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Experimental Analysis of Highway Construction & Recycled Aggregate Approach

Sandeep Singh

Dept. of Civil Engineering, Shree Baba Mast Nath Engineering College, Asthal Bohar, Rohtak, Haryana

Abstract: National highways connect capitals, important places, ports and places of strategic importance of various states. Though national highways account for only 2% of the total road length, they carry nearly 1/3 of the total traffic. Flexible pavement is composed of a bituminous material surface course and underlying base and sub base courses. The bituminous material is more often asphalt whose viscous nature allows significant plastic deformation. Most asphalt surfaces are built on a gravel base, although some 'full depth' asphalt surfaces are built directly on the sub grade. Depending on the temperature at which it is applied, asphalt is categorized as hot mix asphalt (HMA), warm mix asphalt, or cold mix asphalt. Flexible Pavement is so named as the pavement surface reflects the total deflection of all subsequent layers due to the traffic load acting upon it. The flexible pavement design is based on the load distributing characteristics of a layered system.

Road Transport is vital to India's economy. It enables the country's transportation sector contribute 4.7 percent of India's gross domestic product, in comparison to railways that contributed 1 percent, in 2009-2010, despite railways handling of passenger and pure cargo. Road transport has gained in importance over the years despite significant barriers and inefficiencies in inter-state freight and passenger movement compared to railways and air. The government of India considers road network as critical to the country's development, social integration and security needs of the country. India's road network carries over 65 percent of its freight and about 85 percent of passenger traffic. Indian road network is administered by various government authorities, given India's federal form of government.

Keywords: Highway Construction, Recycled Aggregate, pavements.

Introduction

National Highway 5 (NH-5) is a major National Highway in India that runs along India's east coast through the states of Orissa, Andhra Pradesh and Tamil Nadu. The northern terminal is at Jharpokharia in Orissa and the southern terminal is at Chennai in Tamil Nadu. NH 5 is a part of the golden quadrilateral project undertaken by National Highways Development Project. Under the new national highway numbers NH 5 is renamed as NH 16. NH 5 runs for a distance of 1533 km. In Tamil Nadu NH 5 starts from Chennai and shortly enters Andhra Pradesh from Gummidipundi. In Andhra Pradesh, it passes through most of the coastal towns in nine coastal districts including Nellore, Ongole, Chilakaluripet,Guntur, Vijaywada,Eluru,Tanuku,Rajahmundry, Tuni , Visakhapatnam, Srikakulam, Tekkali and Palasakasibugga.

In Orissa, it passés through Baripada, Balasore, Bhadrak, cuttack, Bhubaneswar and Berhampur.

Our project is on Six Laning of Chilakaluripet - Nellore section of NH 5 from km 1182.802 to km 1366.547 (approx length-183.620 km) in the state of Andhra Pradesh under NHDP to be executed as BOT project on DBFOT pattern.

The project was awarded to M/s. KMC-BSCPL JV. BSCPL share is 50 %.

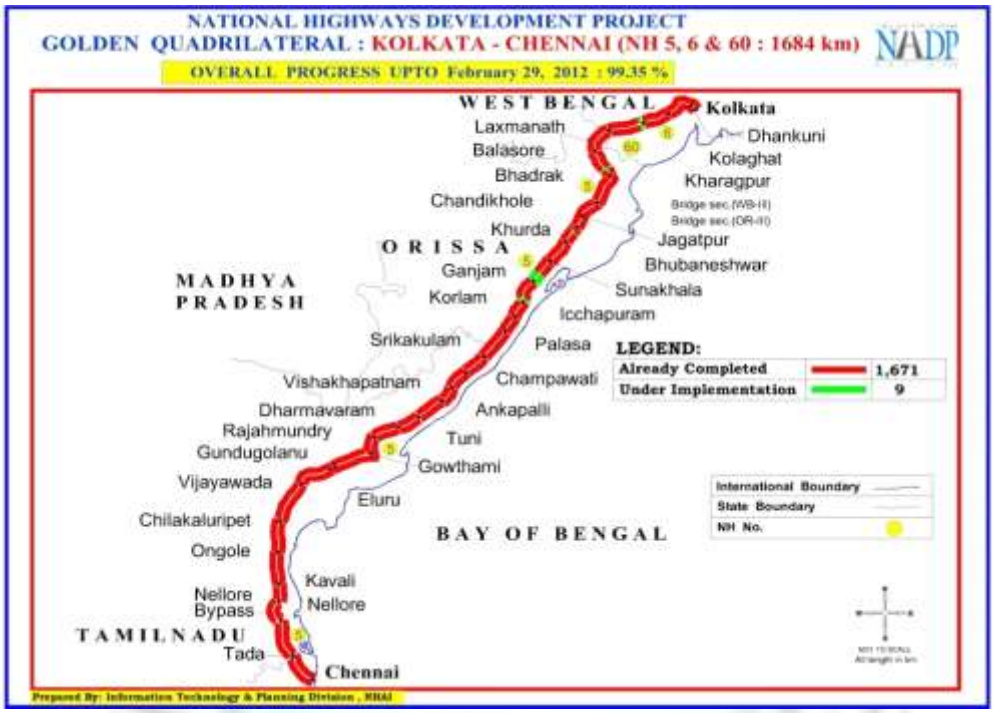

Fig. 1: Natinal Highway (Kolkata-Chennai) Road Project

Classification of roads as per IRC (Nagpur Plan)

National Highways: These are main highways running through the length and breadth of the country connecting major ports, foreign highways, state capitals, large industrial and tourist centers etc.

State Highways: These are arterial routes of states linking direct headquarters and important cities within the state and connecting them with National Highways or Highways of the neighboring states.

Major District Roads: These are important roads within a district serving areas of production and markets, and connecting these with each other or with the main highways.

Other District Roads: These are roads serving rural areas of production and providing them with outlet to market centers, taluka/tehsil headquarters, block development headquarters, or other main roads.

Village Roads: These are roads connecting villages or groups of villages with each other and to the nearest road of higher category.

Geometric Design Standards

The layout and other geometric features of a road have direct influence on the initial cost of its construction and the efficiency and economy of its use by traffic. The safety of operation is also significantly affected by geometric design. The geometric design of a highway is influenced significantly by terrain conditions.

Terrain Classification - The terrain is classified by the general slope of the country across the highway alignment, for which the criterion given in table followed.

Tabel . 1: Terrain classification cross slope of the country

Sl. No.	Terrain classification cross slope of the country	Percent
1.	Plain	0-10
2.	Rolling	10-25
3.	Mountains	25-60
4.	Steep	Greater than 60

Different road materials used:

The most important pavement materials are soils, mineral aggregates, bituminous binders, and stabilizers like lime, cement, etc. Mineral aggregates constitute about 90 percent of total volume of road construction materials used. All roads have to be founded on soil and are required to make optimum use of the locally available materials, if it is to be constructed economically. Materials used in the structural layers of the pavement should be selected based on availability, economy and previous experience.

It transmits load to the sub grade through a combination of layers. Flexible pavement distributes load over a relatively smaller area of the sub grade beneath. The initial installation cost of a flexible pavement is quite low which is why this type of pavement is more commonly seen universally. However, the flexible pavement requires maintenance and routine repairs every few years. Highway surveys involve the location of alignments and computation of volumes materials that must be added, removed, or moved. It initially requires a topographic survey of the site. For large projects, photographic method will be used to develop the base map. The base map is used by surveyors and other professional to create a base plan for the project. After the alignment has been established, the quantities of earth that must be added or removed are computed. The goal of most projects is to minimize the hauling distances of the earth. This is done using mass diagrams. Eventually surveyors layout the elevation and slope of the various sub-grades, base, and top coat materials. The end result is a smooth alignment with smooth transitions from straight to curved sections allowing for safe public transportation.

Soil as road construction material:

Sub grade soil is an integral part of the road pavement structure as it provides support to the pavement as its foundation. The main function of the sub grade is to give adequate support to the pavement and for this the sub grade should possess sufficient stability under adverse climatic and loading conditions. The formation of wave, corrugations, rutting and shoving in black top pavements are generally attributed to poor sub grade conditions. When soil is used in embankment construction, in addition to stability, incompressibility is also important as differential settlement may cause failure. Soil is used in its natural form (gravel and sand) or in a processed form (stabilized layer) for pavement construction. Soil is also used as a binder in water-bound macadam layers. Soil is therefore, considered as one of the principal highway materials.

The foundation of other cross-drainage structures (culverts, bridges and retaining walls) rests on soils and their stability depends on the soil strength, knowledge of soil properties is necessary to select the embankment material, pavement structure, drainage system and foundation of structures. When a high embankment rests on soft ground, its stability can be predicted by studying the properties of soil. Frost action, common in high altitudes, can be taken care of if the soil properties are well known. Soil consists mainly of minerals matter formed by the disintegration of rocks, by the action of water, frost, temperature, and pressure or by plant or animal life. Based on the individual grain size of the soil particles, soil have been classified as gravel, sand, silt, and clay.

Excavation For Cutting

Construction method:

The excavation of cutting shall be carried out in accordance with the drawings and to the slopes, levels, depths, widths and heights shown on the drawings. Prior to commencement of works, surveyor will use the survey data of road alignment and TBM provided by the engineer for setting out the extent of cutting in accordance with the cross sections and put in such

pegs, bars, sight rails and reference markers necessary to control the works. A survey team shall monitor and control each stage of work. All the major setting out works will be carried out jointly with the engineer's surveyor. At the same time, the cut material below the top soil level shall be sampled and tested for laboratory compaction, laboratory CBR, grading and index properties, so that it may be classified as suitable or not for the various categories to fill. Requests for approvals for use of that material as fill will then be submitted.

Before commencement of cut/fill, it will be ensured that the haul roads have sufficient width for to and fro traffic and for smooth movement of the plant. The diversion of traffic, warning signs, flagmen etc to the agreed traffic management plan shall be deployed for the safety of the works, and all necessary ramps be provided to maintain existing accesses to and off the road.

Before starting the mass excavation the top soil shall be stripped from the area, either to a thickness agreed from the soil sampling holes, or as directed on site by the engineer or his designated staff, and afterwards measured by leveling. Requests for approval for commencement of cutting shall then be submitted.

When approvals are received, the mass excavation shall be started from the top of the high ground down to the formation levels. At the specified frequency and at any change of material the engineer will be notified and the material will be sampled and tested for continued suitability of use. If the changed material is considered to be Hard Rock a request for approval for re classification will be submitted. Slopes in cutting shall be trimmed mechanically to neat and even surfaces in accordance with the designed gradients. The tolerance for widths of excavations shall not exceed the dimensions shown on the drawings by more than 150mm or specified limits. Erosion protection measures if desired by the engineer shall be carried out after the completion of trimming.

The construction of side drain shall follow closely to the slope trimming and surface water shall be regulated to discharge to the side drain. If directed by the engineer the slope of cutting shall be cleared of all rock boulders or rock fragments, which move when, pressed by the crowbar. The formation of sub grade on the cut area shall be sampled and tested for lab compaction, lab CBR, and grading and index properties. If found to be suitable for sub grade this will be compacted and tested as to CI.301 and CI.305. Request for approval for placing of sub base will then be submitted. If there is likely to be a delay in immediately placing the sub base then a protective layer 300mm thick shall be left in place above the sub grade level for removal at a later date.

Machinery used:

- Excavator – J.C.B. or Hitachi EX 100 for bulk excavation, loading on trucks and slope trimming.
- Dump truck – For transporting cut materials from the cut area.iii.

Bulldozer – ripping & loosening of earth and rock mixed soil etc .iv. Grader for trimming to final level and maintaining the surface parallel to the finished grade line .

Fig. 2: BMEL BH100 Dump truck

Fig. 3: Backhoes

Construction Method

Excavation of longitudinal and cross trenches shall be carried out all in accordance with the approximate provisions of specification and drawings. At the completion of excavation, Request for Approval forms for placing filter materials will be submitted to the Engineer. Filter cloth shall then be placed to cover the perimeter of the longitudinal trench excavated, with the top open to facilitate the placement of filter material. Subsoil cross pipe is then laid in the cross trench at minimum 1% slope, with the inlet face covered with filter cloth and the outlet being free outfall. The inlet of cross pipe is to be imbedded in the filter material fill placed in the longitudinal trench. Care shall be taken against damage of filter cloth during the construction stage. Filter material shall be placed in longitudinal trench and uniformly compacted. The filter cloth shall be closed at top and backfilled with soil. At the completion of placing filter materials a Request for Approval for placing compacted backfill will be submitted. During backfilling random field density check tests will be carried out.

Conclusion

On the basis of our comparative analysis of test results of the basic properties of concrete with three different percentages of coarse recycled aggregate content (0%, 50% and 100%), the following conclusions are made. The way of preparing recycled aggregate for concrete mixtures influences the concrete workability: workability of concrete with natural and recycled aggregate is almost the same if ―water saturated—surface dry‖ recycled aggregate is used. Also, if dried recycled aggregate is used and additional water quantity is added during mixing, the same workability can be achieved after a prescribed time. Additional water quantity depends on the time for which the same workability has to be achieved. It is determined as water quantity for which the recycled aggregate absorbs for the same period of time. Bulk density of fresh concrete is slightly decreased with increasing quantity of recycled aggregate. The same conclusion is valid for concrete tensile strength (splitting and flexural). The water absorption of concrete depends on the quantity of recycled aggregate. The amount of absorbed water is proportionally increased with increasing recycled aggregate content. Water absorption depends on the porosity of cement matrix in the new concrete and porosity of cement matrix of the recycled concrete: if recycled aggregate is produced from low porosity waste concrete, water absorption of the new concrete depends on the achieved structure of the new cement matrix. Wear resistance of the concrete depends on the amount of recycled aggregate. Concrete wear resistance decreases with increasing recycled aggregate content, due to the increased quantity of hardened cement paste, which wears easier than grains of natural aggregate.

References

[1]. Katz, A. Properties of concrete made with recycled aggregate from partially hydrated old concrete. Cem. Concr. Res. 2003, 33, 703-711.

[2]. Gonzales-Fonteboa, B.; Martinez-Abella, F. Concretes with aggregates from demolition waste and silica fume. Materials and mechanical properties. Build. Environ. 2008, 43, 429-437.

[3]. Poon, C.S.; Lam, C.S. The effect of aggregate-to-cement ratio and types of aggregates on properties of precast concrete blocks. Cem. Concr. Compos. 2008, 30, 283-289.

[4]. Xiao, J.; Li, J.; Zhang, C. Mechanical properties of recycled aggregate concrete under uniaxial loading. Cem. Concr. Res. 2005, 35, 1187-1194

[5]. Limbachiya, M.C.; Koulouris, A.; Roberts, J.J.; Fried, A.N. Performance of recycled aggregate concrete. In Proceeding of RILEM International Symposium on Environment-Conscious Materials and Systems for Sustainable Development, Koriyama, Japan, 6–7 September 2004; pp. 127-136

[6]. Poon, C.S.; Shui, Z.H.; Lam, C.S.; Fok, H.; Kou, S.C. Influence of moisture states of natural and recycled aggregates on the slump and compressive strength of concrete. Cem. Concr. Res. 2004, 34, 31-36.

[7]. Flašar, A. Control of Quality in Construction; Faculty of Technical Sciences-Institute of Civil Engineering (FTN-NOIIG): Novi Sad, Serbia, 1984

[8]. Sagoe-Crentsil, K.K.; Brown, T.; Taylor, A.H. Performance of concrete made with commercially produced coarse recycled concrete aggregate. Cem. Concr. Res. 2001, 31, 707-712.

[9]. Levy, S.M.; Helene, P. Durability of recycled aggregates concrete: A safe way to sustainable development. Cem. Concr. Res. 2004, 34, 1975-1980.

[10]. Fathifazl, G. Structural Performance of Steel Reinforced Recycled Concrete Members; Ph.D. Thesis; Carleton University: Ottawa, ON, Canada, 2008; p. 465.