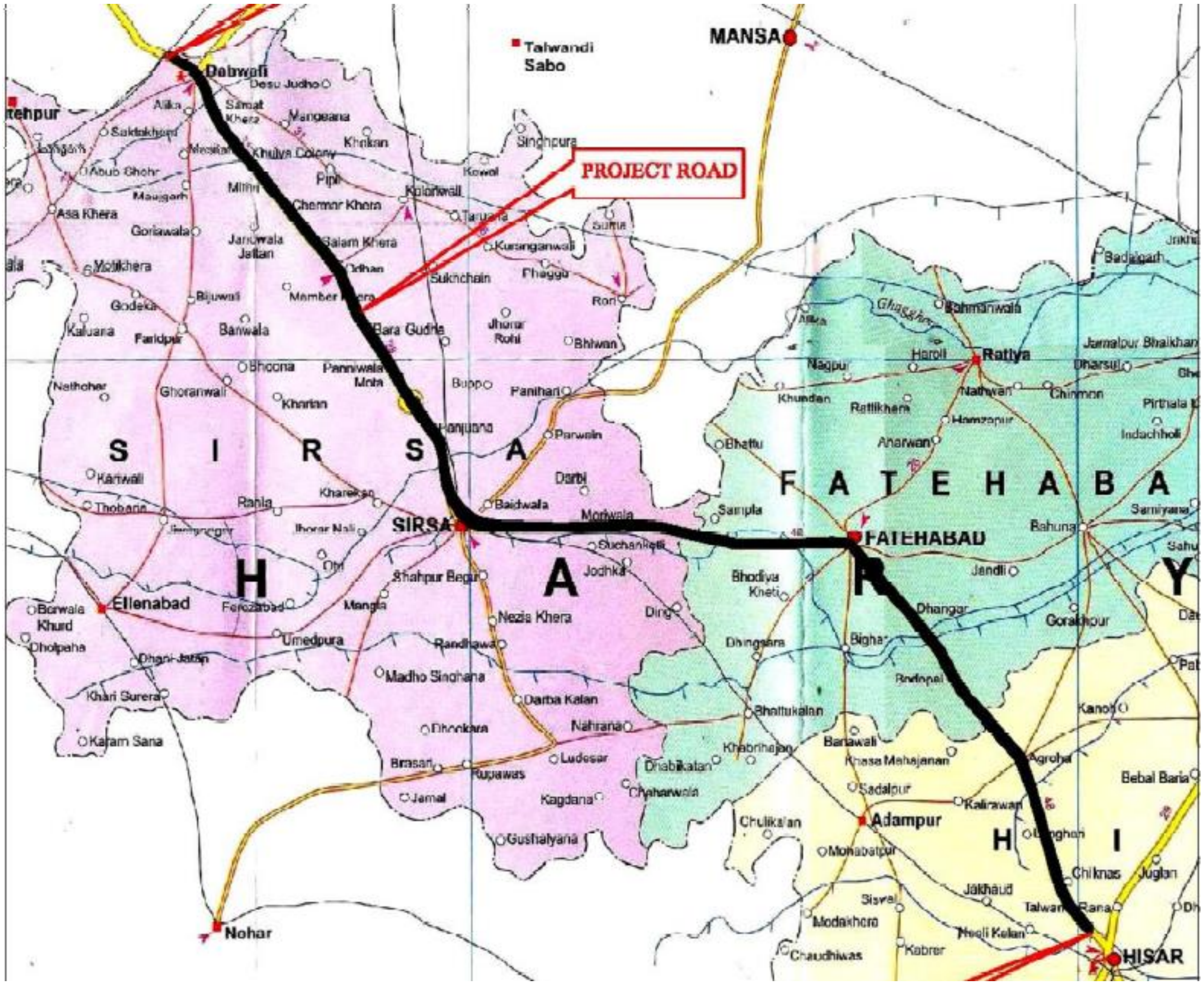
2.1 PROJECT BACKGROUND

National Highway 9 (NH 9) is a major East-West running National Highway in India. Starting at Malaut, the Highway ends at Pithoragarh while passing through the states of Punjab, Haryana, Delhi, Uttar Pradesh and Uttarakhand. The Highway came into being by merging five differently numbered national highways in 2010. The highways that were merged included the **Malaut-Delhi section of Old NH 10**, Delhi-Rampur section of Old NH 24, Rampur-Rudrapur section of Old NH 87, Rudrapur-Sitarganj-Khatima section of Old NH 74 and the Tanakpur-Pithoragarh section of Old NH 125.

This is a project of **' Four Laning of Hisar-Dabwali Section (Package I) of NH-9 from Km.170 to Km. 227.000 in the state of Haryana'** is a prestigious project to be executed on EPC mode under NHDP (National Highway Development Programme) Phase-IV B. This highway was a part of NH-10, but it is merged under NH-9 in 2010.

The alignment has been proposed such that curves and crossings for the road users are minimized. NHAI has proposed to develop 4 lanes from Hisar to Dabwali with number of flyovers, Foot-over bridges (FOB), VUP, PUP & ROBs with AVC Toll Plaza along the road to provide smooth, unobstructed flow and quick transportation of vehicles and goods. Besides it will be helpful for better road connectivity and efficient administrative control. This project has been divided into 3 reaches for each of controlling and monitoring. This project is based on package I as there are other two packages on which work is progressed simultaneously with package I.

The Project Road, Hisar-Dabwali Section (Package I) of NH-9 from Km 170.000 to Km 227.000 is 57 Km long. Project Highway is connected/intersected by two National Highways and crossed by railway lines and canals. In addition, there are 42 junctions with other major and minor roads on the Project Highway. Construction Period is 910 days and Concession Period is 24 Years. The total cost of the project is about 579.76 Crores.



Map of Four Laning Project from Hisar-Dabwali (Figure 1)

The package I of project starts from Hisar and ends at Dariyapur, a village near border of Fatehabad and Sirsa as shown in Figure 1. This map tells us about the trajectory of road from where the road is going from Hisar- Dabwali. The dark black line in figure 1 shows the part on which four laning project is to be accomplished. This project is very useful as there is large traffic on this road as this road connects border districts of Rajasthan and Haryana with Punjab. It is very useful for economy of these three states. The four laning project ends at border of Punjab. There is 1 toll only at Package I near Landhri village near Aghora.

2.2 PROJECT FEATURES

Name of Project	Four Laning of Hisar-Dabwali section from km. 170.00 to 227.00 (Package I) with paved shoulder in the state of Haryana of National Highway-9 under NHDP phase-IV B on EPC mode
Client	National Highway Authority of India
The EPC Contractor	GR INFRAPROJECTS LTD.
Independent Consultant	M/s Theme Engineering Services Pvt. Ltd.
Status	In Progress
Project Cost	INR 579.76 Cr.
Concession Period	24 years
Construction Period	910 Days
Terrain	Plain
Climatic Conditions	Extremely Hot
Average base traffic/ PCU (year 2011)	15772 PCU
Soil Conditions	Sandy Clay to Clay of Low compressibility
Type of Pavement	Flexible (Bituminous)
Number of proposed lanes	4 Lanes
Enviornmental Clearance	Ministry of Environment and Forest (MOEF)

Technical Specifications :

1.	**Pavement width (One side)**	7.5 m
3.	**Width of Flyover (one direction)**	12 m
4.	**Type of Foundation in structures**	Pile
5.	**Type of Super Structures**	RCC Solid Slab/ PSC & Box Girder
6.	**Type of Bearings**	POT-PTFE/ Elastomeric/ Tar Paper
7.	**Type of Expansion Joint**	Strip Seal/ Filler Joint

Reach-3 Salient Features :

Structures:		
1.	**Minor Bridges**	04
2.	**Major Bridges**	00
3.	**ROB**	00
4.	**Flyovers**	5
5.	**Bypass**	01 (14 Km.)
6.	**Major Junctions**	05
7.	**Minor Junctions**	42
8.	**Pipe/ Slab Culverts**	96
9.	**No. of VUP**	01
10	**Underpass**	Nil
11.		
Miscellaneous :		
1.	**Toll plaza**	01
2.	**No. of PUP/Cattle underpass**	03
3.	**Truck Lay bye**	01
4.	**Bus Lay bye**	08

2.3 CONSTRUCTION ON EPC MODE

EPC stands for Engineering, Procurement, Construction and is a prominent form of contracting agreement in the construction industry. The engineering and construction contractor will carry out the detailed engineering design of the project, procure all the equipment and materials necessary, and then construct to deliver a functioning facility or asset to their clients. Companies that deliver EPC Projects are commonly referred to as EPC Contractors.

The EPC phase of the project is also known as the execution phase which normally follows what is known as a FEED or Front-End Engineering design phase. The FEED is a basic engineering design used as the basis for the EPC phase. The FEED can be divided into separate packages covering different portions of the project. The FEED packages are used as the basis for bidding on when the client offers the EPC work to the market,

Normally the EPC contractor has to execute and deliver the project within an agreed time and budget, commonly known as a Lump Sum Turn Key (LSTK) Contract. An EPC LSTK Contract places the risk for schedule and budget on the EPC Contractor.

The project owner or client to the EPC contractors will normally have a presence in the EPC contractor’s offices during the execution of the EPC contract. The client places what can be termed a project management team or PMT to overlook the EPC contractor. The client PMT may require specialist help and bring on board project management consultants or PMC's to assist. The PMT / PMC will ensure the EPC contractor is carrying out the works in accordance with the agreed scope of works and in accordance with the Contract. It is quite common for the engineering and Construction Contractor which delivered the FEED to be offered project management Consultancy (PMC) Contract.

3. OBJECTIVE AND SCOPE OF WORK

3.1 OBJECTIVE OF THE PROJECT

- Literature review of road development in India from 19th century to present & future prospects.
- Study of Indian Standards codes, Indian Road Congress Manual and MORTH regulations
- Detailed Flyover Construction – Survey Work, Clearing and Grubbing, Earthwork excavation, Laying Foundation of Piles, Construction of Superstructure, RE Wall Construction, Laying of Road
- Detailed Highway Construction - Survey works, Road works, Clearing and Grubbing, Earthwork excavation, Embankment, Subgrade, Granular sub-base (GSB), Wet mix macadam (WMM), Dense Bituminous Macadam Construction followed by laying of kerb & application of tack & prime coat
- Comprehensive study of Environmental Impacts and Mitigation Measures.
- Overview of Road Safety in Construction Zones
- Analysis of Highways Maintenance and Modernisation of Maintenance Management

3.2 SCOPE AND NEED

A region's industrial and employment base is closely tied to the quality of the transportation system. Good, dependable transportation infrastructure allows businesses to receive inputs to production facilities and to transport finished goods to market in an efficient manner. An efficient transportation system allows companies to lower transportation costs, which lowers production costs and enhances productivity and profits.

Funds invested to upgrade or maintain the quality of National Highways enable firms currently operating on the system to ship goods more cheaply (as trucks can reach destinations without major delays) and to improve service (as delivery schedules become more reliable). Subsequently, more timely and reliable deliveries allow firms located on or near National Highways routes to minimize their stationary inventories, thereby saving inventory and storage costs and enhancing productivity. Collectively, this translates into higher productivity for the nation.

4. ORGANISATION

The organisation which is majorly working in road infrastructure sector is national highway authority of India (NHAI). NHAI is giving construction tenders to different firms for road infrastructure development. Road Transport is very important for economic development of a country. In India, Road infrastructure is used to transport over 60% of total goods and 85% of total passengers traffic. India has a road network of over 5,472,144 km (3,400,233 mi) as on 31 March 2015, the second largest road network in the world. At 1.66 km of roads per square km of land, the quantitative density of India's road network is higher than that of Japan (0.91) and the United States (0.67), and far higher than that of China (0.46), Brazil (0.18) or Russia (0.08). However, qualitatively India's roads are a mix of modern highways and narrow, unpaved roads, and are being improved. As on 31 March 2015, 61.05% of Indian roads were paved.

It enables the country's transportation sector to contribute 4.7 percent towards India’s gross domestic product, in comparison to railways that contributed 1 percent, in 2009–2010. Road transport has gained its importance over the years despite significant barriers and inefficiencies in inter-state freight and passenger movement compared to railways and air.

It is well recognized that the current road infrastructure is a serious constraint to the economic growth of a country as a large and diversified as India. The Government of India has accordingly, decided to focus on an ambitious and aggressive program of improvement/construction of roads. The development of National Highways is the responsibility of the Government of India. The Government of India has launched major initiatives to upgrade and strengthen National Highways through various phases of National Highways Development project (NHDP) which is a part of NHAI. For the development of Nation’s growth, National Highway Authority of India is encouraging Private Sector to take up major highway Projects based on BOT Model (Build, operate and transfer) system. The Government of India is attempting to promote foreign investment in road projects. Foreign participation in Indian road network construction has attracted 45 international contractors and 40 design/engineering consultants with Malaysia, United Kingdom and United States being largest parties.

4.1 NATIONAL HIGHWAYS AUTHORITY OF INDIA (NHAI)

The National Highways Authority of India (NHAI) is an autonomous agency of the Government of India, responsible for management of a network of over 70,000 km of National Highways in India. The NHAI was created by the *National Highways Authority of India Act, 1988*. In February 1995, the Authority was formally made an autonomous body. It is responsible for the development, maintenance, management and operation of National Highways, totaling over 92,991 Km in length as shown in table 1 along with other state bodies. It is a nodal agency of the Ministry of Road Transport and Highways. Mr. Yudhvir Singh Malik, IAS is the current Chairman while Dr. Yogendra Narain was the first Chairman of NHAI.

Table 1 (Indian Road Network statistic)

Roads Classification	Authority responsible	Length (Km)
National Highway	Ministry of Road Transport	97,991
State Highway	PWD of State/UT	167,109
OTHER PWD roads	PWD of State/UT	1,101,178
Rural roads	Panchayats,JRY and PMGSY	3,377,255
Urban roads	Local government and municipalities	467,105
Project roads	Various government departments and PSUs like SAIL, BRO	301,505
Total	N/A	5,472,144

Source : www.nhai.org

NHAI Vision:

To meet the nation’s need for the provision and maintenance of National Highways network to global standards and to meet user’s expectations in the most time bound and cost effective manner, within the strategic policy framework set by the Government of India and thus promote economic well being and quality of life of the people."

4.2 NATIONAL HIGHWAYS DEVELOPMENT PROJECT (NHDP)

To give boost to the economic development of the country, the Government has embarked upon a massive National Highways Development Project (NHDP) in the country.

The National Highways Development Project is a project to upgrade, rehabilitate and widen major highways in India to a higher standard.

The NHDP is the largest highway project ever undertaken in the country. The NHDP is being implemented by National Highways Authority of India (NHAI) under the Ministry of Road, Transport and Highways.

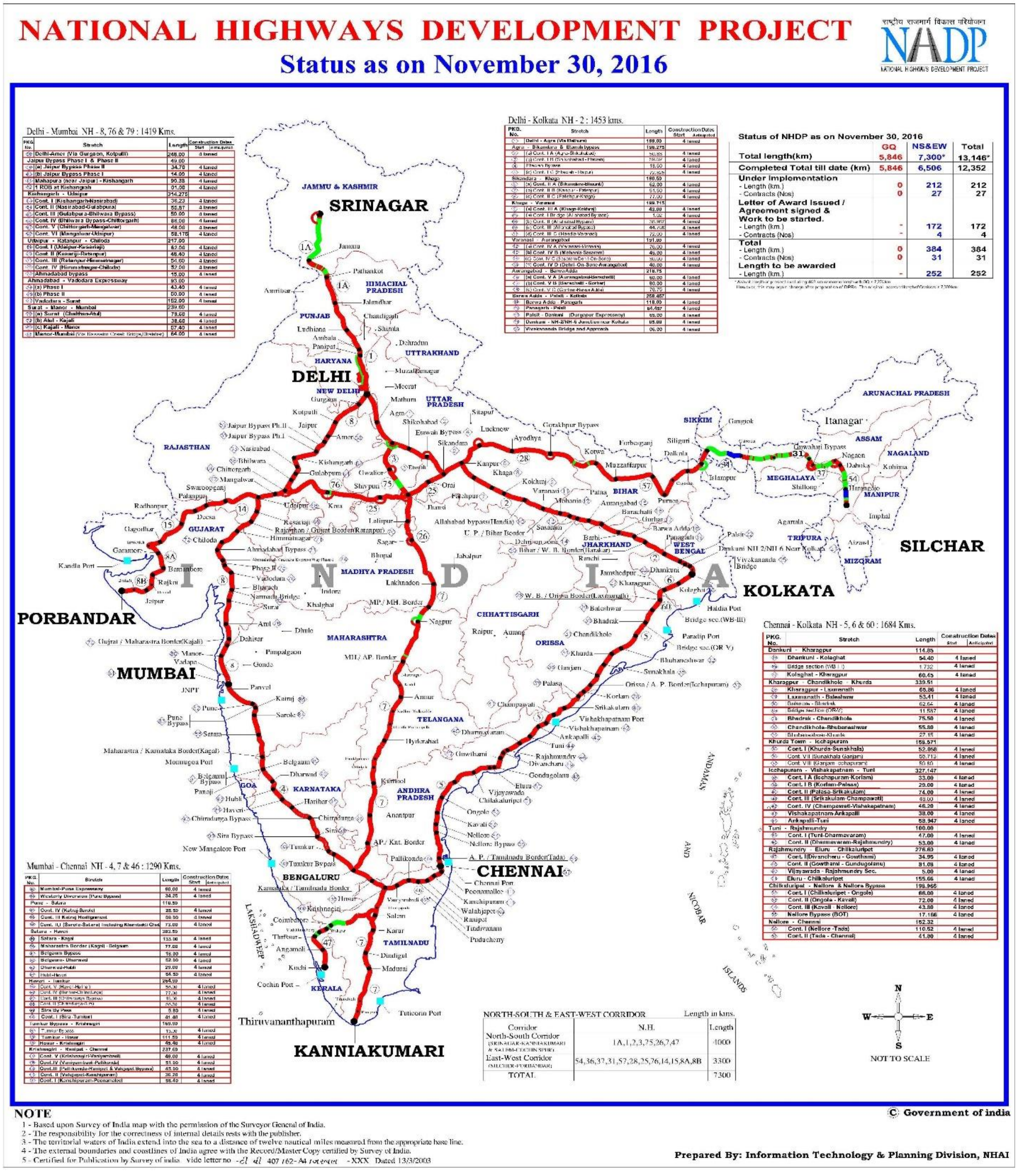
The project is composed of the following phases:

- **Phase I:** *The* Golden *Quadrilateral (GQ; 5,846 km)* connecting the four major cities of Delhi, Mumbai, Chennai and Kolkata. This project connecting four metro cities, would be 5,846 km (3,633 mi). Total cost of the project is Rs.300 billion (US$6.8 billion), funded largely by the government's special petroleum product tax revenues and government borrowing. In January 2012, India announced the four lane GQ highway network as complete.
- **Phase II:** *North-South and East-West corridors* comprising national highways connecting four extreme points of the country. The North–South and East–West Corridor (NS-EW; 7,300 km) connecting Srinagar in the north to Kanyakumari in the south, including spur from Salem to Kanyakumari (Via Coimbatore and Kochi) and Silchar in east to Porbandar in the west. Total length of the network is 7,300 km (4,500 mi). As of April 2012, 84.26% of the project had been completed and 15.7% of the project work is currently at progress. It also includes Port connectivity and other projects — 1,157 km (719 mi). The final completion date to February 28, 2009 at a cost of Rs.350 billion (US$8 billion), with funding similar to Phase I.
- **Phase III:** The government recently approved NHDP-III to upgrade 12,109 km (7,524 mi)of national highways on a Build, Operate and Transfer (BOT) basis, which takes into account high-density traffic, connectivity of state capitals via NHDP Phase I and II, and connectivity to centers of economic importance. Contracts have been awarded for a 2,075 km (1,289 mi).
- **Phase IV**: The government is considering widening 20,000 km (12,000 mi) of highway that were not part of Phase I, II, or III. Phase IV will convert existing single lane highways into

two lanes with paved shoulders. The plan will soon be presented to the government for approval.

- **Phase V:** As road traffic increases over time, a number of four lane highways will need to be upgraded/expanded to six lanes. The current plan calls for upgrade of about 5,000 km (3,100 mi) of four-lane roads, although the government has not yet identified the stretches.
- **Phase VI:** The government is working on constructing expressways that would connect major commercial and industrial townships. It has already identified 400 km (250 mi) of Vadodara (earlier Baroda)-Mumbai section that would connect to the existing Vadodara (earlier Baroda)-Ahmedabad section. The World Bank is studying this project. The project will be funded on BOT basis. The 334 km (208 mi) Expressway between Chennai—Bangalore and 277 km (172 mi) Expressway between Kolkata—Dhanbad has been identified and feasibility study and DPR contract has been awarded by NHAI.
- **Phase VII:** This phase calls for improvements to city road networks by adding ring roads to enable easier connectivity with national highways to important cities. In addition, improvements will be made to stretches of national highways that require additional flyovers and bypasses given population and housing growth along the highways and increasing traffic. The government has not yet identified a firm investment plan for this phase. The 19 km (12 mi) long Chennai Port—Maduravoyal Elevated Expressway is being executed under this phase.

The Phase I and phase II of highways connect most of the major manufacturing centers, commercial and cultural cities of India. The NHAI is also responsible for implementing other projects on National Highways, primarily road connectivity to major ports in India. Figure 2 shows the different phases of NHDP project. In this, red line shows the phase I and phase II. Different highways which are four laned under Phase IV B are shown. The completed projects are shown till 30 November 2016 (Figure 2).



National Highway development project (NHDP) map (Figure 2)

5. LITERATURE REVIEW

5.1 HIGHWAY DEVELOPMENT IN INDIA

5.1.1 Roads in Ancient India

The excavations of Mohenjo-daro and Harappa have revealed the existence of roads in India as early as 25 to 35 centuries B.C. Old records reveal that in early periods the roads were considered indispensible for administrative and military purposes. The ancient sculptures refer to the existence of roads during Aryan period in the 4th century B.C.

5.1.2 Roads in Nineteenth Century during British rule

At the beginning of British rule, the conditions of roads deteriorated. The economic and political shifts caused damage to a great extent in the maintenance of the road transportation. Prior to the introduction of railways, a number of trunk roads were metalled and bridges were provided.

The construction of the Grand Trunk Road was undertaken by the Public Works Department in 1865, led by Lord Dalhousie, the-then Governor General.

5.1.3 Road Development in India during Twentieth Century

During the second decade of 20th century, the motor vehicles using the roads in India increased and this demanded better roads. However, the roads that existed then with 'Water Bound Macadam' (WBM) surface and other inferior surfaces were not able to withstand the mixed traffic consisting of slow moving vehicles and the motor vehicles. The predominant component of the traffic consisted of bullock carts with steel tyred wheels which could abrade, grind and crush the stone aggregates of WBM road surface and form dust. The passage of fast moving automobiles would raise the dust behind them during dry weather and churn up the mud and deteriorate the road surface at a rapid rate during wet weather. Due to the combined effort od the mixed traffic movement the roads deteriorated during this period.

A resolution was passed by both Chambers of the Indian Legislature in 1927 for the appointment of a committee to examine and report on the question of road development in India. In reponse to the resolution, a Road Development Committee was appointed by the Government in 1927, with M.R. Jayakar as the Chairman.

5.1.3.1 Jayakar Committee and the Recommendations

The Jayakar committee submitted its report by the year 1928. These recommendation were very useful for early growth of roads in India. But full growth in road construction occurs after independence. The most important recommendations made by the committee are:

1. The road development in the country should be considered as a national interest as this has become beyond the capacity of provincial governments and local bodies. An extra tax should be levied on petrol from the road users to develop a road development fund called Central Road Fund.
2. A semi-official technical body should be formed to pool technical know-how from various parts of the country and to act as an advisory body on various aspects of roads.
3. A research organization should be instituted to carry out research and development work and to be available for consultations.

5.1.3.2 Central Road Fund

Based on the authority of a resolution adopted by the Indian Legislature, the Central Road Fund (CRF) was formed in March, 1929. The accounts of the CRF are maintained by the Accountant General of Central Revenues and the control on the expenditure is exercised by the Roads Wing of Ministry of Transport. The fund accrued from different sources is distributed for the development and maintenance of national highways, state roads, rural roads and for constructing identified grade separators across railway tracks.

5.1.3.3. Indian Roads Congress

At the instance of central government, a semi-official technical body known as Indian Roads Congress (IRC) was formed in 1934. It was one of the main recommendations by Jayakar Committee. IRC was constituted to provide a forum for regular pooling of experience, technical knowledge and ideas on all matters related to the planning, construction and maintenance of roads in India. The IRC has played important role in the formulation of all road development plans in India.

The IRC has become an active body of national importance controlling specifications, standards and guidelines on materials, design and construction of roads and bridges. IRC publishes journals, research publications, standards, specifications, guidelines and other special publications on various aspects of Highway Engineering. The technical activities of the IRC are mainly carried out by the Highway Research Board and several committees consisting of experts on each subject. The

IRC works in close collaboration with Roads Wing of the Ministry of Road Transport & Highways, Government of India. This lays the foundation for the first road plan in India known as Nagpur Road Conference as described below in section 5.1.3.4

5.1.3.4 Nagpur Road Conference

A conference of the chief Engineers of all states and provinces was convened in 1943 by the Government of India at Nagpur, at initiative of Indian Road Congress to finalize the road development plan for the country as a whole. This is a landmark in the history of road development in India, as it was the first attempt to prepare a coordinated road development programme in a planned manner. This development plan is known as Nagpur Road plan.

The total target road length aimed at the end of this plan period was 16 km per 100 square km area of the country.

5.1.3.5. Central Road Research Institute

CSIR-Central Road Research Institute (CRRI), a premier national laboratory established in 1952, a constituent of Council of Scientific and Industrial Research (CSIR) is engaged in carrying out research and development projects on design, construction and maintenance of roads and runways, traffic and transportation planning of mega and medium cities, management of roads in different terrains, improvement of marginal materials, utilization of industrial waste in road construction, landslide control, ground improvements environmental pollution, road traffic safety and analysis & design, wind, fatigue, corrosion studies, performance monitoring/evaluation, service life assessment and rehabilitation of highway & railway bridges. The institute provides technical and consultancy services to various user organizations in India and abroad. For capacity building of human resources in the area of Highway Engineering to undertake and execute roads and runway projects, Institute has the competence to organize National & International Training Programs continuing education courses since 1962 to disseminate the R&D finding to the masses.

4.1.3.6 Second Twenty Year Road Development Plan, 1961-81

The second twenty-year road development plan for the period 1961-81 was initiated by the IRC and was finalized in 1959 at the meeting of Chief Engineers held at Mumbai and the same was forwarded to the central government. The plan gave due consideration to the development that are actually taking place and developments that have to take place in various regions of country.

The total road length at the end of this second twenty year road development plan was almost double as that of Nagpur road plan target. An outlay of Rs. 5,200 crores for the period ending 1980-81 was envisages for this twenty year plan. The total length of all categories of roads achieved by the year 1974 was 11.45 lakhs km and total density of road length was 34.8 km per 100 sq km area. This plan is also called Bombay Road plan.

5.1.3.7 Highway Research Board

HRB of the Indian Roads Congress was set up in 1973 with a view to give proper direction and guidance to road research activities in India. HRB has recommended suitable financial allocation of research by central and state governments and has chosen high priority research schemes for being taken up first.

The objective of IRC Highway Research Board are to :

- ascertain the nature and extent of research required
- correlate research information from various organisations in India and abroad with a view to exchange publications and information
- co-ordinate and conduct correlation services
- collect and disseminate results of research and channelize consultative services

5.1.3.8 Third Twenty Year Road Development Plan, 1981-2001

The third twenty year road development plan 1981-2001 was prepared by the Road wing of the Ministry of Shipping and Transport with the active co-operation from a number of organizations and experts in the field of Highway Engineering and Transportation. This plan is also called as Lucknow Road plan.

This was aimed at increasing the total road length from 15,02,700 km in 1981 to 27,02,00 km by year 2001. An increase in toad density from 46 km per 100 sq. km in 1981 to 82 km per 100 sq km by year 2001.

4.1.4 Road Development in India during Twenty First Century

4.1.4.1 National Highways Development Projects

Realising the deficiencies of the national highway system in the country, the National Highways Authority of India (NHAI) took up the National Highways Development Projects (NHDP) by the year 2000 in 7 different phases . This included the linking of East-West Corridors as well as North-South Corridors. Also, for connecting the major metropolitan cities of nation, "Golden Quadrilateral" was included in phase-I of NHDP. The Development of expressways was planned as phase VI and improvements of urban road networks as phase VII.

5.1.4.2 Pradhan Mantri Gram Sadak Yojana

An accelerated village road development programme called 'Pradhan Mantri Gram Sadak Yojana' (PMGSY) was launched by central government in December, 2000 to provide village connectivity with all-weather road. The objective of PMGSY is to provide connectivity to all unconnected habitations having population of 500 and above with all-weather roads.

5.2 CONTEMPORARY ROAD DEVELOPMENT & FUTURE PROSPECTS

India has the second largest road network across the world at 4.7 million km. This road network transports more than 60 per cent of all goods in the country and 85 per cent of India’s total passenger traffic. Road transportation has gradually increased over the years with the improvement in connectivity between cities, towns and villages in the country.

In India sales of automobiles and movement of freight by roads is growing at a rapid rate. Cognizant of the need to create an adequate road network to cater to the increased traffic and movement of goods, Government of India has set earmarked 20 per cent of the investment of US$ 1 trillion reserved for infrastructure during the 12th Five-Year Plan (2012–17) to develop the country's roads.

5.2.1 Market Size

The value of roads and bridges infrastructure in India is projected to grow at a Compound Annual Growth Rate (CAGR) of 17.4 per cent over FY12–17. The country's roads and bridges infrastructure, which was valued at US$ 6.9 billion in 2009 is expected to touch US$ 19.2 billion by 2017. The financial outlay for road transport and highways grew at a CAGR of 19.4 per cent in the period FY09-14.The plan outlay for 2015-16 stepped up budgetary support for Road Transport and Highways to Rs 42,912 crore (US$ 6.43 billion).

5.2.2 Key Investments

Some of the key investments and developments in the Indian roads sector are as follows:

- The National Highways Authority of India (NHAI) is planning to acquire 10,000 hectares of land in FY 2015-16, up from 6,733 hectares in FY2014-15, to speed up road laying in the country.

- The Government of India plans to award 100 highway projects under the Public-Private Partnership (PPP) mode in 2016, with expectations that recent amendments in regulations would revive investor sentiments in PPP projects in the infrastructure sector.
- The Ministry of Road Transport and Highways has undertaken development of about 7,000 km of national highways under Bharatmala Pariyojana at an estimated cost of Rs 80,000 crore (US$ 12 billion) in consultation with state governments. The Cabinet Committee on Economic Affairs (CCEA) has permitted 100 per cent equity divestment by private developers after two years of construction completion for all Build–Operate–Transfer (BOT) projects, irrespective of the year of award of the project.
- The Union government approved the construction of around 1,000 km of expressways at a cost of Rs 16.68 crore (US$ 2.5 million) on a design-build-finance-operate-transfer (DBFOT) mode.
- The Ministry of Road Transports and Highways plans to award 273 road projects covering a length of around 12,900 km at an estimated cost of Rs 1,26,700 crore (US$ 19 billion) in FY 2015-16.
- Chhattisgarh is planning to invest Rs 9,500 crore (US$ 1.42 billion) to upgrade 44 roads in the state

5.2.3 Government Initiative

- The Government has unveiled investments plans totaling Rs 10 trillion (US$ 150 billion) in highways and shipping sector by 2019.A total of 599 highways projects covering around 12,903 km of national highways have been sanctioned1, incurring an expenditure of Rs 108,000 crore (US$ 16.2 billion).

Some of the recent developments are as follows:

- Minister of Road Transport and Highways Mr Nitin Gadkari has announced that the target for laying out new roads in India will be increased to 150,000 kilometers per year from 2016 compared to existing 96,000 kilometers. Also, the government is planning a compensation policy for road sector developers, which will seek to compensate companies for any delays related to clearance for road projects.
- The Government of India signed the agreement for third and last tranche of US$ 273 million loan, out of total US$ 800 million loan agreement with The Asian Development Bank (ADB), for constructing 6,000 kms of all-weather rural roads in Assam, Chhattisgarh, Madhya Pradesh, Odisha and West Bengal, by December 2017.

- In the month of November 2015, among various areas of infrastructure spending by the government, the roads segment led in terms of tenders issued (59 per cent of total tenders) and contracts awarded, with an increasing shift to Engineering, Procurement and Construction (EPC) type of contracts for road projects.
- India and Japan are planning to enter into a partnership and launch an infrastructure finance company which will provide soft loans for Indian road projects with a credit target of Rs 2 lakh crore (US$ 30 billion).
- The Cabinet Committee on Economic Affairs (CCEA) has approved a one-time fund infusion in road projects which are at least 50 per cent complete till November 2014, but have not progressed further because of shortage of funds.
- The Ministry for Road Transport and Highways showcased revival of 34 projects worth more than Rs 26,000 crore (US$ 3.9 billion) in its latest presentation on infrastructure targets to Prime Minister Mr Narendra Modi, saying the projects spanning over 4,084 km are being restructured or converted from public-private partnership to engineering, procurement and construction (EPC) mode to get them going. Of these, five projects have been handed over to the state governments concerned while another 18 will be awarded in EPC mode.

The government, through a series of initiatives, is working on policies to attract significant investor interest. The Indian government plans to develop a total of 66,117 km of roads under different programmes such as National Highways Development Project (NHDP), Special Accelerated Road Development Programme in North East (SARDP-NE) and Left Wing Extremism (LWE), and has set an objective of building 30 km of road a day from 2016.

6. METHODOLOGY

My work was majorly focused on the site work and supervision at flyover mainly on reinforced earth wall construction. Also, construction of service lanes near flyover and construction of other roads were one of my other tasks.

FLYOVER CONSTRUCTION:

1. Site clearance
2. True and proper setting out and layout of work
3. Providing pile foundations
4. Providing Substructure including pile cap, pier, pier cap and abutments
5. Providing super structure including bearings, deck, girders etc.
6. Earthwork excavation
7. Construction of reinforced earth wall (RE Wall)
8. Construction of road including granular sub base (GSB), wet mix macadam (WMM) and bituminous pavement
9. Providing footpath, median, crash barrier

6.1 SITE CLEARANCE

The work shall commence soon after mobilization at the site has been completed to the extent that this activity can be taken up.

Site clearance shall be carried out using bull dozers to generally scrap off the top crest of the formation bed with the main aim to clear the proposed road corridor of major bushes, unwanted waste materials and vegetation's and roots to enable field survey works to be carried out up to reasonable precision and accuracy besides conducting soil sampling and testing, visual or laboratory, on the existing ground materials to enable decision on further course of action on mode of flyover construction.

During this course of such clearance unwanted materials shall be disposed of to the designated places as directed, by using tippers. At the same time, all that soil which is found reusable in terms of execution of this project shall be stock piled along the work stretches. Mainly the area where pile foundation is to be installed is to be cleared first because rest of the area is acting as passage to the existing traffic.

6.2 TRUE AND PROPER SETTING OUT AND LAYOUT OF WORK

After the ground clearance at site mainly the area where foundation is to be laid, survey work is done majorly so that proper setting and layout of the work is done. A temporary benchmark is set up near the flyover site so that the precise location of site can be decided. It is done according to the map and reduced levels given on the map are used. An auto level is used to get the reduced level of the site according to given in design reduced levels (RLs). It is done as firstly auto level is placed at a point and adding staff height to the temporary benchmark provided. Then the height of instrument (HI) is used to find the RL of any point. This can be done by placing the staff at where we need RL and then subtracting the staff height to get the RL of any arbitrary point. The temporary benchmark is used to find the RL of any point near the benchmark so that it can match with the design RL. After getting the design RL, we can estimate cutting and filling required and the different point where foundation is to be laid etc. In this way, proper setting and layout of work is done in accordance with design data.

6.3 PROVIDING PILE FOUNDATION

Since the bridge must carry a big live load and its dead weight is also very large so we cannot go for simple foundation but pile foundation. Pile foundation is one type of deep foundation. It is used where the good soil is at higher depth (10 or 15m) or soil having low bearing capacity. Pile is also used for tall structures. In pile foundation, the load coming from the super structure is taken by pile cap and equally distributed in no of piles, pile transfers this load into the soil. The installation procedure of pile foundation is as follows:

6.3.1. Excavation of Pile Shaft

The bored pile equipment set including hydraulic oscillator, hydraulic vibrator, hammer grab and rock chisel used in this project is very common and being widely used for shaft excavation.

1. Set out the correct position of the bored pile on site.

2. Excavate about 3 - 4m of the pile to remove shallow obstructions and then backfill, wherever necessary.

3. Install the bottom section of temporary casing of required diameter into the ground by oscillating and jacking or by vibrating motion exerted by the oscillator and the vibrator respectively.

4. Set up hydraulic oscillator or vibrator in conjunction with a crawler crane.

5.Excavate within the casing by hammer grab and redrive the steel casing simultaneously by using the heavy-duty casing oscillator or vibrator. Rock chisel in various types will be employed for removal of obstruction or hard materials during the above process.

6. Extend the steel casing by bolting or welding on additional casing during the excavation.
7. Water will be pumped into the casing during excavation and constant water head will be maintained to prevent any ingress of material from the bottom of casing.
8. Verticality of the casing will be monitored by means of spirit level from time to time.
9.Continue the above procedure until the founding level of pile has been reached.
10. Pile base enlargement will be formed by employing a bell out chisel or a reverse-circulation drill.

6.3.2 Cleaning of pile shaft

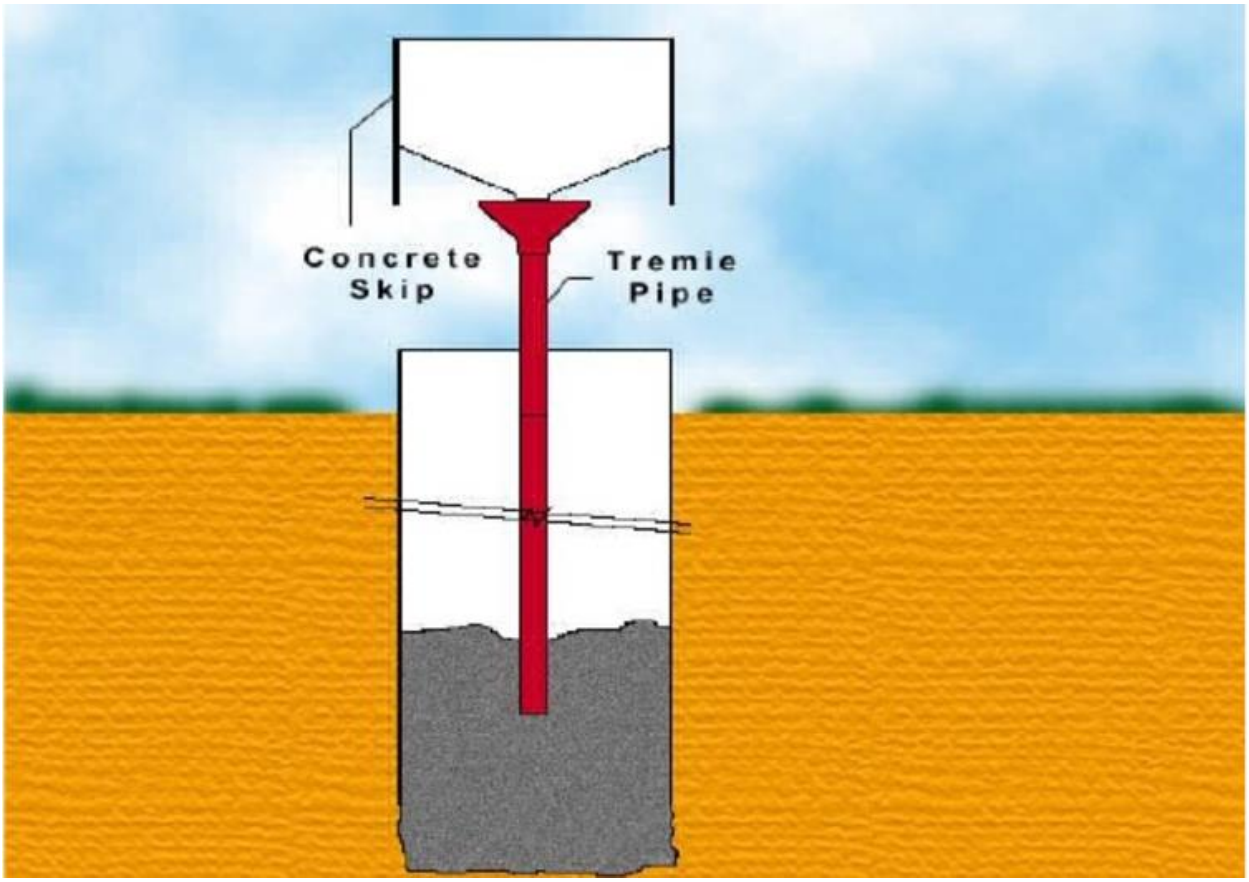
Final cleaning will be carried out by the air-fitting method using high pressure air compressors. The slime and muddy water within the casing will be cleared and delivered into a desilting tank before discharge.

6.3.3 Tremie Concreting

1. The pile shaft will be concreted by "Underwater Tremie Technique". The tremie pipe sections will be inserted and be jointed until it reaches the bottom of pile shaft. Concrete will be poured into the tremie pipe by using a concrete skip. Concreting will be carried out in one continuous operation until the required level has been reached as shown in figure 3.
2. As concreting proceeds, the level of the concrete relative to the ground level will be monitored by measuring with weighted tape after each skip of concrete is placed.
3. The base of the tremie pipe will be kept with a minimum depth of approximate 1 to 2m below the surface of the concrete.
4.The temporary casing will be extracted simultaneously by the oscillator during concreting. A head is always maintained between the top of concrete and the bottom of steel casing.

6.3.4 Installation of Reinforcement

After the completion of concreting, dowel bars of required length and numbers will be installed into the pile shaft and down to the predetermined level before the extraction of bottom steel casing.



Procedure of Tremie Concreting (Figure 3)

6.4 PROVIDING SUBSTRUCTURE INCLUDING PILE CAP, PIER, PIER CAP

Depending from project to project, substructure of a flyover is installed. There are three basic parts of a substructure:

6.4.1 Pile Cap: This is used to transfer load to the foundation by the superstructure. On this cap, pier and pier cap rests along with superstructure. This can be easily installed with the help of a rectangular formwork of steel with concrete casted in situ as shown in figure 4. Pile cap is half above the ground and half part approximately below it. It has to be constructed with high quality concrete because it acts as a base to pier and pier cap.

Pile cap reinforced structure (Figure 4)

6.4.2 Pier: It is a circular reinforcement with high quality concrete used to provide support to superstructure as shown in figure 5. It is casted same as pile cap by in situ casting. The construction process is simple as formwork of steel and then concrete of high quality is poured into it. Wherever required, slender piers should be used so that there is sufficient flexibility to allow for shrinking, creep and temperature effect to be transmitted to the abutments without the need of bearings at piers or the intermediate joints at deck.

6.4.3 Pier Cap: It is situated above pier and this is used as resting structure for superstructure. This is used as transfer mechanism for concentrated load of deck to pier. Pier cap is installed in situ by reinforced concrete. This is shaped as a flat slab on which bearing is placed along with girders as shown in figure 5.

6.4.4 Abutments: It is a substructure provided at the ends of span on which superstructure or deck of slab rests. In case of multi span bridge, the end support is supported by piers and intermediate slab are supported by piers. Its function is to support the approach slab and to restrict lateral moments. The abutment is cross wall as in case of reinforced earth wall construction comprised of two span which are carried by abutments.

Part of substructure (Figure 5)

6.5 PROVIDING SUPER STRUCTURE INCLUDING BEARINGS, DECK, GIRDERS

6.5.1 BEARINGS: It is an interface between substructure and superstructure. This interface is vital because superstructure undergoes dimensional changes and deformations due to various factors like thermal expansion, creep etc. If the movement between superstructure and substructure is not allowed to take place freely, it will develop large moments and causes damage to the superstructure. Since the bearing is used to accommodate various permitted movements. Thus, it is important to provide a bearing so that it can transfer all loads from superstructure to substructure. It is generally provided with a pedestal on pier cap as an interface between substructure and superstructure as shown in figure 6.

6.5.2 DECK: It is a superstructure which bears the traffic loads. It is a flat surface which is supported by girders of precast, post tensioned concrete. Finishing on deck is done by coats of asphalt and concrete. As shown in figure 7, an approach slab is also prepared with deck as a part of superstructure near deck on both sides. This is done to provide ease for traffic in approaching deck and to match the level of superstructure easily by reinforced earth wall on both sides. A deflection check by authorities is also done on the superstructure by placing heavy weight on deck and deflection is noted near the bearing to check for proper deflection so to ensure safety in construction. Also, to see whether the company has maintained proper guidelines while making superstructure. This check is very important for superstructure.

Bearing at pedestal supported on pier cap (Figure 6)

Deck or span with approach slab (Figure 7)

6.5.3 GIRDERS: It is that part of superstructure which supports deck and transfer loads to the piers or abutments as shown in figure 8. The technique of pre-stressing girders eliminates cracking of concrete under all stages of loading and enables the entire section to take part in resisting moments. As dead load moments are neutralized and the shear stresses are reduced, the sections required are much smaller than in reinforced concrete. Pre-stressing can be accomplished in three ways: pre-tensioned concrete, and bonded or unbonded post-tensioned concrete. The unbonded post tensioned concrete is mainly used. In this system, firstly high tensile steel cables/wires (also known as strands or tendon) encased in sheathing pipes were laid as per design and then concreting is done. The transfer of tension to the concrete is achieved by the steel cable acting against steel anchors embedded in the perimeter of the slab. After the hardening of concrete the stretching of wires was done by means of hydraulic jacks. The jacking was done from both ends. The wires were jacked a few percent above their specified initial pre-stress to minimize creep in steel and to reduce frictional loss of pre-stress. The wires are anchored to concrete after stretching by wedge action producing a friction grip on wires. For individual strand tendons, no additional tendon ducting is used and no post-stressing grouting operation is required, unlike for bonded post-tensioning. Permanent corrosion protection of the strands is provided by the combined layers of grease, plastic sheathing, and surrounding concrete.

PRECAUTION TO BE TAKEN DURING PLACING OF CONCRETE:

1.Under no circumstances, the water should be added to the concrete during its passage from mixer to the formwork

2.The formwork or the surface which is to receive the fresh concrete should be properly cleaned prepared and well-watered.

3. As far as possible, the concrete should be placed in single thickness. In case of deep sections, the concrete should be place in successive horizontal layers and proper care should be taken to develop enough bonds between successive layers.

4.The concrete should be thoroughly worked around the reinforcement and tapped in such a way that no honeycombed surface appears on removal of the formwork.

5.The concrete should be place on the formwork as soon as possible.

6.During placing, it should be seen that all edges and corners of concrete surface remain unbroken, sharp and straight in line.

7.Placing of concrete must be carried out uninterrupted between predetermined construction joint.

CONSOLIDATION OF CONCRETE: The main aim of consolidation of concrete is to eliminate air bubble sand thus to give maximum density to the concrete. These vibrators consist of a steel tube which is inserted in fresh concrete. This steel tube is called the poker and it is connected to an electric motor. The poker vibrates while it is being inserted. The internal vibrators should be inserted and withdrawn slowly and they should be operated continuously while they are being withdrawn. Otherwise holes will be formed inside the concrete.

Different types of Girder supporting slab (Figure 8)

6.6 EARTHWORK EXCAVATION

For construction of reinforced earth wall, we need to excavate earth with the help of excavators according to the given design.

1) Before the earthwork is started, the whole area where the work is to be done should be cleared of grass, roots of trees and unwanted debris.

2) Excavation should be carried out exactly in accordance with the dimensions shown on the drawings or any other dimension, as decided by the Site-in-Charge.

3) Sides of the trenches shall be vertical and its bottom shall be perfectly levelled, both longitudinally and transversely. Where the soil is soft, loose or slushy, the trench shall be widened for allowing steps on either side or the sides sloped or shored up.

4) During excavation if rocks or rocky soils are found, they shall be levelled as far as possible and the small spaces which are difficult to level shall be filled in with concrete.

5) If the excavation is in earth, the bottom of the trenches shall be sprinkled with a little water and

rammed.

6) No material excavated from the foundation trenches shall be placed nearer than one metre to the outer edges of the excavation.

7) Water in trenches must be bailed or pumped out and where it is apprehended that the sides may fall or cave in, arrangement shall be made for adequate timber shoring.

8) When it is specified that the work is to be carried out without removing cables, pipes, sewers etc. all of them shall be temporarily shored and saved from any damage.

9) The cost of all materials and labour required for fencing/barricading in and protection against risk of accidents due to open excavation should be provided.

6.7 CONSTRUCTION OF REINFORCED EARTH WALL (RE WALL):

Reinforced earth wall is a composite material formed by the friction between the earth and the reinforcement. By means of friction the soil transfers to the reinforcement the forces built up in the earth mass. The reinforcement thus develops tension and the earth behaves as if it has cohesion. Reinforced members are composed of thin wide strips ties. For reinforcement, the GI strips are used which are 40 mm wide and 5 mm thick and the length varies as according to the tensile stress at various place and levels. The facing elements for backfill are precast concrete panels having general dimension 1.5m x 1.5m with some aesthetic appearance. A completed reinforced earth wall is shown in figure 9.

6.7.1 Procedure

Place and compact initial lifts of select granular backfill up to bottom row of panel tie strips. The level of the compacted backfill should be 50 mm above the tie strips. The panels are erected with the help of crane in such a manner so that makes a wall and panels got fall outside as shown in figure 10. To avoid pushing the brace panels out of alignment, initial lifts of backfill are neither placed nor compacted against the back of the panels. Compact each backfill lift using a large smooth-drum vibratory roller except within a 100cm zone directly behind the panels where a small hand-operated vibratory compactor must be used to avoid undue panel movement. After compaction has taken place, check wall alignment visually and with a level adjust panels as necessary. A drainage system is made near panels by laying 20 mm coarse aggregates near panels up to a width of 60 cm throughout the depth and at the bottom a semi perforated pipe is used to drain out the water. Immediate gradation and moisture testing is required if either excessive panel movement or backfill pumping occurs during construction.

A completed reinforced earth wall (Figure 9)

Erection of panels to construct RE Wall (Figure 10)

6.7.2 Compaction: Large smooth-drum vibratory rollers are used to accomplish mass compaction of backfill materials, except for fine sands. Fine uniform sands, which contain more than 60 percent passing at 425 µm sieve used for backfilling must be compacted using a smooth drum static roller. Sometimes flyash is also used with uniform sand as shown in figure 11. Vibratory compaction equipment should not be used to compact fine uniform sands. Moisture content of backfill material during placement should be approximately 1% to 2% more than its optimum moisture content.

Use of flyash with sand in construction of flyover (Figure 11)

6.7.3 Reinforcing Strips: Place reinforcing strips on the compacted backfill. Position strips perpendicular to the facing panels, unless otherwise shown on the plans. Reinforcing strips are supplied in lengths as shown on plans. Connect each reinforcing strip to the embedded panel tie strip by inserting the end of the reinforcing strip into the gap between the two exposed ends of the tie strip called loops as shown in figure 12. Match the three loopes and push a bolt through the holes from below, threading on a nut and tightening. Dump backfill on the reinforcing strips so that the toe of the backfill pile is 3-4 feet from the panels. Metal tracks of earthmoving equipment must never come in contact with the reinforcing strips. Rubber-tired vehicles, however, can operate directly on the exposed strips if backfill conditions permit and care is exercised.

Installation of GI strips on uniform bed (figure 12)

6.7.4 Geotextiles: At the joints of panels a special type of semi permeable textile known as geo-textile is used to stop the backfill from slipping out of the panels. Also, a necessary 600 mm filter media of coarse aggregate is used to provide necessary stop to the sand and allowing passage along with application of geo-textile. A geotextile along with filter media is shown in figure 13. These are placed along panels so that no backfill material including sand may not go out of the panels.

Geotextile along with filter media (Figure 13)

6.8 CONSTRUCTION OF ROADS

The construction of bituminous pavement in flyover is same as in construction of road and materials used is also same, the difference is that subgrade of sand is already prepared as shown in figure 14 in the case of flyover, but it is to be prepared as in the case of roads.

6.8.1 GRANULAR SUB-BASE CONSTRUCTION

Procedure:

1. The toe line and centre line are marked and pegs will be driven on the subgrade of flyover.
2. The material shall be dumped in site at respective location.
3. The material shall be spread in layers of uniform thickness not exceeding 200mm compacted thicknesses over the entire width of the embankment by mechanical means and will be graded with motor grader to the required camber.
4. Moisture content of the material shall be checked and extra required will be added.
5. The moisture content of each layer shall be checked and it should be within the range of OMC +1% to OMC -2%. If moisture content is found out of these limits the same will be brought within the limits by addition of water or by aeration.
6. The compaction shall be done with the help of vibratory roller of 8 to 10 ton static weight. Each layer shall be thoroughly compacted to the densities specified.
7. Loose pockets if any will be removed and replaced with approved material.
8. The above stages shall be repeated till the top level of the embankment is reached to the specified levels and grades. These levels should be in permissible limits (<25 mm).

The specification of materials of GSB is given in Table 2. It is very important to follow these guidelines while construction of roads or flyover.

Table 2 Material Specifications of GSB

CBR (4 days soaked)	Min 30% @98%MDD
Ten percent Fines	Min 50KN (testing as per BS:812)
Liquid Limit	Max 25%
Plasticity Index	Max 6

Relative compaction as % of maximum laboratory dry density as per IS : 2720 for Granular Sub Base should not be less than 98% of MDD.

Final sand bed of flyover acting as a subgrade (Figure 14)

6.8.2. WET MIX MACADAM CONSTRUCTION

1. Wet mix macadam base shall consist of laying and compacting clean, crushed graded aggregate and granular material, premixed with water to a dense mass on prepared sub base in accordance with the specifications.

2. Coarse aggregate proposed to be used in WMM are obtained by crushing the rocks, obtained from approved quarries. Before removing the rock, the quarry area is stripped of earth loam, clay and vegetable matter.

3. Independent tests will be carried out on this material as follows:

- Sieve analysis.
- Los Angeles abrasion.
- Aggregate impact value.
- Combined flakiness & elongation indices.
- Blending (Mix Design).
- Modified proctor density.
- Liquid limit & plasticity index of portion through 425 micron sieve.

4. Proposed 'Base' material will be obtained by mixing various sizes of aggregates (as per approved mix design) & water in the wet mix macadam plant.

5. W.M.M. material will be carried to the site in dumpers

6. W.M.M. material will be laid in layers (150 mm compacted) on prepared sub - base using mechanical pavers or motor grader to maintain required thickness and slope and to achieve finished surface in narrow areas, WMM will be spread manually in layers as shown in figure 15.

7. Each layer will be compacted with Vibro Roller, to achieve required degree of compaction i.e. 98% of modified density. The areas which are not accessible to roller will be compacted with plate compactor/ or mini rollers as near panels of reinforced earth walls.

Laying of WMM by motor grader and compacted by vibratory roller (Figure 15)

8. Top surface will be checked for its designed levels, before & after compaction & material will be removed or added as required.

9. Segregated material will not be allowed to be placed. The tolerance on levels shall not exceed 12 mm and deviation from 3000mm straight edge shall not exceed 10mm.

10. After final compaction, surface will be checked for its finish and top levels. Any segregated material like only coarse or only fine will be removed and the pocket will be filled with premixed material.

6.8.3 DENSE BITUMINOUS MACADAM CONSTRUCTION

6.8.3.1 Preparation and Transportation of Mix:

1. The Individual bins of hot mix plant shall be calibrated for the size of material.
2. Material shall be fed to the mixing plant bins provided for individual sizes of aggregates to meet the required gradation.
3. The temperature of binder at the time of mixing shall be in the range of 150-165 degree centigrade and the aggregate in the range 150 to 170 degree centigrade. The difference between the aggregate temperature shall not exceed 14 degree centigrade any time.
4. The mix shall be transported to the site with Tippers properly covered with tarpaulins.

6.8.3.2 Preparation of Base:

1. The sub base shall be checked for proper lines and levels.
2. The surface shall be swept free from dust with air compressor.
3. The tack coat shall be done if the WMM surface was primed and left for quite some time.

6.8.3.3 Laying of DBM:

The mix shall be laid with paver finisher. The paver shall have suitable loading hoppers and distribution mechanism. The paver shall have electronic sensor paver and string wire shall be run on steel pegs driven on both sides at 10 m interval in straight portions and 5m interval in curved portions.

The mix shall be laid manually in places where the paver movement is not possible like near panels.

The rolling shall be done with 80-100 KN smooth wheeled tandem roller, 12-15 tones pneumatic tyre roller.

The DBM should be laid in 2 layers as shown in figure 16.

Construction of DBM (Figure 16)

The compaction shall be checked by taking cores for every 250 sq.m area and the degree of compaction shall not be less than 98% of lab Marshall Density or as specified. The top shall be checked for level control and the levels shall be within + or -6mm of designed level.

6.8.3.4 Equipment Used:

1. Hot mix plant: 1 No
2. Tippers:10-20
3. Rollers:80-100KN smooth wheeled tandem rollers 2 No & 12-15 tones PTR 2 No
4. Paver Finisher: 1No
5. Steel pegs:50

6.9 PROVIDING FOOTPATH, MEDIAN, CRASH BARRIER

6.9.1 MEDIAN: It is used to separate the traffic going in different direction to avoid collisions. It is also used to prevent the light coming from opposite direction by growing vegetation at median. The procedure of construction of median is as follows:

1. The machine should be clean and oiling thoroughly. Machine will be placed to the proper

position so that the line of mark on the sensor touches the string line.

2. The mix is proposed in the concrete mixture and transported to machine. Mix material should be used within 30 minutes after production. Sand should be screened before using for slurry. The slurry will be prepared separately and transported to the slurry chamber.

3. The operator should check the machine before starting it; He should check the string line time to time to get the proper dimensions. Finishing should be done through sponge to avoid plastic cracks. Additional material should not be used for finishing.

4. Curing should be done by curing compound at wet condition of concrete and up to 15 to 20m behind the machine. The rate of spray will be specified. The construction of median is shown in figure 17.

Construction of median (Figure 17)

6.9.2 FOOTHPATH AND CRASH BARRIER:

These two parts in flyover are made simultaneously connected with each other to strengthen each part.

6.9.2.1 FOOTPATH: This is used for two purposes in flyover as to strengthen the crash barrier and to provide a walkway to the passengers on flyover safely. Many times, to increase the capacity of flyover, a footpath is made and then bituminous pavement is applied on it to make a four laned flyover to six lanes. The procedure of construction of footpath is as follows:

1. A base is prepared of reinforced concrete on the bed of sand prepared to make an even bed as shown in figure.
2. The level is checked after preparation of base with auto level.
3. Then a reinforced structure of steel is made which relates to crash barrier to strengthen each other as shown in figure 18
4. Finally the concrete is poured into it and level are checked for final specification as shown in figure 18.

Pouring of concrete into reinforced formwork for footpath construction (figure 18)

6.9.2.2 CRASH BARRIER: It is used to prevent the vehicle from falling off from it. It is used to mark the ending of lanes where footpath is not made. The construction procedure of crash barrier is as follows:

1. A coping of high quality concrete is done on panels according to specified levels. The coping is done in a slanting manner as shown in figure 19 so as to make an even base before crash barrier.
2. A reinforced which is made by footpath is extended to coping and then is covered by both sides.
3. Finally, concrete of high quality is poured into the reinforced structure and crash barrier is prepared.

Coping over panels in a slanting manner (figure 19)

7. SUPERVISION AND FIELD WORK

7. 1 STUDY OF MACHINERY:

7.1.1 Dozers

A dozer is a tractor unit that has a blade attached to the machine's front as shown in figure 20. It is designed to provide tractive power for drawbar work. It has no set volumetric capacity. The dozers used here are the Wheel type dozers instead of crawler dozers because of the plain terrain. They are used for ripping, land clearing, spreading and backfilling depending upon their blade type.

A Wheel type dozer with Universal Blade at a construction site (Figure 20)

7.1.2 Cranes

Cranes are a broad class of construction equipment used to hoist and place loads. Each type of crane is designed and manufactured to work economically in specific site situations. All-terrain crane is designed with an under-carriage capable of long-distance highway travel. They have high ground clearance, large tires and hence a larger cost. A crane is shown in figure 21. These are mainly used in construction site of flyover to erect panels. These crane operators should be very skillful for panel erection operation.

7.1.3 Asphalt Pavers

An asphalt paver consists of a tractor, either track or rubber-tired and a screed. The tractor power unit has a receiving hopper in front and a system of slat conveyors to move the mix through a tunnel under the power plant to the rear of the tractor unit. At the rear of the tractor unit, the mix is deposited on the surface to be paved, and augers are used to spread the asphalt evenly across the front of the trailing screed. Pavers can receive mix directly into their hoppers or can pick up a windrow of material placed in front of the paver. The traditional method for loading the hopper has the truck dump the mix directly into the paver hopper. An asphalt for schematic representation is shown in figure 22.

A crane used for panel erection (Figure 21)

Ashphalt paver (Figure 22)

7.1.4 Tippers

Tippers which are also known in commercial industry as dumper or Rigid-Frame Rear-Dump Trucks are suitable for use in hauling many types of material. The shape of the body, such as the extent of sharp angles and corners, and the contour of the rear, through which the materials must flow during dumping, will affect the waste or difficulty of loading and dumping. A tipper which is normally used in shown in figure 23. The bodies of trucks that will be used to haul wet clay and similar materials should be free of sharp angles and corners. Dry sand and gravel can flow easily from these trucks. These are used in many numbers for construction work in projects. These carries gravel, sand or anything which is required in large quantities.

Tipper or dumper (Figure 23)

7.1.5 Backhoe loader or JCB

A **backhoe loader**, or colloquially shortened to **backhoe** or sometimes just **JCB** (because of the maker) within the industry, is a heavy equipment vehicle that consists of a tractor like unit fitted with a shovel/bucket on the front and a small backhoe on the back as shown in figure 24. Due to its (relatively) small size and versatility, backhoe loaders are very common in urban engineering and small construction projects (such as building a small house, fixing urban roads, etc.) as well as developing countries.

Backhoe loaders are very common and can be used for a wide variety of tasks: construction, small demolitions, light transportation of building materials, powering building equipment, digging holes/excavation, landscaping, breaking asphalt, and paving roads. Its main function in construction of reinforced earth wall is to erection of pane near wall where crane cannot alone erect the panel. This is also used to spread filter media near panels. These are multipurpose and commonly known as JCB in industry.

7.1.6 Compactors or vibratory rollers

Compactors are used to compact soil, gravel, concrete, or asphalt in the construction of roads and foundations, similar rollers are used also at landfills or in agriculture. These are commonly called roller in construction industry. These are used for compaction of sand and thus to increase their density. For sand bed in flyover, density should be greater than 95 (Kg/Cubic meter) in normal conditions. These can be operated with vibration or without it. Along roller, water is sprinkled to increase density.

The smooth-drum compactors, whether single or dual drum models generate compactive forces: (1) pressure, (2) impact, and (3) vibration. These rollers are most effective on granular materials, with particle size ranging from large rocks to fine sand. They are made up of a larger roller shape with two tyres as shown in figure 25 and can be only operated at site.

A JCB used for unloading from tipper (Figure 24)

A compactor used for compacting DBM layer (Figure 25)

7.1.7 Excavator

Excavators (Hydraulic Excavators) are heavy construction equipment consisting of a boom, dipper (or stick), bucket and cab on a rotating platform known as the "house" as shown in figure 26. The house sits atop an undercarriage with tracks or wheels. They are a natural progression from the steam shovels and often mistakenly called power shovels. All movement and functions of a hydraulic excavator are accomplished through the use of hydraulic fluid, with hydraulic cylinders and hydraulic motors.

Front shovels are used predominantly for hard digging above truck level & for loading haul units. Shovels can develop high breakout force with their buckets, but the material being excavated should be such that it stands as a vertical bank. The size of a shovel is indicated by the size of the bucket, expressed in Cu meters /yards.They are very powerful and can remove many stong reinforced constructions.

Excavator (Figure 26)

7.1.8 Transit mixer

Transit mixer is a truck on which a mixer is mounted which is at some site from batching plant. Concrete is placed in transit mixer and to prevent it from segregation and transported to site. To control it there is a controlling unit attached with it. Following units are attached with it:

• A controlling unit (both automatically or manually)
• Scrapper, skip, rotating drum water tank, chemical tank.
• A mixer, which has two components, the drum and propeller.

Output of a concrete mixer is expressed in cubic meter of finely mixed concrete per hour.

7.2 FIELD DRY DENSITY TEST

7.2.1 Sand Replacement Method

Objective

Determine the in situ density of natural or compacted soils using sand pouring cylinders.

Reference IS Code: IS 2720- Part XXVIII

Need and Scope:

The in situ density of natural soil is needed for the determination of bearing capacity of soils, for the purpose of stability analysis of slopes, for the determination of pressures on underlying strata for the calculation of settlement and the design of underground structures. It is very quality control test, where compaction is required, in the cases like embankment and pavement construction. This test is used to find the density of sand beds in flyover whether it has achieved the required density or not. Only after this test in field, the bed is passed to have placing of GI strips. If the bed is having density is greater than 95 kg/cubic meter, it is said to have achieved the required compaction and GI strips then only be allowed.

Apparatus Required

1. Sand pouring cylinder of 3 litre/16.5 litre capacity, mounted above a pouring come and separated by a shutter cover plate.
2. Tools for excavating holes; suitable tools such as scraper tool to make a level surface.
3. Cylindrical calibrating container with an internal diameter of 100 mm/200 mm and an internal depth of 150 mm/250 mm fitted with a flange 50 mm/75 mm wide and about 5 mm surrounding the open end.
4. Balance to weigh unto an accuracy of 1g.
5. Metal containers to collect excavated soil.
6. Metal tray with 300 mm/450 mm square and 40 mm/50 mm deep with a 100 mm/200 mm diameter hole in the center.
7. Glass plate about 450 mm/600 mm square and 10mm thick.
8. Clean, uniformly graded natural sand passing through 1.00 mm I.S. sieve and retained on the 600micron I.S. sieve. It shall be free from organic matter and shall have been oven dried and exposed to atmospheric humidity.
9. Suitable non-corrodible airtight containers.

Theory

By conducting this test, it is possible to determine the field density of the soil. The moisture content is likely to vary from time and hence the field density also the relationship that can be established between the dry density with known moisture content is as follows:

$$\gamma_d = \gamma_b / (1 + w)$$

$$\gamma_d = Dry\ density$$

$$\gamma_b = Bulk\ density$$

$$w = water\ content$$

Procedure

Calibration of the Cylinder

1. Fill the sand pouring cylinder with clean sand so that the level of the sand in the cylinder is within about 10 mm from the top. Find out the initial weight of the cylinder plus sand (W_1) and this weight should be maintained constant throughout the test for which the calibration is used.

2. Allow the sand of volume equal to that of the calibrating container to run out of the cylinder by opening the shutter, close the shutter and place the cylinder on the glass sand takes place in the cylinder close the shutter and remove the cylinder carefully. Weigh the sand collected on the glass plate. Its weight(W_2) gives the weight of sand filling the cone portion of the sand pouring cylinder. Repeat this step at least three times and take the mean weight (W_2) Put the sand back into the sand pouring cylinder to have the same initial constant weight (W_1)

Determination of Bulk Density of Soil

3. Determine the volume (V) of the container be filling it with water to the brim. Check this volume by calculating from the measured internal dimensions of the container.

4. Place the sand poring cylinder centrally on top of the calibrating container making sure that constant weight (W_1) is maintained. Open the shutter and permit the sand to run into the container. When no further movement of sand is seen close the shutter, remove the pouring cylinder and find its weight (W_3).

Determination of Dry Density of Soil In Place

5. Approximately 60 sq.cm of area of soil to be tested should be trimmed down to a level surface, approximately of the size of the container. Keep the metal tray on the level surface and excavate a circular hole of volume equal to that of the calibrating container as shown in figure 27. Collect all

the excavated soil in the tray and find out the weight of the excavated soil (W_w). Remove the tray, and place the sand pouring cylinder filled to constant weight so that the base of the cylinder covers the hole concentrically. Open the shutter and permit the sand to run into the hole. Close the shutter when no further movement of the sand is seen. Remove the cylinder and determine its weight (W_3).
6. Keep a representative sample of the excavated sample of the soil for water content determination.

By this method, we can easily find out the density of sand bed which is required in flyover construction to allow the GI strips to be placed.

Pouring of sand with known density into hole to find the density of bed (figure 27)

7.2.2 Core Cutter Method

Aim: To determine the field or in-situ density of soil by core cutter method

Reference IS Code: IS 2720- Part XXIX

Materials and Equipment:

1. Cylindrical core cutter (1000 cc)
2. Steel rammer
3. Steel dolly
4. Balance of capacity 5 Kg and sensitivity 1 gm.
5. Balance of capacity 200gms and sensitivity 0.01 gms.
6. Scale
7. Spade or crowbar
8. Straight edge
9. Oven
10. Water content containers

Procedure:

1. Measure the height and internal diameter of the core cutter and calculate its volume. Find the weight of the core cutter (without dolly).
2. Clean and level the ground where the density is to be determined. Put the dolly on top of the core cutter and drive the assembly into the soil with the help of rammer until the top of the dolly protrudes about 1.5 cm above the surface.
3. Remove the soil around the cutter by spade. Lift up the cutter and trim the top and bottom surfaces of the sample carefully with the help of straight edge.
4. Clean the outside surface of the cutter. Take the weight of the core cutter with the soil.
5. Remove the soil core from the cutter and take representative samples in
6. The water content containers to determine the moisture content

Repeat the test at two or three locations nearby and find the average dry density.

This test is less popular as compared to sand replacement as it is easy to conduct sand replacement method with higher accuracy. So, sand replacement is used for finding the field dry density.

7.3 FOOTPATH MEASUREMENTS

Footpaths play an important role in transportation and integral to highways as they provide a safe path for people to walk along that is separated from the motorized traffic. They aid road safety by minimizing interaction between pedestrians and motorized traffic. Footpaths are normally in pairs, one on each side of the road, with the center section of the road for motorized vehicles. So, footpath measurement is very common process as it is necessary to find the length of footpath for any type of construction.

7.4 ROAD MARKINGS

Road markings are defined as lines, patterns, words or other devices, except signs, set into applied or attached to the carriageway or kerbs or to objects within or adjacent to the carriageway, for controlling, warning, guiding and informing the users.

Yellow (conforming to IS Colour no. 356) as given in IS:164-1986(revised), **white** and **black** colours are the standard colours used for markings.

Paint, sometimes with additives such as **retro-reflective glass beads**, is generally used to mark travel lanes. Paint is a low-cost marking and has been in widespread use since approximately the early 1950s.Paint consists of three main components: pigments, resins or binders, and water or solvents. Pigments are finely grounded materials that give out colors or block out the surface beneath it. They may contain other materials such as UV stabilizer, and fillers which bring out the color pigments to the required level. Resins or binders are the glue of the paint to bind pigment and glass beads together to the road surface.

Paint is usually applied right after the road has been paved. Paint is heated at an optimal temperature as per IS:164-1981 specifications and applied to the roadway surface along with the application of glass beads for retro-reflectivity. After application, the paint dries quickly. Sometimes the glass beads are mixed in with the paint and apply together which is not a recommended method. The usual method is to use a separate gun to spray the glass beads on to the wet paint during the application.

All the road markings are done strictly as per IRC:35-2015.

7.5 SURVEY WORK USING AUTO LEVEL

One of the most cumbersome but easy task in the flyover construction is survey work or finding reduced levels (RL) of any point which is required. After every bed, we need to find the RL to check whether the bed is prepared according to the designed plan. This is to be done at every 10m or according to given in plan. Also, to find the RL at points of road construction is very cumbersome. We need to find RL at every layer including GSB, WMM and DBM. This can be done with the help of simple equipment's namely auto level with required precision and staff. The procedure to find the RL at any point is as follows:

1. Setup a temporary benchmark near the road or flyover where the construction is going on. This can be done with the help of a machine which is used to give correct RL of that point.
2. Setup a landmark at temporary benchmark and note down the value of RL found out. This should be done at every 250m for required accuracy in work.
3. Setup auto level from where staff is visible at both point, at temporary benchmark and secondly where we need to find the RL or we can change the position of auto level accordingly.
4. Setup the auto level with bubble in centre and at a firm ground.
5. Note down the staff height of temporary benchmark and add the RL into it to find the Height of Instrument (HI).
6. Now find the staff height from auto level with accuracy at where we need to find the RL.
7. Subtract Staff height from height of instrument to find the RL of that point.

Staff height of Temporary benchmark + RL of temporary benchmark (given) = Height of Instrument (HI) = Staff height of arbitrary point + RL of that point

In this way, we can find RL of any given point. We can also change the position of auto level if staff is not visible with applying same concept as described above.

To check whether the bed is prepared or not, this is majorly used in construction of layers of GSB, WMM and GSB in flyover and roads. An error or subtraction is introduced in height of instrument to find whether the bed is prepared or not. Normally a dip of 350 mm is given because we can't find whether the bed is prepared or not visibly. So, we need to give a dip and put the staff on that place along with a thread to find out whether the bed is prepared or not. If bed is prepared, the staff height should come as 300 cm. If it comes less than 300 mm, it means it should be reduced to such a level till it gets 300 mm. If it comes more than 300, it means filling required till it reduced to 300 mm level.

7.6 SUPERVISION OF RE WALL

My major part in the project is construction of flyover in which I have done supervision of reinforced earth (RE wall) as one my major task. It is necessary to erect the panels in such a way that panels don't fall on outer side during construction or after construction. This can be done by some measure which are as follows:

1. The base on which whole of the RE wall is to be constructed must be plain as shown in figure 28. If the base is uneven, it will lead to dislocation of panels.

2. All panels are inclined towards the 45 mm inner side while erection because vibratory roller will push them outwards. An iron rod is used for doing this work as shown in figure 29. Also, for proper alignment thread and plumb bob are used along with visual judgement.

3. In between each panel, there should be a rubber material be placed so that panels don't touch each other known as EPDM.

4. Vibratory rollers should not have very high frequency near the panel as they might dislocate.

5. No broken panel or panel having honeycomb problem should be used for RE wall construction.

6. Panels at corners should be installed very properly as we need very special panels near corner because standard size panels would not fit in. A special casted corner panel of 'M' shape is shown in figure 30.

7. During construction period, edge clamp must be used as shown in figure 31 so panel don't fall out during construction. Then they are removed after erection of other panel and placed on that panels for safety purpose.

8. After every 200 mm, the sand bed should be compacted and tested for density >95kg/cubic meter to get proper strength.

9. Near panels filter media of 600 mm of gravel and geotextile should be used so that sand don't fall out of panels due to pressure developed but allow water to go out.

Construction of base with help of shuttering and pouring of fresh concrete (Figure 28)

Use of iron rod in erection and inclination of panels (Figure 29)

Erection of corner panel along with special casted panels on both sides (Figure 30)

Use of edge clamp for safety purpose and proper alignment (Figure 31)

8. REIVIEW OF ENVIRONMENTAL IMPACTS OF CONSTRUCTION

Road projects generally improve economic and social welfare of people, reduce travel time, cost of vehicle operations and improve access to markets, medical and educational facilities. However, people in the direct path of the roads are affected due to loss of community assets. Other adverse impacts could be soil erosion, interference with animal and plant life. It is, therefore, essential to carry out social and environmental impact assessments to ensure that the individuals affected adversely are compensated and resettled adequately and mitigation measures to reduce the adverse environment impact are put on ground. The World Bank and the ADB also mandate such requirements as per their policy and guidelines as part of loan assistance programmes and execution of works by the implementation agencies.

8.1 LAND ENVIRONMENT

Anticipated Impact

- Highway projects require large quantum of land and causes disturbance to the existing land usage. Impact on the land use pattern should be assessed
- Impact due to the removal of topsoil during highway construction and from storing, stockyards, workers camp etc.
- Impact on productive lands on selection of borrow areas
- Impact due to erosion and consequent modification of natural conditions
- Impact due to destabilization of slopes
- Impact due to diversion of natural surface water flows
- Impact due to construction of embankment leading to blocking of cross drainage and causing water logging
- Impact due to construction of bridges across streams, rivers/water bodies
- Impact on haul roads due to usage of heavy machinery for material transportation
- Impact due to ribbon development along the highway

Mitigation Measures

- While selecting road alignment attention must be paid to avoid areas prone to landslides, soil erosion, subsidence, fertile agricultural lands etc.
- The erosion potential of alternatives should be carefully examined and the one involving least

disturbance to the natural ground should be preferred.

- Balancing filling and cutting requirements through alignment choice to reduce the need for borrow pits and to minimize excess spoil material generation should be considered
- Drainage improvements to avoid water logging and flooding due to disturbance of natural drainage pattern should be considered
- Possibility of storing and reuse topsoil by separating topsoil from subsoil during the initial excavation should be considered
- Engineering measures for slope protection and erosion prevention should be considered
- Maintenance of haul roads should be planned
- Borrow areas should be opened preferably from barren and infertile lands
- The stored topsoil should be spread back to restore the productivity of the exhausted borrow areas/ the accumulated top soil should be utilized for developing median plantation and for raising turfs in the embankment slopes
- Drainage improvements for prevention of soil erosion and siltation of watercourses should be planned. Slope stabilization techniques and erosion control measures should be planned especially for the projects undertaken in hilly areas, such as increasing vegetation, sausage walls/ gabions

8.2 WATER ENVIRONMENT

Anticipated Impact

- Road construction activities that intersect drainage basins, generally modify the natural flow of surface water by concentrating flows at certain points and in many cases, increasing the speed of flow resulting in flooding, soil erosion, channel modification and siltation of streams. Impact due to surface water flow modifications should be assessed
- Impact on water table due to road drainage, excavation and construction of embankments and structures should be assessed
- Impact due to spillages and accidents of vehicles carrying chemicals should be assessed, especially if drinking water bodies are located within 500 meters in the u/s of the highway alignment
- Impact on water facilities such as, wells, hand pumps, tube wells etc falling along the highway alignment should be assessed
- Impact due to disposal of wastewater generated from the temporary project offices and

temporary workers housing area should be assessed

Mitigation Measures

- Labour camps should not be located near to water bodies. No discharge from such establishments should follow their path into nearby water bodies. Dumping of debris in or nearby water bodies should be strictly avoided. All the waste generated from the camps should be collected, stored and disposed in environmentally suitable manner.
- Appropriate drainage arrangements with catch drains and catch pits should be planned to prevent the spillage of chemicals and fuels reaching the water bodies
- Possibility of avoiding alignments which are susceptible to erosion
- Water flow speed control should be exercised to check surface runoff's and silt loads during construction activities
- The effect of the proposed highway project on channel capacities and existing floodways should be evaluated. Care must be taken to evaluate the effects related to the delayed release from detention facilities since an increase in downstream peak discharges
- In dry areas road drainage can be designed to retain water in small dams or maintain a high water table, which increases the availability of more water and recharging of local aquifers

8.3 AIR ENVIRONMENT

Anticipated Impact

- The immediate surroundings may have a greater impact. The existing surrounding features such as habitation, hospitals, schools, notified sanctuaries etc. up to 500 meters and impact on them should be addressed
- Impact due to dust generation from excavation of soil, cutting of embankment near to habitation, hospitals, schools, sanctuaries etc., up to 500 meters should be addressed
- Impact due to movement of heavy vehicles carrying construction materials in the haul roads
- Impact due to dust generation from material handling, storage, operation of crushers and hot mix plants, movement of construction vehicles and construction activities
- Impact due to vehicular emissions from vehicles used for construction purpose
- Emission levels are expected to increase with the increase in vehicle numbers. There are models developed by various international agencies to predict vehicular emissions. In order to

know the increase in pollution level, a mathematical modeling based on emission factors of various vehicles and traffic projection, increase in pollutants load in atmosphere can be calculated

Mitigation Measures

- Selecting road alignment, which avoids passing close to housing, schools, hospitals etc,
- Providing sufficient capacity to avoid traffic congestion, even with projected increase in traffic flow
- Provision of local access roads where access to main arteries has been restricted for the purpose of promoting traffic efficiency and safety
- Planting tall leafy vegetation between roads and human settlements
- Water sprinkling and transporting construction materials with tarpaulin coverage during the construction stage. During the sub-grade construction, sprinkling of water should be carried out on regular basis during the entire construction period especially in the winter and summer seasons. Special attention should be given in the sections where the alignment passes through sensitive areas such as schools, hospitals and urban areas. As soon as construction is over the surplus earth should be utilized properly and in no case, loose earth should be allowed to pile up along the alignment
- All the vehicles used during the construction stage to have valid PUC certificate
- Provision of air pollution control systems in stone crushers to meet the suspended PM value at distance of 40 meters less than 600 micrograms/Nm3. The stone crushing units should adopt the following pollution control measures:
  - Dust containment cum suppression system for the equipment
  - Construction of wind breaking walls
  - Construction of the metalled roads within the premises
  - Regular cleaning and wetting of the ground within the premises
  - Growing of a green belt along the periphery
- Hot mix units, if used on site, should be equipped with requisite air pollution equipment to meet the prescribed standard of MoEF and SPCBs
- Integration with the local government awareness campaign programmes on good practices of vehicle maintenance etc. to reduce the air emissions

8.4 BIOLOGICAL ENVIRONMENT

Anticipated Impact

- Impact due to removal of trees in the highway alignment
- Impact on forest resources, economically important plants including medicinal plants and threat to endangered species
- Impact on wildlife habitat and biodiversity due to change in land use
- Impact due to fragmentation of wildlife habitat and territories
- Impact due to changes in water quality, soil profile, noise, light and air pollution, which may affect the nature and character of habitats
- Pressure on habitats wildlife because of increased access provided by roads

Mitigating Measures

- Tree plantation plan to compensate the trees cut should be prepared as per the government norms
- Possibility of tree transplantation should be examined
- Identification of sensitive natural environments in the early planning stage so that alternative routes, changes in width of the road can be examined
- Possibility of twin new road corridors with previously established transport rights-of-way, such as railway lines
- Provision of wildlife underpass and hydraulic structure
- Compensate the loss of forest coverage by appropriate plantation programme. Survival rate of plants must be included in the contract specifications so as to ensure that the compensatory plantation achieves its objective
- Development of green belt on either side of the highway consisting of a variety of trees would help to enrich ecology of the area and add to aesthetics. The location for roadside green belt should be finalized keeping in view of future expansion of the highway
- Regeneration of rare plants of economic importance including medicinal plants
- Conservation plan for conservation and protection of flora and fauna, wildlife migratory species and medicinal plants

8.5 SOCIO - ECONOMIC AND HEALTH ENVIRONMENT

Anticipated Impact

- Analysis of positive and negative impact on the present status of livelihood.
- Displacement of human settlement from proposed site. Impact on livelihood and loss of properties
- Impact on the existing travel areas due to faster traffic, access controls and median barriers
- Employment opportunity and access to other amenities such as primary education and health care facilities for local people

Mitigation Measures

- The splitting of a community can be minimized by taking account of local movements at the road design stage and by making provision for improved crossings or alternative access routes
- Institutional arrangement for effective implementation and periodical review through project implementation
- Institutional capabilities to carry out the relocation and rehabilitation operation be assessed and if necessary is strengthened
- Training to local people for employing them in the proposed project
- Mechanism for providing effective guidance in financial planning to effected people
- Integration with the local master plan to prevent conflict of interest

8.6 SOLID WASTE MANAGEMENT

Anticipated Impact

- Waste generated during construction may impact soil, agriculture and water quality
- Waste generated from workers camps may impact surface and ground water quality and agriculture
- Impact due to oil spillage/leakage from machines and vehicles

Mitigation Measures

- As far as possible road design and alignment should be finalized to minimize waste generation through balancing of cut and fill operations and minimizing excess cuts requiring disposal
- In case debris generated from cutting in hill areas could not be reused, method of disposal should be addressed**.** The figure indicates construction of gabion walls on valley side at ridge locations to form a through for waste disposal. As the ridge locations usually have streams flowing

through, length of the pipe provided at the culvert should be extended to let runoff flow out of the disposal location. After filling up of the disposal site, it shall be grassed and suitably vegetated to prevent erosion of the disposed soil

- Suitable topsoil management should be prepared. Loss of topsoil is a long term impact in highway projects due to site clearance and widening for road formation, development of borrow areas and temporary construction activities such as construction camps, material storage locations, etc. The stripped topsoil should be carefully stockpiled at suitable places. In case of hilly and desert areas, topsoil with humus wherever encountered while opening the site for construction should be stripped and stockpiled.

9. CONCLUSION AND FUTURE SCOPE

There are ample opportunities in the field of construction in future. India is a developing country, and thus its infrastructure needs can never get exhausted. Be it roads, bridges, railways or projects like dams, airports, water canals etc. they are never ending. Moreover, smart city mission will also require the smart technological use in the field of Roads and building for sustainable development. So, we can surely say that infrastructure is one sector where job opportunities will never run out. Also in today's modern world emphasis is being given on construction of ecofriendly roads, bridges and buildings. We need to encourage sustainable development like growing vegetation in large amounts on the sides of flyover so that it can generate oxygen by taking carbon dioxide of vehicle. These kinds of initiative with use of technology must be taken to ensure sustainable development.

The Project Semester was a great experience as I learned how the things that we find in books are applied in the field & what is the importance of Civil Engineering in present day world, what are the problems that are faced by a Civil Engineer & how to tackle the same. In a nutshell, it meant "a lot for me to my upcoming career as it was the first exposure to a construction site & will be helpful to me during the early days as a Civil Engineer" & also thereafter.

I covered various aspects of civil engineering within the same project. In the starting of my training, I learned all the constructional aspects of the project and surveying instruments to find reduced levels. Moving further, I did the most important and experience gaining part of my training i.e. understanding the drawing of flyovers and roads. I also learnt about the problems we face while construction of RE wall and what are precaution to be taken for safety. I learnt about the various environmental problems due to construction and how they can be mitigated. It was also a very nice learning experience. At the end, I felt confident and independent. I also felt that this training has given many valuable things at present as well as in future which would help me throughout my professional life. This training will help me to decide about my future because of exposure I got there will be valuable and help me pursue my career in civil engineering field.

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11. DIFFICULTY FACED DURING TRAINING SEMESTER

1. Weather was a major problem as it was difficult for everyone and construction work to be fast enough in hot climatic conditions.
2. Labour was very unproductive and doing mistakes again and again.
3. During construction, the most difficult part was the quality control and strictly following the design and specifications.
4. Due to dislocation of one panel, it was very difficult and cumbersome to start from beginning again.
5. Due to many companies working together, there was mismanagement of resources and time.