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**Government of India**
**Ministry of Road Transport & Highways**
**(S&R (P&B/New Technology) Zone)**
Transport Bhawan, 1, Parliament Street, New Delhi-110001

**Dated: 30th August, 2022**

**CIRCULAR**

To

1. The Chief Secretaries of all the State Governments/ UTs.
2. The Principal Secretaries/ Secretaries of all States/ UTs Public Works Department/ Road Construction Department/ Highways Department (dealing with National Highways and other centrally sponsored schemes).
3. The Chairperson, National Highways Authority of India, G-5 & 6, Sector-10, Dwarka, New Delhi-110 075.
4. The Managing Director, NHIDCL, PTI Building, New Delhi-110001.
5. The Director General (Border Roads), Seema Sadak Bhawan, Ring Road, New Delhi-110 010.
6. All Engineers-in-Chief and Chief Engineers of Public Works Department of States/ UTs/ Road Construction Department/ Highways Departments (dealing with National Highways and other centrally sponsored schemes).
7. All CE-ROs, ROs and ELOs of the Ministry.

**Subject: - Value Engineering Practices for the Design, Construction & Maintenance of National Highways Projects- Reg.**

Madam/Sir,

The Government of India has set an ambitious plan for development of National Highways in the country. Many initiatives have been taken to materialise this ambitious plan such as adopting worldwide best practices in engineering techniques in design, construction and maintenance of highways, bridges and tunnels. Further, the need is felt to adopt value engineering practices in design, construction and maintenance with regards to use of materials and technology as an important and vital step to meet the sustainable development of the NH network throughout the country in a cost-effective manner with improved durability & safety, de-carbonise & grow, reduction in project execution timeline, increase in quality and reduction in maintenance.

2. The value engineering is very crucial for sustainable highway development. It is a systematic method to achieve the targeted function of the highway at the lowest whole-of-life cost without compromising on functionality, quality, performance, safety and aesthetics. Value Engineering practices aim at optimizing the value of the project at various stages viz. project inception, project preparation, project bidding stage, project implementation and maintenance management to achieve at least one or all of the following objectives:

a. Increasing the speed of construction without compromising the quality

b. Reducing the cost of construction and maintenance

c. Improving asset durability

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d. Improving aesthetics

e. Enhanced safety

f. Promoting environmental sustainability

g. Increasing resilience to climate change and

h. Lowest life cycle cost

3. Value engineering can be applied at any point in a project, even in construction. However, the earlier it is applied the higher is the return on the time and effort invested and also the acceptance. As per the World Bank report on the Indian Road Construction Industry, it has been established that the savings realized by undertaking value engineering exercises can be in the order of 10-15% of the cost of the originally designed project.

4. EPC/ HAM / BOT mode of project implementation has the potential that the contractors/concessionaire would be able to adopt designs and construction methodologies to suit the requirements of the project to bring down the initial construction cost while not impacting other aspects such as functionality, quality or durability. Although enabling provisions for value engineering is laid out in the governing IRC Manuals for highway projects (IRC SP: 73/84/87/99), however Contractors / Concessionaire, out of an apprehension that the Authority would take adverse views about any alternative technologies, avoid any deviations from the specifications/technologies specified in the Concession/ Contract Agreement. The Concessionaire/ Contractors are also apprehensive about the long-term risks of adopting innovative value engineering proposals, which would be entirely borne by them.

5. To dispel such apprehensions and mind-set among Feasibility & DPR Consultant/Concessionaire/Contractors/IE/AE and add value engineering practices for the design, construction & maintenance of the National Highway, following has been decided:

5.1 Value Engineering shall be assigned as one of the tasks in the Terms of Reference (ToR) for Feasibility Study and Detailed Engineering Projects. In the Inception Report itself, there shall be a Chapter regarding Value Engineering, in which the Consultant shall include the potential & project-specific value engineering aspects identified by the respective domain experts based on site reconnaissance surveys. In the Feasibility Report, the Consultant shall examine the applicability, durability, constructability & appropriateness of the identified value engineering aspects and recommend the cost-effective strategies. During the design stage, the design shall be done for the approved value engineering criteria and considering the same the Schedules and Project Costs shall be prepared. Some examples of value engineering concepts are given in **Appendix-1**. However, in addition to the same other value engineering aspects shall also be explored.

5.2 During the Project appraisal, in PATSC/SFC memo, there shall be a para regarding Value engineering Practices examined and finally adopted.

5.3 Further during implementation, the Concessionaire/ Contractors shall be allowed to propose value-engineered alternative design/ material/ technology. IE/AE shall review the proposed value-engineered design and if it is not reviewed within the stipulated time period specified in the Contract/Concession Agreement or rejected for any frivolous reason, Authority may take appropriate action against the IE/AE.

5.3.1 After acceptance of design, a detailed construction methodology along with requisite details such as proposed machinery/plants/equipment, quality assurance & quality control,

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traffic diversion, pollution control measures, environmental compliance/construction sequence/material design shall be submitted to IE/AE for review.

5.3.2 Subsequently, during trial laying, validation of considered material characteristic in design shall be done and if necessary, modification in design shall be done. Construction shall be started incorporating the modifications, if any.

5.3.3 The Concessionaire/Contractors shall be entitled to retain all the savings accrued to them on account of value engineering practices adopted by them.

6. The content of this circular shall be applicable for all the ongoing/upcoming projects henceforth and until any further orders.

7. It is requested that the contents of the circular may be brought into the notice of all concerned for immediate needful compliance.

8. This issues with the approval of Competent Authority.

Yours sincerely,

Bidur Kant Jha
30/08/2022

(Bidur Kant Jha)
Director
(New Technology for Highway Development)
For Director General (Road Development) & Special Secretary

Copy to:

1. All CEs in the Ministry of Road Transport & Highways
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3. The Secretary General, Indian Roads Congress
4. Technical circular file of S&R (P&B) Section
5. NIC-for uploading on Ministry's website under "What's new"

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## Appendix-1: Formulation of Value Engineering Strategy for National Highway Projects

The cost component of a highway project generally comprises of 70% of Material costs, 20% of Machineries costs and 10.0% of Manpower costs. Hence, to have a value-engineered optimum highway emphasis shall be on material selection and design.

### 1. Policy for Design & Construction of Futuristic Flexible Pavement (FFP)

Flexible Pavement (New Construction) shall be designed for maximum allowed effective subgrade design CBR 15.0% as per IRC: 37-2018. It can be achieved by:

- using select soil (either borrow or excavated) of required CBR for subgrade and embankment construction as per IRC:37 and MORT&H Specification,
- improved subgrade upper layer(top 250mm) using select soil treated with hydrated lime/cement/fly ash/pond ash etc. as per IRC:37, MORT&H Specification, and IRC:SP:89(Part I & Part II),
- using mechanical modification of select soil blended with Pond Ash/non-plastic soil/sand/gravel/mining waste/crushed aggregate/reclaimed granular material etc. in subgrade layer construction as per IRC:SP:89(Part I)

For stabilization purpose built soil stabilizer shall be used. Use of indigenous equipments/plants/machineries shall be encouraged.

Enhanced quality control more particularly the compliance of minimum specified compaction, 4-days soaked CBR at specified density and design stabilizer content shall be met in construction.

**Benefits of Futuristic flexible Pavement (FFP)**

i. Exploitation of maximum soil strength using technology (as we cannot minimize earthwork quantity for a particular design road level)

ii. No need of any re-work in subgrade at the time of rehabilitation i.e. it is compatible with future maintenance/augmentation etc. i.e. futuristic pavement

iii. Enhanced performance

iv. Reduction in designed pavement composition i.e. lesser thicknesses of subbase/base/bituminous layer (reduction of DBM thickness in the range of 20-50mm) resulting into a cost reduction in the range of 5-15.0 %

v. Less consumption of aggregates

vi. Less burning of bitumen i.e. lower emission of Green House Gases(GHG)

vii. Cost-effective, durable and environmentally sustainable.

### 2. Rational Inputs for Rate Analysis

Presently, inputs used for rate analysis is not closely simulated with the inputs taken by the developer in actual construction. That is why, there is a bidding cost difference in the tune of 20-30% lower side than that of Ministry. To have more closely simulation or rate analysis at same platform, following strategy can be adopted.

i. The minimum rate of bitumen from the Government refinery and private producers shall be taken as per stipulated guidelines.

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ii. The minimum rate of Steel from the SAIL/TISCO and private manufacturers shall be taken.

iii. The rate analysis of concrete shall be taken considering 20 per cent fly ash by weight of total cementitious material subjected to availability of fly ash within economic haulage.

**3. Suggested Flexible Pavement layer Combination** - All the layer combinations alternatives available in IRC: 37-2018 shall be techno-economically evaluated and recommend the appropriate one. All designs and estimations shall necessarily be based on actual optimal requirements for layer thicknesses as per IRC: 37-2018. Suggestive thicknesses as per catalogues (Ref. Section 12 of IRC: 37-2018) shall not be used even for estimation purposes.

**4. Use of Glass/Carbon/Aramid Fiber Reinforced Polymer Rebar for non-load bearing/ minor CD Structures**

Fiber Reinforced Polymers (FRP's) are a proven and successful alternative reinforcing that will give structures a longer service life. To reduce the demand of conventional reinforcement for highway projects, it is prudent to allow **Glass/Carbon/Aramid Fiber Reinforced Polymer Rebar** for non-load bearing structures like Crash barrier, Drain and minor CD structures i.e. Hume pipe Culvert and box Culvert. There is a reduction of 5-10% of the cost.

As the IRC Guideline and State-of-Art Report for Glass Fiber Reinforced Polymer Bars has recently been finalised. However following design standards & Specifications may also be referred:

- **AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings, First Edition.**
  - Published in November 2009, this document offers authoritative design guidance to the bridge design community in safely adopting FRP bars in bridge decks and railings.
- **CSA S-806 - Canadian Code**
  - "Design and Construction of Building Components with Fibre-Reinforced Polymers".
- **CSA S-6 Canadian Highway Bridge Design Code**
  - Widespread adoption of GFRP bars in Canadian bridge structures is being made possible by this important document.
- **ACI 440.1R "Guide for the Design and Construction of Structural Concrete Reinforced with FRP Bars"**
  - The American Concrete Institute 440 guide is a mature and living document that as undergone a number of revisions since its first publication in 2001. Companion documents to the 440.1R design guide include the ACI 440.3R "Guide Test Methods for FRP's for Reinforcing or Strengthening Concrete Structures" which is intended as an interim document

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superseded by new ASTM test methods as they become available.

**International Studies**

- **FIB Task Group 9.3 - bulletin 40 "FRP Reinforcement in RC Structures"**
  - **In Europe, the Federation Internationale du Beton FIB Task Group 9.3 has published a technical report "Bulletin 40", which is a "state of the art" of FRP reinforcement in RC structures. Work is under way on provisions for FRP bars in Euro Code 2 format. Norway and Italy have published internal design codes for the use of FRP bars.**
- **4th Structural Specialty Conference of the Canadian Society for Civil engineering Montréal. 2002**
  - **Field application of FRP composite bars as reinforcement for bridges and decks.**

**5. Use of Locally available marginal/ road building material/Industrial Waste/Municipal Solid Waste landfill for Road construction**

To reduce the GHG gases emission and cost of transportation, it is suggested during DPR stage itself the locally available marginal road building material as well as industrial waste/Slag/mines waste has to be evaluated. DPR must have the recommendations regarding improvement measures to uplift locally available material/industrial/mines waste to the premium road building material in the vicinity of the Project Road.

**6. Type of Concrete Pavement**

**6.1 Bonded Concrete Pavement**

Bonded Concrete pavement shall be designed as per IRC: 58-2015 for new construction. It is similar to conventional concrete pavement except no polythene sheet in between DLC and PQC. However, joint groove cuts are required in the DLC layer for 1/3rd depth exactly at the location of the joints in PQC to avoid random reflection cracking of the PQC due to cracks in the DLC. Generally the thickness of conventional concrete pavement is 280-300mm, whereas with bonded concrete pavement it is 220-240mm. That is reduction of 20-25% PQC concrete volume and initially construction cost itself is comparable to the conventional flexible pavement.

**6.2 Short-Panelled Concrete Pavement/Geo-cell filled Concrete Pavement**

For new construction, even short-panelled concrete pavement may be considered. It is similar to conventional concrete pavement with shorter panel sizes i.e. 1.0mX1.0m, 1.5mX1.5m and 1.75mX1.75m. The design thickness may generally vary from 150-220mm. Trial sections have been laid in some of the projects, such as Panagarh - Barwa Adda (NH-2) , Baharagora - Kharagpur section of NH-33, NH 848 (Nashik Peth Section) and are being monitored; so far generally the performance has been observed as satisfactory. IRC Guidelines for the same are under development presently.

**6.3 Pre-tensioned Pre-cast Concrete Pavement (PPCP)**

For construction of new concrete pavement in urban/congested locations and panel replacement of existing concrete pavement, pre-tensioned pre-cast concrete pavement (PPCP) shall be adopted. The design thickness varies from 180-200mm.It shall be designed

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using IRC: 58-2002 and computation of stresses should be done based on Finite Element Modelling (FEM). Sections have been laid in some of the projects, such as Nagpur Inner Ring Road, Nagpur Hingla Industrial Area, Amravati Pathan Chowk; so far generally the performance has been observed as satisfactory. IRC Guidelines for the same are under development presently.

### 6.4 White-Topping for Existing Flexible Pavement Rehabilitation

White-topping shall be also evaluated for rehabilitation of existing flexible pavement. Its thickness varies from 150-180mm as per IRC: SP: 76-2015.

## 7. Utilisation/re-use of Reclaimed Road Material

### 7.1 Expansive Black Cotton Soil

Expansive black cotton soil is available in Maharashtra, Madhya Pradesh, Andra Pradesh, Chhattisgarh, Gujarat and Karnataka. Generally this unsuitable soil is being removed and replaced with suitable material to a minimum depth of 500mm. For the same, there is always a problem of dumping site.

It is better to improve this unsuitable soil with fly ash/pond ash/hydrated lime/cement and reuse it for earthwork. With the same, there is no requirement of suitable borrow earth as well as savings in transportation cost and reduction in GHG emission.

Therefore, suitable decision may be taken to adopt appropriate methodology based on relative scale of economy of alternate options.

### 7.2 Reuse of Excavated Soil

There must be accountability regarding reuse of excavated suitable soil.

### 7.3 Reuse of Reclaimed Existing Pavement Granular layer material

It is observed that there is a substantial generation of granular layer material while doing up-gradation/capacity augmentation/rehabilitation/submerging due to proposed VUP/PUP.

It is prudent to reclaim the same and use in subbase/base of proposed pavement. There must be accountability regarding reuse of reclaimed existing pavement granular layer material.

### 7.4 Reuse of Reclaimed Bituminous layer material (RAP) of existing flexible Pavement

It is observed that there is a substantial generation of existing bituminous layer material while doing up-gradation/capacity augmentation/rehabilitation/submerging due to proposed VUP/PUP/conversion of flexible to concrete pavement.

Generally it is observed that the existing bituminous layer material is dismantled and dumped along national Highway in case of reconstruction/submerging due to proposed VUP/Pup/change of pavement type to concrete pavement. It is merely a huge loss to the nation due to wastage of costly RAP. There must be a RAP bank along the National Highway.

However, in rehabilitation of existing flexible pavement it is being reclaimed through milling and being reused in DBM layer mix. The proportion of RAP is 20-30% with conventional Hot Mix Plant (batch type) with RAP attachment. It can be further increased to with purpose-built Double barrel continuous hot mix plant.

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The milled RAP is also being used as RAP layer by adding 25% virgin aggregate, 1.0% cement and 2-3% foamed bitumen/emulsion. RAP is used as bituminous base course.

Even RAP can be used for DLC of Concrete Pavement.

It is prudent to reclaim the same and re-use RAP generated. There must be accountability regarding reuse of reclaimed RAP.

The guidelines to be referred are IRC: 37-2018 and IRC: 120-2015 except for % of RAP, which may be increased with the approval of authority.

**8. Use of Fiber Reinforced Micro-surfacing for Renewal Course**

Micro-surfacing is an eco-friendly treatment which is used to restore the surface characteristics of the road. If the pavement is structurally adequate, Micro-surfacing is very suitable to preserve the pavement from ageing, oxidation, aggregate loss and polishing irrespective of the t raffic (i.e. suitable for low, medium, and high traffic). Fibre-reinforced Micro-surfacing is much superior to conventional Micro-surfacing. Presence of glass fibre in Fibre-reinforced Micro-surfacing helps in enhancing the flexural strength of the Micro-surfacing and thereby drastically reduces the chances of reflective cracking. There are no specifications in India for Fiber-reinforced Micro-surfacing, hence Downers Report to be referred. Generally the doses of fiber is 0.2% by dry weight of aggregate. The guideline for conventional micro-surfacing to be referred is IRC: SP: 81.

For wearing course renewal, fiber reinforced micro-surfacing of 8-10mnm thickness shall be adopted.

**9. Use of Integral Super-Structures in Major Structures**

Integral structure deck super-structure, which gives continuity shall be used. Due to deck continuity, there will be reduction in deck depth, lesser number of bearings & expansion joints and hence lesser maintenance and improved rideability.

**10. Use of High Damping Rubber bearing for Structures**

High Damping Rubber (HDR) bearing may be used. It will also act as seismic isolators during earthquake and cost-effective. Design codes and testing procedures for such bearings are already available in some countries, as also, in CEN (2005) "Eurocode 8: Design of Structures for Earthquake Resistance - Part 2: Bridges", pr EN 1998-2 (Final Draft), Comité Européen de Normalisation, Brussels, Belgium.

**11. Use of Pre-cast Structures**

Use of pre-cast for VUP/LVUP/PUP/Box Culvert shall be promoted. It will result into time savings. Use of precast element like Girders/ planks/segments for all types of structures may be adopted as per project suitability. Use of Precast Arch type Culvert or Minor-Bridges or animal underpass or cut & cover tunnel with nominal or zero Reinforcement may be adopted instead of Conventional Structures. Use of Precast Pre-stressing Elements for Box-Type and Other Structures (i.e. Precast Pre-stressed Raft, Wall, Slab, Toe-Wall, Retaining Wall, Road Side Drain etc.) may also be adopted. The Ministry's policy on the use of Pre-cast technology issued from time to time may be referred in this context.

**12. Waste to Wealth**

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Pond Ash is the proven material for embankment/subgrade layer construction. Its availability shall be ensured for the construction of highways.

**13. Use of Soil Stabilised Earthen Shoulder**

Presently in upper 150mm of earthen shoulder crushed aggregate is being used. As a cost-effective alternative soil treated with 3-4% cement shall be used. It will also not require virgin aggregate. The guideline to be referred is Kenyan Pavement design Manual.

**14. Use of Construction & Demolition(C&D) Waste**

A C&D bank shall be along the National Highway and the material shall be used as an alternative to sand/fine aggregate for concrete. For this crushing of C&D material will be required. The guideline to be referred is IRC: 121- 2017 "Guidelines for Use of Construction and Demolition Waste in Road Sector".

**15. 100% Recycling of Reclaimed Bituminous Layer Material**

India has presently about 1.41 lakh km length of National Highways Network. Progress of about 37 km per day was achieved for development works on NHs during 2021-22. However, the quantum of the aged asset is increasing, which warrant rehabilitation to extend its life further. Therefore, emphasis is also required to be given for taking up rehabilitation/strengthening works on NHs. Therefore to have cost-effective and sustainable rehabilitation/strengthening, It is prudent to reclaim the bituminous layer material and reuse as much as permitted with the approval of authority by adding innovative rejuvenating agents to get reclaimed bitumen properties at par with fresh bitumen.

**16. Promote use of new sustainable materials for bridges (Such as Stainless Steel, Weathering Steel ...etc.) based on life cycle costing**

**17. Promote use of modular, prefabricated, adaptable and re-usable structures for temporary, emergency and permanent bridges in remote areas**

**18. Use of Fiber Reinforced/High Strength Shotcrete for Tunnel works**

**19. Geometric Design**

FRL / Culvert sizes shall be fixed based on hydrological modelling. FRL of VUP shall be fixed in duly consideration of the cross-road level.

Avoid the **Curvature Sections & super elevation** on the major structure locations, since it may increase the cost of structure and pose safety issues.

During road profile design, section having lined drains, the profile should be such that natural streams / proposed/existing CD structures shall be the natural disposal of storm water. This will result in economic sections of the drain.

With afore-mentioned value engineering practices, there may be a reduction of initial project cost in the tune of **20-30 %**. Besides this, there is a time savings, less consumption of road building materials and less emission of GHG without compromising performance durability of the National Highways Asset.

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