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FEASIBILITY STUDY OF FOUR LANE ROADS CONNECTION BETWEEN KHAMMAM TO WARANGAL HIGHWAY

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Abstract:

Feasibility studies are normally conducted to justify investments the vital importance of feasibility studies in supporting decisions related to public spending on infrastructure projects, there are no attempts to evaluate such studies after construction of facilities. An analysis of a previous feasibility study for a national highway 563 construction and traffic conditions The national highway development in India is carried out by a national highway authority of India (NHAI) .In India as well as in the whole world transport system plays very important role in the development of country as a economic way and in the other ways also such as development of agriculture and industries The national highway (NH 563) development and implemented in India is 249 kms is total length. It takes from khammam to Warangal the development is going on NH563 and its becoming 4 lane roads. Some portions of NH563 highways are completed by becoming 4 lane highways but some portion are still the under construction. The design procedures for flexible pavements based on C.B.R values. The pavement design has accompanied by the code IRC: 37-2012 and Ministry of State Transportation (MOST) specifications. In this project report, the pavement layers, its prescribed limits by Ministry of State Transportation (MOST) and sources of raw materials required for the laying of pavement associated with laying of 4 lanes on National Highway (NH)-563 between khammam to Warangal. The alignment of highway passes through plain terrain for 249 km generally, the existing road is on 0.5-2.5 m high embankment except at approaches to major bridges the existing carriage width is 7.0 m with 1.5 m paved shoulder at locations of settlements. These include 4 major bridges, 69 minor bridges and 210 culverts.

INTRODUCTION

Government of India has decided to take up through National Highways Authority of India (NHAI) about 1000Kms of expressways under of the National Highways Development Project (NHDP). NHAI has decided to take up the Bangalore-Chennai Expressway project to facilitate high speed travel in this corridor. The

existing National Highway–563 which is running parallel to the proposed expressway carries one of the highest traffic carrying corridors in India. The proposed expressway facility is to be developed as a fully access controlled facility on a new alignment. as consultants to carryout Consultancy Services for Feasibility Study cum Preliminary Design Report for the Khammam To Warangal way The proposed six lane expressway would be a fully access controlled high speed facility. Therefore all the entry, exits and crossings have to be planned suitably as grade separated facilities. Safety in design, construction, and operation is of paramount importance for the facility and needs to be integrated at the planning stage itself. The Feasibility cum Preliminary Design Report thus prepared shall contain, inter-alia, the scheme and layout of the expressway and the project facility, preliminary design and costing. The report will form the basis on which a Financial Consultant and legal consultant, appointed separately will prepare an RFP document for inviting bids from private entrepreneurs to award a BOT (Toll) concession. The concession will be on DBFO pattern, wherein the concessionaire shall, in accordance with the model concession agreement approved by the Government, take full responsibility to carry out the detailed design, construction, maintenance and operation of the project expressway and the project facilities confirming to the standards specified in the concession agreement. Concessionaire will obtain all the finances required for the project, and eventually transfer the project to NHAI after expiry of the concession period in a state as specified in the concession agreement. The Feasibility cum Preliminary Design report would provide all the technical details, based on which realistic bids will be received from the prospective bidders.The issues, concerns and specific interventions for these sectors have been discussed. Adaptation interventions have been designed for these sectors such as agriculture, rural development, transportation, tourism, forestry and biodiversity, urban development, health and family welfare, while mitigation options have also been identified for energy, industry and transport. Research or knowledge development on climate change specific to Telangana has also been identified as a sector which should be developed to support data on mitigation and adaptation for the other 9 sectors. This technical / knowledge support on the subject can be provided and coordinated by a cell or department in one of the research institutes like EPTRI. An indicative list of sect oral concerns, adaptation/mitigation interventions and corresponding challenges has been tabulated here.

- Development of crop varieties resilient to heat, cold and water stress including breeder seed production
- Replacement of inorganic fertilisers by bio-fertilisers
- Assured credit facility, including for tenant farmers
- Insurance against crop failures (not just for the bank loan component)

Managing climate risks is a major challenge of today and for the future. Climate related disaster risk is increasing. The number of

reported hydro-meteorological hazards (droughts, heat waves, wind storms, forest fires or landslides) has significantly increased in recent decades, causing deaths and economic losses. Extreme climate events affect multiple sectors including agriculture, food security, water resources and health. Climatic variability can trigger crop failures, shortages of water for irrigation, food insecurity and hunger. Impacts of extreme events such as droughts and heat waves frequently accumulate into setbacks to development gains and towards achieving the MDGs related to poverty, hunger and human health.

Floods by nature depend on several factors; one being incessant rains; rains in a short period of time crippling natural drainage. However, other factors such as nature of the collecting basin, nature of the streams, type of soil, natural and man-made vegetation, amount of rainfall, obstruction to natural drainage etc. determine the type and extent of floods. Warangal district in Telangana region is most prone to monsoon floods

Tanks are the main source of irrigation in Telangana for centuries. Over a period of time, due to lack of proper maintenance and siltation, most of these tanks have either shrunk or become defunct. Reduced availability of surface water has resulted in over stress on the available ground water resources. In the state, there are about 46,531 minor irrigation sources. The ayacut that can be irrigated with the above allocated water is about 18 to 20 lakh acres. Keeping this in view, Government of Telangana has taken up major initiative for restoration of tanks in mission mode known as 'Mission Kakatiya'.

Government has initiated 'Green Curtain' project in the city of Khammam to increase the green cover. Over 1,000 kilometres are planned to be covered under the project and to start with, 50 locations have been identified, of which, plantations have been completed in 15 locations.

Adaptive capacity is the property of a system, either social or physical, to adjust itself and expand its coping range under existing climate variability, or future climate conditions. In practical terms, adaptive capacity is the ability to design, implement and maintain an effective adaptation strategy for each of the social or physical aspects of the system, or to develop the ability to react to evolving hazards. The objective behind enhancement of the adaptive capacity is to reduce the stresses on the system due to the occurrence and/or the magnitude of harmful outcomes resulting from climate-related hazards. The adaptation process requires the capacity to learn from previous experiences to cope with current climate, and to apply these lessons to cope with future climate change and any other consequences.

The economic status is an indication of the capability of a district to adapt to the adverse effects of CC and therefore, higher economic status means higher adaptive capacity. There are a number of separate determining parameters which can give an overview of the economic status of the district. Two parameters were used in this report namely per capita GDP and percentage of agricultural workers.

Development of infrastructure is important to enhance the climate resilience of a district or State. Therefore, with a higher infrastructure facility and better access to

these facilities, the district can have a better adaptability to climate change. In this aspect also there are a number of parameters which aggregate to give an overview of the Infrastructure Indices of the district relative to the other districts of the State.

Climate change is always associated with a number of health issues. Therefore access to better health infrastructure helps the population to adapt to health problems arising out of the adverse effects of climate change. Therefore, better the health infrastructure and access to health, higher will be the Adaptive Capacity.

LITERATURE REVIEW

AGASSIZ (1999) the last few years the traffic in the citys as well as on the highways are continously increasing thats why the rate of accident are also increasing. Government are continously working on the development of roads for the safety of people. Many highways are already developed and some are going on. One of the developing highway is NH3. The some parts of NH3 highway are already developed by converting into 4 lane from 2 lane. But some part of highway are still under construction. The length of highways in india is 66,590 kms. The NH3 highway is one of the largest india national highway which starts from agra in uttar pradesh and ends in mumbai in maharastra. The highway is passes through the citys of uttar pradesh , rajasthan , madhya pradesh and maharastra. The NH3 highway is also known as agra – bombay highway. The length of NH3 highway is 1,190 kms. Currently the road between agra and gwalior is four lane.

JAMIESON (2003) applied to Lochaber the much improved understanding of glacial flow (that ice en masse acts as a viscous fluid) that Alpine geologists had meanwhile been developing. He made a new and more thorough survey of the Roads and other features, particularly scratched bedrock surfaces, moraines and erratics, which enabled him to reconstruct former glaciers that could have dammed the vanished “Loch Gloy”, “Loch Roy” and “Loch Spean” in a complex sequence of phases that accounted for all classes of evidence: Roads, overflow cols, scratched bedrock, moraines etc (1863). Darwin then abandoned his marine explanation, though with great reluctance. But by this time his species theory had long overtaken his global tectonic theory as the focus of his research, and anyway the former no longer required the biogeographical model that had in part motivated the latter.

Chiou, Y.-C.; Lai, Y.-H (2008) the road network will be easily blocked when an earthquake occurs. Therefore, it is necessary to study the connection reliability of the road network nodes and to judge the key sections and optimize the emergency medical rescue path believe that disaster preparedness is regarded as the cornerstone of emergency management. From the point of view of the whole country, a country needs to establish a national disaster prevention framework and a whole community disaster prevention system. On the other hand, the state should establish emergency management schools to promote disaster prevention at the community level and carry out appropriate emergency training. As a supplement to government forces, enterprises and non-governmental organizations should also act to respond to emergencies. Many researchers have studied

the road network stability and the changes in the traffic flow in emergencies. stressed network stability after disasters and provided an efficient and quick road-network-performance-assessment method. built a performance simulation model for traffic networks in emergencies, and it can provide decisions for emergencies in different scenarios. These authors also verified the benefits of network management with examples such as Boston, Massachusetts elaborated upon the performance of transportation infrastructure during a disaster, including the risk, vulnerability, reliability and flexibility

Haddow, G.D.; Bullock (2017) A balanced temporary traffic control strategy can help meet the demands of the emergency rescue time and minimize the negative impact on society. The proposed PD-TCM model and relevant algorithms give full consideration to the optimization determination method of the emergency paths and control domain. To make full use of the road capacity and reduce the change in the network connectivity, a variety of control types with changeable control intensities are proposed, methods for the diverging domain to attract and distribute the traffic flow spillover from the control domain are used, and adjustments of the BPR function according to different road areas is improved. We also obtained the following management insights: (i) strengthen the daily information propaganda and constantly improve public awareness of the crisis and the authorities' ability to respond to it. If people have enough coping capacity, the blindness of post-disaster traffic would significantly reduce; (ii) accelerate the construction of an emergency rescue linkage mechanism to ensure that the emergency management department and people can obtain enough real-time and correct information to avoid the adverse effects of information asymmetry; and (iii) conduct risk assessments, implement early warnings of the risk and develop emergency and rescue plans. Frequent emergency rescue drills should be carried out to improve the government and the public's emergency response capability.

Kurauchi, F.; Iida, Y.; Shimada (2003) In a short period of time, rescue vehicles from all over the country began to quickly gather in the disaster area, causing a large range of congestion. Of course, these measures played a great role in the earthquake relief and greatly reduced the losses from the earthquake, but inevitably produced some negative effects. At the same time, the normal order of life of the people in the non-earthquake area was also affected. For example, the fact that the rescue vehicles were occupying the driveway caused some people to bypass; this is a conflict between the public's right to travel and the limits of the emergency. We believe that the life and property of the people in the disaster areas are very important and that the state must make every effort to carry out rescues, but that the right of ordinary people to normal travel should also be respected to a certain extent. When contradictions arise, we should seek an optimal solution which not only meets the needs of disaster relief but also does not damage people's travel rights due to excessive disaster relief. This is the key problem our research hopes to solve.

Liu, H.X.; Ban, J.X (2007) In recent years many scholars have conducted research on normal traffic management and optimization and have achieved fruitful results. With the increase of the occurrence frequency and harm degree of emergencies, some researchers have begun to pay attention to road traffic management and dispersion under emergency conditions since the Many sociologists have studied the traffic system construction, traffic control system and community disaster prevention. Based the strong earthquake that occurred in studied the serious impact of the earthquake on the transport system and proposed a stronger resilience traffic system. The author also discusses the reliability of the infrastructure structure, the reliability of the node and the time reliability of the traffic network. At the time of reliability, researchers believe that the construction of detour roads is very important for disaster relief activities, and flexible traffic control and some regulations on private cars, as well as some training and preparation to avoid bottlenecks occurring in peacetime are also crucial.

Oshima, D.; Tanaka, S.; Oguchi, (2012) Road damage after an earthquake, proposed a fuzzy multi-objective programming algorithm and used a traffic control scheme to control vehicles entering and leaving the disaster area also considered meeting the demands of disaster relief and the public. As a goal, a multi-objective traffic control scheme model was established based on the theory of bi-level programming methods and network optimization, and a fuzzy interactive algorithm and genetic algorithm were used to find the solution. Proposed a model reference adaptive control (MRAC) framework to conduct real-time traffic management during a post-disaster emergency evacuation to dynamically control the traffic flow and reduce casualties and property losses. In consideration of the demands of emergency responders after accidents, studied the joint planning problem of emergency evacuation and emergency traffic management They established a two-stage optimization model and proposed a lane reversal method to improve the network performance.

METHODOLOGY

Feasibility Studies Based on Data and information the project preparation support team (PPST) has examined feasibility of roads under the screening by assessing institutional capacity of APRDC, Alternative alignments, road safety and indigenous people and preliminary cost and budget. For institutional arrangements requirements, capacity building approach is adopted. Role of important stakeholders are identified. Existing roads have been examined in terms of congestion, geometry, and availability of Row and accordingly improvement proposals for like alternative alignments/bypasses and geometric improvements are made. Decisions taken during consultation, and suggestion of local engineers have been given due weightage. Consequently these socially acceptable improvement proposals have been shared with technical team to finalize design of the road. To understand impact of road improvement on road users and road side communities in terms of road safety. Secondary data support from (APSACS) and stakeholders' consultation have been given importance. Elaborate consultations with

various stakeholder groups have been carried out that helped to develop insight for building up strategy of intervention process. Road safety strategy for community awareness has been formulated based on information collected from secondary sources from concerned department and to ensure participation. Major junctions and important curves have been considered as hot spots for road design. These locations will be considered to generate road safety awareness. Indigenous people are perhaps the most vulnerable section of the society. Finally strategy for Scheduled Tribe was formulated based on secondary level data, field observation and consultation.

Hwy 563 Improvements

- Planned development and roadway improvements will, over time, result in Hwy 563 ceasing to function as a Provincial Highway corridor.
- It is considered prudent for the Province to have discussions with the County to affect the transfer of the Hwy 563 corridor to the local municipal jurisdictions in advance of the initial Hwy 1/RR-31 interchange improvements.
- This study suggests a future function and form for the various segments of the Hwy however most infrastructure requirements along the majority of the length of the corridor will, for the most part, be driven by adjacent development initiatives

Non-Motorized Traffic Survey:

During traffic surveying it is important to consider non-motorized traffic in addition to motorized traffic since it will benefit from construction of the project. The benefit to non-motorized traffic is quantified and included in the benefit streams of the project. Therefore, the volume and composition of non-motorized traffic currently using the project road was surveyed for 7 days during 12-hours of daytime where pedestrians, pack animals, animal drawn carts and motor cycles were recorded

Traffic Forecasts:

Based on the traffic count that will be conducted and historic traffic data collected, the traffic is forecasted over the design period. The traffic forecast included:

• Normal traffic using the road;

• Diverted traffic from alternative routes due to the project road;

• Diverted traffic to alternative routes due to various options;

• Generated/induced traffic due to improved road conditions. Market, community and facility surveys will be conducted to understand the communities‟ future plan in use of the upgraded road. The study had surveyed aspects such as:

Traffic Survey:

Manual traffic count surveys at appropriate locations in the project influence area were carried out. Comparison of traffic growth considered in the study and the actual number from the new counts is made to arrive at a conclusion on possible traffic growth over the design period. Vehicle traffic surveys were conducted on the project road that forms part of the route. Where the new road follows the alignment of existing paths, trials and tracks, then surveys were undertaken to determine all movements of pedestrians, animals, animal carts and vehicles. Traffic counts were

conducted for seven days of 12 hours. The consultant used standard traffic count format to conduct the counts. The vehicles were classified into the following categories by adopting international practice as indicated below:

- Exhibit 2-3 presents the current (2012) average morning and afternoon peak hour traffic volumes along the Hwy 1 corridor. Daily traffic volumes on:
- Hwy 1 west of the Hwy 563/Old Banff Coach Road/RR-31 interchange are currently in the range of 23,000-to-24,000 vehicles-per-day Summer AADTs reach 28,500 vpd. Approximately 6% of the Hwy 1 vehicle traffic in the vicinity of the interchange is considered heavy vehicle traffic;
- Hwy 1 east of the Hwy 563/Old Banff Coach Road/RR-31 interchange are currently in the range of 28,000-to-29,000 vpd. Summer AADTs reach 34,100 vpd;
- Hwy 1 west of the Stoney Trail interchange are in the range of 39,000-to-40,000 vpd. Summer AADTs reach 43,720 vpd; and Hwy 563 between RR-31 and Spring bank Road, are in the range of 1,500-to-2,000 vpd.

ROUTE PLANNING:

- Planning with respect to road construction takes into the account of present and near uses of the transportation system to satisfy
- Maximum service with a minimum of financial and environmental cost. The main objective of the initial phase of road network from khammam to Warangal highway
- development is to establish specific goals and prescriptions for road network development along with the more general location
- needs the route planning phase is the time to calculate environmental and economic settlement and should set the stages for the
- remainder of the road development process

RESULTS

Roads into highways with pavements constructed from local natural stone bound with local crude oil. The gradual development of the road network has optimized local resources and conditions within tight budget constraints. Traditional tracks and transport routes were upgraded quickly using local building materials with small investments to provide the largest possible network across the country. The sub-base, culverts and bridges were constructed to international standards, however the pavement construction relied local stone bound with local crude oil. Under increasing traffic loads the surface has been upgraded with concrete and bitumen products depending on the local circumstances and elevation Rural Roads Connectivity is one of the key for rural development, as it promotes access to economic and social services, generating increased agricultural income and employment. While building rural roads, the provisions based on the parameters that affect the sustainability a t minimum cost. The conventional methods and specifications tend to recommend

technology and materials, however difficult and distance away they may be, which normally result in higher cost of construction. Though such methods and technologies were tried world over, they could not become popular in India, due to procedural constraints and lack of awareness. An attempt is made to bring in together innovative technologies and discuss their positive impacts so as to convince the field engineers in adopting such technologies at placed found effective

The natural subgrade, which is the lowest layer of a road and can consist of remnants that have been left from old roads or may be the natural soil that is unearthed for new road building

- The sub-base, which consists of compacted gravel, stone or sand and is the first layer that the road builder puts down on the natural subgrade. Primarily, this layer contributes to the strength of the road, but also provides a platform for operating the machinery.
- The road base, made of graded mineral aggregates, is considered the main working layer of the road and provides strength and flexibility. The mixture may contain bitumen if the load bearing requirements are high.
- The base course, comprised of aggregates and bitumen, is an even surface foundation for the top layer and further strengthens the road.

The wearing course, usually made of a finely textured mixture of aggregate and bitumen, must be able to resist the abrasion of traffic and provide a smooth surface for vehicles to travel. It must be weather-proof and capable of dispersing water effectively so as to minimize dangerous incidences such as skidding.

Geometric Overview of Existing Highway 563:

The design review of the existing Highway 563 corridor involved a desktop assessment and an evaluation of the corridor based on a site overview. The review of existing conditions served to identify the following geometric and access management issues:

Horizontal Alignment: A review of the geometry of the 12 horizontal curves along the existing Highway 563 alignment indicated that only 6 of the curves meet current highway standards33.

***Vertical Alignment*:** The Highway 563 corridor consists of 22 vertical curves (12 sag and 10 crest), with sag curves ranging from K19-to-K153 and crest curves in the range K13-to- K53. The Highway 563 grades vary from 0.0% to 7.2% (where a 6% grade is desirable for this highway facility). A comparison of these curves to the permitted Kmin values (required to accommodate stopping sight distance) was undertaken:

Approximately 23 % (5 of 22) of the existing Highway 563 vertical curves satisfy design criteria for 3R/4R projects that are applied to improvements proposed along existing paved highways35;

Three segments of the Highway 563 corridor, over a total length 0.6km (or 10% of the length of the corridor in both directions), exceed the 6% desirable maximum gradient36 for a rural 2-lane undivided highway A thorough survey of the vertical profile should be performed to more

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accurately determine areas for further improvement.

Pavement Width: The current minimum standard for an undivided rural highway surface (exclusive of shoulders) requires a 7.0m pavement width38. The existing Highway 563 pavement width along its entire length within the study area is 6.9m

Access Management: The intersection and private access spacing along Highway 563 is inconsistent with AT access management guidelines39 for collectors and can be characterized as follows:

- spacing between the existing public road intersections varies from 1.9-to-3.8km;
- private access spacing ranges from 100m-to-425m; and
- access to intersection spacing ranges from 22m-to-440m.

Feasibility Study on four lane Construction Process:

Collision Data: The findings compared favourably to those detailed in the previous section The assessment identified various trends in the collision information: there were a significant percentage of off-road collisions, including a notable number of vehicles in the median; The 1km section between the Hwy 563/Old Banff Coach Road/RR-31 interchange and the top of the crest hill had a high number of collisions particularly in the eastbound direction and Widening the highway in the future without improving the vertical alignment can result in higher operational speeds and frequency of collisions Road construction introduces huge quantities of foreign material to the natural environment and disrupts the soil conditions and runoff behaviour for hundreds of kilometres.

Figure: Four lane roads

Consequently, the road construction process is paramount in reducing the environmental impact of roads. The environmental impact of road construction materials is governed by two major factors – the choice of materials and the processes through which those materials are used to construct the road. In general, the materials used for road construction affect the chemical composition of the surrounding environment (through the toxicity of leachate, runoff and groundwater) while the design and construction methods cause mechanical damage (erosion, soil disruption, watershed changes).

CONCLUSIONS

The conclusions of this PSA are that the communities and road transport sector will benefit directly, with significant increase expected in the level of passenger transport services; and, growth in the transport of goods by roads by small-scale transporters and other private car. In the longer-term the agricultural and local/community business sector will grow, with new micro, small and medium enterprises being established that will take advantage of better transport services and lower transport costs to operate and provide services. The benefit of proposed widening of NH- 563

Development lead to changes in the level of well- being and human development, through their benefit of consumption level, educational attainments The road construction will provide better transportation facility for tourists visiting regions the pavement and we found that rigid pavement is more economic than flexible pavement after adding the 20 year life cycle cost. For reduction in accident installation of proper road safety system through signage, barricades, crash barriers, will add to be safety of the vehicular traffic on the stretch of the road. This includes health and education services for which current access is insufficient and inadequate. It also includes services that are presently not available such as access to government services and infrastructure like electricity/water supply and veterinary extension services. The data presented enhances the clear approach on parallel road construction on khammam and Warangal highway.

REFERENCES:

1. Pandey, Y., Sangita, Kardam, R., & Singh, M. (2015) Laboratory Study for Use of Alternate Coal Mixed Waste Aggregates vis-a-vis Natural Aggregates for Bituminous Concrete Layer. International Journal of Emerging Technology and Advanced Engineering, 5(5), 401-403
2. Singh, M. P., & Shishodia, A.(2015).Green Technology for Construction and Maintenance of Roads. Civil Engineering & Construction Review, 28(9), 71-74.
3. Rynathiang, M. Mazumdar (2005) IIT Kharagpur, "Structural Behaviour of Cast n Situ Concrete Block Pavement", Journal of Transportation Engineering, Vol.131, Issue 9, pp.662-668
4. Austroads 2008, Guide to Pavement Technology, Part 2: Pavement Structural Design
5. Green Highways, American Concrete Pavement Association, Baton Rouge, Louisiana - April 2008
6. Doolan C, Concrete Pavements. Main Roads Western Australia - August 2010
7. Hodgkinson J R, Introduction to Concrete Road Pavements, CACA Aust Technical Note - June 1982.
8. Tinni A, Introduction to Concrete Pavements, Dept of Transport, Environment and Infrastructure, Adelaide - 19 January 2011
9. Tinni A. Life Cycle Cost Analysis for Optimal Pavement Selection. Road Design, Construction and Upgrade Conference, Brisbane - June 2010
10. Tinni A, Evaluation and Comparison of Performance of Heavy Duty Road Pavements. Baltic International Roads Conference, Kuresaare, Estonia – August 2006
11. Mawjoud and Mohammed G. Jamel (2016). Using The Analytic Hierarchy Process and GIS For Decision Making In Rural Highway Route Location, International Journal of Civil Engineering and Technology, 7(2), 2016, pp. 359–375
12. Hameedaswad Mohammed, (2016) The Influence of Road Geometric Design Elements on Highway Safety

.International Journal of Civil Engineering and Technology, 4(4), 2013, pp.146–162

13. Islam M. Abo Elnaga (2014),Development of Traffic Accidents Prediction Models at Rural Highways in Egypt. *International Journal of Civil Engineering and Technology*, 5(6), 2014, pp.16–24
14. Mawjoud and Mohammed G. Jamel (2016) Using The Analytic Hierarchy Process and GIS For Decision Making In Rural Highway Route Location, International Journal of Civil Engineering and Technology, 7(2), 2016, pp. 359–375
15. Nadeem khan1, Rakesh Gupta (2016) A study of Detailed Project Report for Up gradation of Nh-3 from Two to Four Lane", International Journal of Engineering Development and Research Volume 7, Issue 4, July-August 2016, pp. 406–421