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Road Project Appraisal Process in India

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Abstract: In India, road development is an integral part of planning. The highest level of planning is at the national level, known as Five Year Economic Development Plans. The plans are formulated at national level by focusing sector wise policies, issues and estimation of resources and their allocation for development of the sector. Under road sector, the policies are mainly to guide and identify the road network improvements based on the needs and demands estimated by various implementing agencies.

Keywords: Economic development need and demands.

I. INTRODUCTION

The required estimation of resources are worked out based on the standards/norms/guidelines which are normally proposed for new road projects and existing roads, emphasizing on capacity augmentation in terms of increasing lanes, geometric improvements, or providing a by-pass to a congested urban area and creating accessibility / connectivity to the villages by providing all-weather road. Based on the policies and the targets proposed in the Five Year Plans, the funds are allocated annually through budgetary allocation to the road development agencies.

II. ROAD DEVELOPMENT PLANS

Twenty Year Road Development Plans were prepared to guide the National level policies and programmes for development of roads in India. So far, three such plans have been formulated viz., (i) First 20 Year Road Development Plan (1940-60), (ii) Second 20 Year Road Development Plan (1961-80) and (iii) Third 20 year Road Development Plan (1981-2000). Currently, Road Development Plan -Vision 2020 has been prepared with a broad objective to guide the Central and State government agencies for development of roads under the changing economic policy of liberalization and globalization.

III. CLASSIFICATION OF ROADS

Roads are classified into two broad categories viz. Urban Roads and Non-urban roads. In India, urban roads are further classified as:

- Expressways
- Arterial Roads
- Sub-Arterial Roads
- Collector streets and
- Local streets

Non-urban roads too are classified into five categories from the administrative and functional considerations. The classification was suggested in the Nagpur Plan (Second 20 year Road Development Plan). The classes of road and their descriptions are given in Table 1.

S.No	Class	Description
1	National Highways	These roads traverse the length and breadth of the country and are of national importance for strategic, administrative and other purposes. They connect capitals of states, ports, foreign highways, large towns and industrial centres. They can be deemed to be the primary road network of the country.
2	State Highways	These roads are the main arterials of traffic within a State, serving important cities, and connected to the National highways system and important highways of adjacent states.
3	District Roads	The branch roads of the State and National Highways is to serve as the main roads for intra-district movements. They traverse the length and breadth of a district to connect the areas of production and marketing in the district to one another and to the national Highways. Further they are divided in to Major district roads and other district roads.
4	Rural Roads (Village roads)	These roads connect villages and groups of villages with one another to market places and district roads.

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In the Third Road Development Plan (1981-2001), a slight modification to the classification system was suggested by Indian Roads Congress (IRC) in 1984. The reclassification of roads, as suggested by IRC, is:

(A) Primary system
(1) Expressways
(2) National Highways

(B) Secondary system
(1) State Highways
(2) Major District Roads

(C) Tertiary system
(1) Other District Roads
(2) Village Roads

IV. CURRENT ROAD DEVELOPMENT PROGRAMMES

During the year 1990, Government of India identified certain sections of National Highway for improvement/upgradation by carrying out field studies. After deliberations at various forums, Government of India launched a Major highway development improvement programme known as 'National Highways Development Programme (NHDP)' with the aim to upgrade existing National Highways to International Standards.

Under NHDP, two major programmes were identified (i) North-South Corridor (between Srinagar to Kanyakumari) and East-West Corridor (between Silchar to Porbandar) covering around 7,300 km of road length and (ii) Golden Quadrilateral High Density Traffic Corridors linking metro cities like Delhi, Mumbai, Chennai & Kolkata which is covering around 5846 km and has been taken up for development in first phase. In the second phase of NHDP, about 650 km of port road connectivity has also been proposed for improvement. In the final phase, 10,000 km length of National Highways connecting the State Capitals will be taken up for upgradation/improvement .

Apart from the National Highways Development programme (NHDP), the Government has launched Rural Connectivity Programme popularly known as Pradhan Mantri Gram Sadak Yojana (Prime Minister's Rural Road Programme) during the year 2000-01. The Pradhan Mantri Gram Sadak Yojana (PMGSY) aims to provide connectivity to rural habitations for population above 500 with all-weather road, by the year 2007.

However, for Hill states, Desert Areas and Tribal areas, connectivity will be provided for habitations with population of 250 persons and above. Nearly 50 per cent of the 6,00,000 habitations would be provided connectivity with all-weather road through this programme. This programme also emphasizes to upgrade the existing rural roads to the prescribed standards (bituminous surfacing).

V. INSTITUTIONAL AND ADMINISTRATIVE FRAMEWORK

National Highways fall directly under the control of Central Government with complete financial liability for the development and maintenance of highways. The Central Government is vested with the authority to declare any other category of road to be a National Highway, if it satisfies the requirement of National Highway. Policy matters are handled by the Ministry of Road Transport and Highways with major functional responsibilities such as administering funds as well as to formulate plans for development and maintenance of National Highways in consultation with the executing agencies like State Public Works Department / Highways Department. Rural roads development is also the responsibility of the State Governments. They are planned and developed under the aegis of State Rural Development Department and are executed by the Public works Department or Rural Engineering Department. Under the PMGSY programme, funds are being allocated by the Central Government to the State Governments for execution of the programme. Each State Government agencies formed a separate rural road Project-implementation unit (PIU) for effective implementation of this programme. The National Rural Road Development Authority, an agency under the Ministry of Rural Development, Government of India, has been formed to guide technically and monitor the execution of the programme at national level.
Improvement of priority National Highways network is assigned to the National Highways Authority of India (NHAI), which is an autonomous body with executive responsibility for construction operation and maintenance of National Highways. It's work is under the administrative control of the Ministry of Road Transport and Highways (MORTH), Government of India. The remaining National Highways are looked after by the MORTH. The concerned State Governments have the responsibility of development and maintenance of State Highways, District Roads and Rural Roads. The State Public Works Department/Highway departments generally look after these categories of roads.

VI. THE INDIAN ROADS CONGRESS

Indian Roads Congress (IRC) is a governing body of professional highway engineers in India. The major objective is to promote and encourage the science and practice of road building and maintenance and development and use of standard specifications and practices for India on planning, design, construction, operation and maintenance of roads. Its technical publications serve the purpose of disseminating technical knowledge and stimulate the science of road engineering. The Highway Research Board of the IRC identifies the various research needs and monitors the progress on scheme, which are taken up for execution. Dissemination of research results is given due importance.

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VII. PROJECT APPRAISAL PROCESS

a) Detailed Project Report

The detailed project report is normally prepared for new roads and for upgradation and rehabilitation of the existing roads. The Indian Roads Congress has come out with a manual for preparation of detailed projects reports. The various stages involved in project preparation are given in Figure 1. The practicing engineers follow the guidelines provided in the manual while preparing the project report.
The project preparation is carried out in the following stages:

- Pre-feasibility study
- Feasibility study
- Detailed engineering studies
- Preparation of detailed report, drawings and tender documents

b) Procedure for Economic Analysis

The Indian Roads Congress has come out with manual for economic analysis of highway projects. The economic analysis procedure for road projects involves normally the following steps (IRC, 1993):

c) Stages Involved in Project Preparation

- Identification and definition of the project, project area and other related details.
- Collection of basic data on economy.
- Selection of policy variables for analysis and decision criteria.
- Inventory of existing roads.
- Traffic projection and assignment.
- Engineering design alternatives by using standard techniques.
- Estimation of cost for the proposed facilities as per the proposed alternatives including maintenance cost etc.
- Performing economic analysis.

The manual also provides the data related to road user costs and vehicle operating costs for individual vehicles based on the Road User Cost Studies (RUCS) conducted for India. Recently, the Ministry of Road Transport and Highways and CRRI has updated the above database by including the new technology vehicles.

d) Pavement Design

Pavement is designed to support the wheel loads imposed on it as a result of traffic moving over it. Additional stresses are also imposed by changes in the environment. The pavement structure should be strong and thick enough to resist the stresses and to distribute the external loads on the sub-grade, so that the sub-grade can safely bear it.

e) Pavement Courses

Pavement structure consists of one or more layers as given in Figure 2. The top most layer is surfacing/wearing course, the purpose of which is to provide smooth, abrasion resistant, dust free, reasonably water proof and strong layer. The base, which comes immediately next to surfacing, is the medium through which the stresses imposed are distributed evenly. Additional help in distributing the loads is provided by the sub-base layer. The sub-grade is the compacted natural earth immediately below the sub-base layer.

f) Pavement Types

From the structural performance point of view, pavement can be classified as:

1. Flexible
2. Rigid
3. Semi-rigid
4. Composite

A flexible pavement is essentially a layered system, which has low flexural strength. However, the external load is largely transmitted to the sub-grade by the lateral distribution with increasing depth. Because of the low flexural strength, the pavement deflects momentarily under load and rebound to its original level on removal of load. If the pavement itself is strong and constructed on poor sub-grade, it will fail.

A rigid pavement derives its capacity to withstand loads from flexural strength or beam strength (modulus of elasticity), permitting the slab to bridge over minor irregularities in the sub-grade, sub-base or base upon which it rests. The slab itself plays a major role in resisting the wheel load.

A semi-rigid pavement has become popular during recent times. It represents an intermediate state between the flexible and the rigid pavement. Flexural strength is lower compare to the concrete slab, but it also derives support by the lateral distribution of loads through the pavement depth as in a flexible pavement.

A composite pavement is the one, which comprises of multiple, structurally significant layers of different and sometimes heterogeneous composition.

g) Factors Affecting Pavement Design

Pavement design is governed by a number of factors and these are:

- Design Life
- Traffic factors
- Environmental Factors
- Sub-grade Strength and Drainage
- Availability of good materials locally

h) Design Life

The design life is defined in terms of the cumulative number of standard axles that can be carried before strengthening of the pavement is necessary. It is suggested in IRC that National Highways and State Highway should be designed for a life of 15 years and Expressways and Urban roads may be designed for a longer life of 20 years. For other categories of roads, a design life of 10 to 15 years may be adopted.

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i) Traffic Factors

Wheel Load: Pavement wheel load causes stresses and strains in pavement layers and sub-grade and tyre pressure determines the area of application.

Impact: Imperfections in surface and at joints causes additional load due to impact.

Repetition of Wheel Loads: Apart from single wheel load design criterion, the cumulative load applications during the design life cause plastic and elastic deformations.

Position of Wheel Load Across Pavement: the concentration of wheel load at a localized width of pavement can cause extra distress.

Iron-tyred Vehicle: Bullock carts with iron tyres can cause sever stresses in pavement.

j) Environmental Factors

Rainfall: Rainfall affects pavement drainage and can be a significant factor.

Frost: Frost heave can disrupt pavement structure.

Temperature: Variation in temperature can cause stresses in the pavement.

k) Sub-grade Strength and Drainage

Sub-grade soil type and compacted density significantly affect pavement design. Surface and subsurface drainage of pavement and from adjoining land also affect sub-grade strength significantly and hence the pavement design.

l) Availability of good materials locally

The strength of sub-grade soil and granular material in the sub-base layer is generally determined in terms of CBR on samples compacted to the specified densities at optimum moisture contents and often these samples are soaked for 96 hours before testing.

m) Design of Rigid Pavement

The early approach to the design of rigid pavements was based on Westergaard's analysis. Recent advances in knowledge have led to vast changes in the design methodology. In the earlier version of IRC:58-1988, the calculation of load stresses was done as per Westergaard's equations modified by Teller and Sutherland. The use of these equations has its own limitation because they do not take into account the configuration of the wheels. Picket & Ray's chart is used for stress computation in the interior portion as well as at the edge of concrete slabs. Using the fundamental concept of Westergaard and Picket & Ray's pioneering work, a Computer programme IITRIGID developed at IIT Kharagpur is used for computation of stresses for the edge load condition in the revised guideline IRC 58-2002 "Guidelines for the design of plain jointed rigid pavements for highways". The stress charts for single as well as tandem axles for different magnitudes of single and tandem axle loads are given in the revised IRC guideline. Thus the salient features of the revised guideline are computation of flexural stress due to the placement of single and tandem axle loads along the edge and the introduction of the cumulative fatigue damage approach in the design. Most of the work till recently is aimed at modifications and adaptations of Westergaard's work for matching better and actual performance and for simplifying the analysis of design. The present philosophy in design is based on warping stresses developed in the slabs due to temperature variations and bending of the slabs due to axle load. The stress ratio concept is used to account for axle load repetitions by which actual repetitions of axle load and allowable repetitions of axle load are compared as per the recommended design procedures given in IRC: 58-2002 and IRC: 15-2002.

A. Design of Flexible Pavement

The IRC guideline for flexible pavement, published in 1970 was the basis for design of flexible pavements in India till recent past. Design procedure was based on CBR value and traffic in terms of Commercial vehicles per day (CVPD), the laden weight of a commercial vehicle exceeding 3 tonnes. The required thickness is given by design curve.

IRC guidelines were revised in 1984. The features of the new practices were:

1. A set of curves for determining pavement thickness relating the cumulative standard axles and CBR value to the thickness.
2. Revised design thickness curves/blocks relating the traffic in terms of cumulative standard axles and the CBR value.
3. Recommendations on types of pavement material suitable for various structural layers.

The IRC have recently brought out a second revised version, IRC: 37-2001. The features of this document are:

a) The design catalogue is based on the results of MORTH study entitled "Analytical Design Approach for Flexible Pavement".
b) The flexible pavement has been designed as a four-layer structure.
c) The catalogue covers soils having CBR values in the range of 2-10.

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d) Traffic loading upto 150 million standard axles (msa) have been considered.
e) Damaging effect of axle loads has been considered.
f) Two different design thickness charts were developed (i) for 1 to 10 msa and (ii) for 10 to 150 msa

B. Overlay Design

Pavements, which have been in service, deteriorate due to variety of factors. A part of such deterioration can be maintained by patching and periodic renewals. When the extent of deterioration is beyond maintenance solutions, the pavement needs an additional overlay. Strengthening will overcome the structural inadequacy caused by the traffic that has used the pavement so far and will enable the strengthened pavement to withstand the expected traffic in the subsequent design period.

C. 3.6.1 Overlay Design for Flexible Pavement

IRC formulated guidelines (IRC: 81-1981) for design of overlay on flexible pavements. The method is based on measurement of pavement surface deflections by the Benkelman beam using CGRA method. Deflection measurements are very sensitive to temperature and seasonal variation and accordingly correction measures were suggested. Set of equations was developed to calculate the required overlay thickness.

The latest version of these guidelines (IRC: 81-1997), has suggested a set of curves for determining the overlay thickness. The thickness is in terms of bituminous macadam (BM) construction (considering conversion factor as 1cm BM is equal to 0.7 cm of DBM or BC/AC).

D. 4.0 Highway Geometric Design of Highways

Geometric design is an important aspect of highway design that deals with visible dimensions of roadway. It is the process where by the layout of the road in the terrain is designed to meet the needs of the road user. The primary geometric design elements of a road are the horizontal alignment, vertical alignment and the cross section. The geometric design standards in India generally are adopted as per Indian Roads Congress (IRC) guidelines. The optimal design for a given traffic flow will depend on terrain and other characteristics. Appropriate standards and combinations of these elements should be defined in relation to the following controls and criteria:

- Topography, land use and physical features
- Road function and control of access
- Traffic volume and capacity
- Design vehicle and vehicle characteristics
- Design speed and other speed controls
- Road safety considerations
- Environmental considerations
- Economic and financial considerations

The above controls and criteria should be considered not only for new road construction, but also for upgradation and rehabilitation of existing roads. The principal objective of a feasibility or detailed study should be to suggest recommendations about the geometric design standards for a project, such that the optimum balance between road construction cost and road user cost is obtained over the project analysis period. The aim shall be to arrive at a final design, which will meet future traffic requirements and encourage consistency and uniformity of operation.

a. **Elements of Geometric Design**

The main elements of geometric design include horizontal alignment, vertical alignment and road cross section. Further, these design elements will also depend on terrain classification and design speed. The design elements have been explained briefly in subsequent paragraphs.

E. 4.1.1 Terrain Classification

The method of classifying the terrain is given in IRC: 73-1980. IRC: SP 30 has also classified the terrain on the basis of quantification of curvature and gradient.

F. 4.1.2 Design Speed

Alignment design is made in compliance with the design speeds for rural highways as per IRC 73-1980. IRC 86-1983 also suggests design speed recommendations for urban roads, but it has recommended using minimum radii if greater radius is not feasible for economic, technical or environmental reasons.

G. 4.1.3 Horizontal Alignment Standards

1) a) Minimum radius

When vehicles negotiate a curve, a sideways frictional force is developed between tyres and road surface and this friction must be less than the maximum available friction. If the bend is to be traversed safely, super elevation will be introduced to reduce the friction The general relationship for this effect is recommended in IRC 38:1989.

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2) b) Transition Curves

Transition curves are introduced for comfort, safety and aesthetic reasons, besides permitting gradual application of the super-elevation and possible widening of the carriageway in smaller horizontal curves. Clothoids/spirals will be used as transition curves. The minimum spiral lengths required for the corresponding design speeds and the type of terrain has been recommended in IRC 38: 1989.

3) c) Sight Distance

Design speed is basically a control on sight distance. The highway facility must provide users with adequate sight distance to see far enough to safely execute any required movements. Sufficient sight distance should be provided on curves and gradients. Formulae to calculate the minimum space free of obstructions like houses, walls, trees etc., is given in IRC 38: 1989.

4) d) Setback Distance

The distance from centerline of road, from which the obstruction should be cleared to ensure the needed visibility, is called "set-back" distance. The minimum requirement of setback distance for various categories of roads has been specified in IRC 38-1989.

5) e) Extra Widening at Curves

It is common to widen the pavement slightly more than the normal width on horizontal curves. Widening of pavement is needed on curves due to off tracking. IRC recommends that widening is not required for horizontal curves with radii greater than 300 m. The extra width of carriageway should be provided on horizontal curves for radii less than 300m as per IRC 38: 1988.

H. 4.1.4 Vertical Alignment Standards

The vertical alignment of a road has a strong influence upon the construction cost and operating cost of vehicle. Vertical alignment should be designed according to IRC: 73 for rural highways and IRC: 86 for urban highways.

I. 4.1.5 Cross Sectional Standards

6) a) Right of Way

Right of way requirements for different classes of roads in India is specified in IRC SP 15-1974.

b) Width of Road way and Carriageway

7) Minimum width requirement for roadway and carriageway for various categories of roads have been specified in IRC 86: -1983. The IRC code has also given guidelines and specifications for median and shoulder requirements.

8) c) Camber

The percentage of camber to be provided will depend on the surface type and the intensity of rainfall. The standards for various types of surface course in India are specified in IRC 73-1980.

9) 4.1.5 Intersection Design

Intersections are divided into two types and these are At-graded intersection and Grade - separated intersection. For design of At-grade intersection, IRC SP: 41:1994 has been recommended. The detailed specification and the requirement for grade-separated intersection for various highways has been specified in IRC 92:1985. Apart from this, Ministry of Road Transport and Highways (MORT&H) specifies level junctions designing "Type Designs for Intersections on National Highways, 1995". It reveals that junctions shall be designed for projected traffic for a period of 10 years.

4.1.6 Road Accessories

Safety and efficiency of an operation depends considerably on the geometric design. Effective road markings, road signs and other road accessories should supplement the physical layout. These will improve the driver's perception and comprehension of the continually changing appearance of the road. The requirements of road accessories and their design specifications have been specified in IRC.

i. Software Tools for Highway Geometric Design

Researchers and consultants are now using computer softwares to assist in the design of transportation facilities. Such design packages are used in conjunction with computer aided drawing (CAD) software to produce facility plans. Software models (listed below) presently available are based on template and string concept. In template based models, the road is treated as the group of combinations of various cross sections and on the other hand, string based models are considered as a group of master and minor strings.

A) Template based software models

- Inroads
- Soft desk
- Auto Civil Design

B) String Based software models

- Mx Roads (Extension of MOSS)
- HEADS

J. 5.0 Environmental Studies

Environmental protection and ecologically sustainable development has acquired an important dimension in the present national context. While this situation has evolved over the last three decades in developed nations, it is only more recently that environmental issues are being addressed in developing countries like India.

Pace of developmental activities involving road infrastructure has been showing unprecedented growth in the recent past, Development of highway or road infrastructure is not only a catalytic agent, but also a pre-requisite for the economic growth of the nation. The basic objective of highway projects is efficiency, equity, environment and energy. By this, it is meant that the highway projects are to achieve maximum efficiency in movement at minimum consumption of energy and distribute benefits equally to the community while having minimum adverse effects on environment and to achieve

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sustainable development. Emphasis on the development of infrastructure, including roads and highways, by taking up important road projects like North-South and East-West highway corridors and Pradhan Mantri Gram Sadak Yojana, is evident, necessitating the need that environmental concerns are explicitly addressed and incorporated into the project decision making process. General awareness of environmental impacts of road/highway project has been growing in the past. The Government of India has enacted several laws in the last decade, to ensure environment against degradation. A systematic environmental assessment can ensure environmentally sustainable development through timely incorporation of environmental issues. It is especially relevant for projects involving construction of a new highway through non-urban or urban areas. Environmental impact assessment (EIA) of such projects can ensure that the development option under construction is environmentally sound and sustainable and that any environmental consequences are recognized early in the project cycle and considered while preparing project design, and costs of implementing the project.

Ministry of Environment and Forest (MOEF), Government of India, has been assigned the responsibility for the appraisal of projects with regard to their environmental implications. Based on the EIA report and issues arising there from, decisions are taken by competent authority in respect of projects, including selection of sites. EIA is a part of environmental clearance procedure, as it is a pre-requisite for consideration of development projects for funding by international funding agencies like World Bank, United Nations Development Programme (UNDP), and Asian Development Bank (ADB) etc. Earlier, Environmental Protection Act (EPA), 1986, in conjunction with Environmental (Protection) Rule, 1986, empowered the Central Government to introduce requirement of formal EIA procedure prior to clearance of the projects likely to have significant environmental impacts. Subsequently, a list of projects/sectors was prepared which were expected to carry out EIA studies before MOEF can clear those projects. "Road & Highway" projects were not included in EIA preview. As a result, till 1994 no comprehensive and authentic EIA was carried out and submitted to MOEF for environmental clearance, and projects like East Cost Road Project have been in limelight due to their serious environmental consequences. However, EIA notification, first issued in January, 1994 (later amended in May, 1994) (MOEF, 1994) included roads and highway projects along with other 28 types of projects and sectors. A total of 29 types of projects are included in the EIA preview, specifying certain conditions. Another notable feature of the notification was to treat EIA process as statutory requirement rather than an administrative requirement. It specified that any road and/or highway project costing more than Rs. 500 million (US $ 11 million) necessarily has to have EIA. It was further specified that in Himalayan region, Tarred road construction, irrespective of cost would require EIA for Environmental Clearance. The above EIA notification of January 1994 has been amended several times since then. Although, the basic features and sprit of EIA notification has not changed but some of the provisions have direct implications on the Roads and Highway Projects. As per the existing guidelines (MOEF notification dated October 15, 1999) environmental clearance is required for highway projects except projects relating to improvement work including widening and strengthening of roads with marginal land acquisition (not exceeding 20 m on either side put together) along the existing alignment provided they do not pass through ecologically sensitive areas such as national parks, reserve forests etc. Further, vide MOEF notification dated November 21, 2001, bypass (highways by passing an urban area) would be treated as stand above project and would require environmental clearance, if project exceeds Rs. 1000 million (US $ 22 million). Earlier, vide MOEF notification dated December 13, 2000, defence related road construction projects in border areas have been exempted from the purview of the EIA notification. Further, MOEF notification dated June 13, 2002 made public hearing mandatory in all the districts through which the highway (project) is passing.

EIA guidelines for roads and highway projects were prepared by Indian Roads Congress (IRC), in 1988 (IRC, 1989) and Ministry of Environment & Forest (MOEF) in 1989. (Environmental Guidelines for Rail/ Road /Highway Projects, 1989). These guidelines are unsuitable due to their qualitative and generalized approach, besides they are inherently incomparable for casting long-term changes and cumulative impacts.

These guidelines also fail in addressing the issues especially when roads pass through environmentally sensitive areas like forest, waste lands, hilly regions, areas with tribal population etc. The cumulative environmental consequences of such projects need to be brought to fore on scientific basis. It is apparent that, as on date, the planning and designing of highways is normally done, almost purely, on the basis of economic and traffic flow considerations. However, the environmental impacts of the road construction activities and the implications of air and noise pollution caused by the vehicular movement on the roads and the need of evolving an efficient approach to deal with such effects are now receiving focussed attention. In India, EIA for road and highway projects is carried out only after the route alignment has been finalized. Therefore, EIA is limited to identify, predict and evaluate various impacts along the route alignment or along the roads if upgradation is being carried out.

6.0 Social Impacts Studies

Socio-Economic impacts are also very much important in any road/highway project and should be given due weightage. The National Highway Development project (NHDP) under the auspices of National Highways Authority of India (NHAI), Govt. of India, has also brought in the concept of Social Impact Assessment (SIA) along with environmental considerations into decision-

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making/ project implementation process in India. Social Impact Assessment of any infrastructure project (including Highway projects) is a prerequisite for the projects funded by multi-lateral funding agencies. These agencies have made it mandatory to conduct SIA during the design stage to avoid, reduce or mitigate potential negative impacts of project action and enhance positive impacts, sustainability and developmental benefits. Various SIA studies carried out for NHDP has revealed that the approach and methodology for such studies vary for different projects depending upon whether the project is WB/ADB funded or funded by NHAI or by same Government agency (Sharma 2004). These projects have also highlighted the need of formulating comprehensive Resettlement and Rehabilitation (R&R) policy/guidelines in India and role of NGOs in implementing them for the benefit of Project Affected Persons (PAPs) or Project Affected Families (PAFs).

Though India has a strong environmental policy framework, but its implementation is inadequate and much remains to be done to meet the environmental challenges of rapid urban growth and infrastructure development. The key reason for continued environmental degradation in India is due to inadequate implementation and enforcement of environmental policies, poor understanding of cumulative effect of development and economic policies that provide disincentives for environmental consideration.

K. 6.1 Social Issues in Rural Road Projects

Under the PMGSY programme, while preparing the DPR, the PIU will hold a consultations with the local community through the mechanism of the Gram Panchayat (Lowest level of rural local self Government) in order to determine the most suitable alignment, sort out issues of land availability (including forest land), moderate and adverse social and environmental impact and elicit necessary community participation in the programme. For this it is proposed that the PIU will organize an informal 'Transect Walk' along the proposed alignment. It should consider the following points and incorporate it with the DPR report.

- The transect walk shall be done by the Assistant Engineer or Junior Engineer of PIU accompanied by the Patwari (village land record keeper)/village Development Officer and the Pradhan/Panch of the Panchayat/Ward (elected village leaders) after adequate advance publicity. The local forest officials may also be associated.
- During the walk, issues relating to alternative alignments, land requirements for the road and its impact on landowners etc. will be discussed with members of the local community present.
- Environmental impact on vegetation, soil and water etc. shall be identified for resolution
- During the walk, due opportunity shall be given to interested persons to put forward their point of view.
- At the end of the walk, alignment shall be finalized after recording the issues. This shall be reduced to writing in a document by the Secretary of the Panchayat and countersigned by the Panch/Pradhan. A copy of this document will be attached to the finalized DPR.

L. Traffic Demand Estimate

Forecasting of traffic is a pre-requisite for taking appropriate decisions in highway planning, design, construction and maintenance. It becomes all the more important when decision involves huge investments. However, when the capital available is scarce and has competing demands, the investments in a transport project have to be planned carefully, keeping in view not only the present demand but also the requirements for a reasonable period in future. To a great extent, the accurate estimate of future traffic will influence the engineering design of the facility and the economic decision whether to take up the project or not.

The practice hitherto adopted in India is to collect seven days traffic volume counts twice a year on National highways and 1 to 3 days on other roads. Besides, the Ministry of Road Transport and Highways (MORTH), Government of India has established Permanent Traffic Counting Stations (PTCS) using Automatic Traffic Counter cum Analyzer for obtaining uninterrupted data round the clock over the years on some selected locations. The database so obtained will give the required reliability when used for traffic forecasting. However, the reliability is not merely a function of the base data but will also depend on the type of technique and methodology adopted for forecasting.

In India, NHDP programmes generally follow three techniques for traffic projection:

- Past Trend Data
- Vehicles Registration
- Elasticity of Transport Demand

Past Trend Data: Available records over the past 5-10 years are collected from NH Division or respective PWD departments. This data is the base for observing the traffic growth of the present scenario and the same trend is used

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to predict the future demand. This method is adopted at feasibility stage.

Based on Vehicle Registration Data: Vehicle registration data is obtained from Motor Transport Statistics of India. Based on this data it is possible to predict the growth rate of vehicle registration of each individual vehicle through regression analysis. This technique too is adopted at feasibility stage/ level.

Elasticity of Transport Demand: Long term forecasting of the projected traffic, during the time horizon of the study, is required for designing highway and assessing the economic viability of the proposed investment for improving the facility. In view of this, the projected future traffic incorporates analysis of some of the key socio-economic characteristics and rate of change expected during the study period in the project influence area. In India, the computed elasticities are comparable to the World Bank's recommended elasticities. This method is adopted at detailed project preparation stage.

The Transport consultants and research organizations are using SPSS, MS Excel and Excel STAT software models to find out the future traffic growth.

7.1 Appraisal Tools (including HDM-4 Models)

There are many appraisal tools like Road Investment Decision Model (RIDM) based on the Road User Cost Study (RUCS), which are used in India for economic analysis of different project options. Updation of the road user cost study was, later on, taken up by Central Road Research Institute to incorporate the advancements in the automobile industry in the light of the introduction of new technology vehicles. A window-based software was developed based on the Updated Road User Cost Study, which is used in India for ascertaining the economic viability of projects at pre-feasibility stage and feasibility stage.

HDM -4 model is widely used for Strategic Option Studies (SOS), Pre-feasibility studies and Feasibility studies for economic analysis of a network of roads. It is common that many World Bank / Asian Development Bank funded projects use HDM -4 Strategy Analysis, Programme Analysis and Project Analysis tools to prioritize various investment decisions on a network level. HDM tool were used in some of the projects in India, which include Kerala State Transport Project (KSTP), Andhra Pradesh State Highways Project (APSHP) and Haryana Highway Upgrading Project (HHUP). HDM-4 was also used for the first time in India for a four lanning project of a National Highway in the state of Orissa. Key economic indicators like internal rate of return, net present value, incremental benefit/ cost ratio etc are used to prioritize the investment decisions for different network of roads. The road deterioration models are used to predict the roughness and life cycle cost analysis of different project options. Pavement Option Studies, which is mandatory in major highway projects is done by the life cycle cost analysis as outlined by HDM-4. Road user effects models and road work effects are used for finalizing the maintenance programmes in some of the states in India. Exhaustive studies like Expenditure Budgeting Modeling (EBM) are not generally used by Public work Departments and its use are largely confined to the research fraternity in India. CRRI has been identified as nodal agency for training and dissemination of HDM-4 in Asia. In this regard, several training programmes have been organized in India and abroad in recent past. Attempts are also being made to use Roads Economic Decision (RED) Model for economic analysis of rural roads.

Currently, the efforts are being made to assess the impacts in terms of post-construction evaluation of roads projects especially for the NHDP and PMGSY-rural roads on the economy, environment and society in general.

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There is little doubt that rural roads are vital to agrobased industry and rural development, to create jobs, and to make the country's growth more broad based. As all-weather road network through PMGSY is expanding we are witnessing social and economic change beyond our expectations. Though a watertight system to maintain this vast network is not in place, it is unlikely that village community would let it fall into disuse..

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Rural Road connectivity is a key component of rural development, since it promotes access to economic and social services, thereby generating increased agricultural productivity, non-agriculture employment as well as non-agricultural productivity, which in turn expands rural growth opportunities and real income through which poverty can be reduced. A study (Fan et al. 1999) carried out by the International Food Policy Research Institute on linkages between government expenditure and poverty in rural India has revealed that an investment of Rs 1 crore in roads lifts 1650 poor persons above the poverty line. Public investment on roads impacts rural poverty through its effect on improved agricultural productivity, higher non-farm employment opportunities and increased rural wages. Improvement in agricultural productivity not only reduces rural poverty directly by increasing income of poor households, it also causes decline in poverty indirectly by raising agricultural wages and lowering food prices (since poor households are net buyers of foodgrains). Similarly, increased non-farm employment and higher rural wages also enhance incomes of the rural poor and consequently, reduce rural poverty. This study estimated that while the 'productivity effect' of government spending on rural roads accounts for 24 per cent of total impact on poverty, increased non-farm employment accounts for 55 per cent and higher rural wages accounts for the remaining 31 per cent. Further, of the total productivity effect on poverty, 75 per cent arises from the direct impact of roads in increasing incomes, while the remaining 25 per cent arises from lower food prices (15 per cent) and increased wages (10 per cent). Similar results are found in other developing countries. The study by the same institute (Fan et al. 2000)) in China revealed that with every 10,000 Yuan (about $1200) spent on rural roads eleven persons are lifted above the poverty line. Living Standard Survey in Vietnam in 2002 showed that populations living within 2 km of all-weather roads have lower poverty rates as noted in the draft Vision Document for Rural Roads, 2006 (MoRD, 2006)..