

# **CHAPTER—III**

## **Preparation of Estimates and Technical Sanction**



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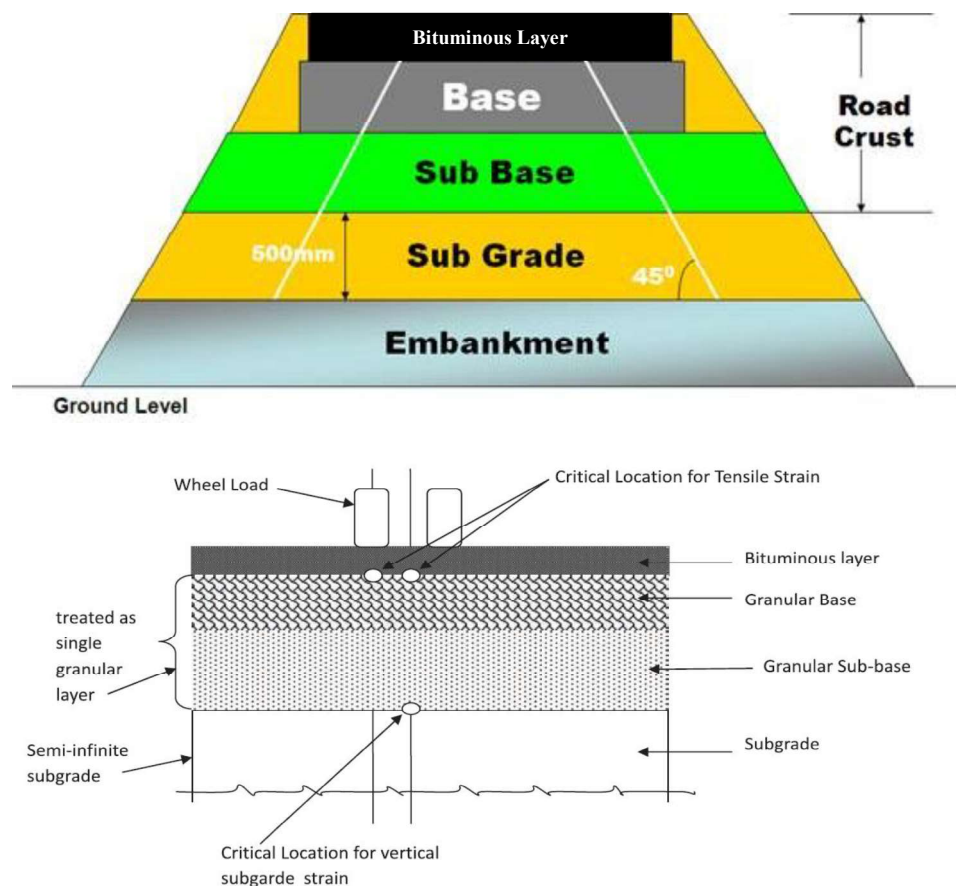
This Chapter deals with the audit observations to assess whether preparation of detailed estimates were in accordance with the extant rules and standards. The departmental officers did not adhere to the IRC norms for pavement designing to assess the required crust overlay. The traffic census, axle load survey, soil testing and other necessary tests were not carried out as per norms.

### Introduction

**3.1** Preparation of estimates and its subsequent sanction have a direct bearing on the total project cost, quality of works executed and timeliness of completion of road works. Therefore, it is required that rules and standards/norms prescribed in this regard are strictly adhered to in preparing estimates and according technical sanctions.

**Composition of Road Structure:** The structure of a road is composed of various layers as illustrated in **Diagram 3.1** below:

**Diagram 3.1: Cross section of road structure**



**Subgrade:** The subgrade is the top 500 mm of the embankment immediately below the bottom of the pavement, and is made up of in-situ material, select soil or stabilised soil that forms the foundation of a pavement.

**Sub-base:** The sub-base layer consists of granular material and serves three functions, viz., to protect the subgrade from overstressing, to provide a platform for the construction traffic and to serve as drainage and filter layer.

**Base:** The unbound base layer may consist of granular layer such as wet mix macadam and water bound macadam. The bound base layer may consist of granular materials treated with bitumen emulsion or foamed bitumen.

**Bituminous Layer (Black topping):** The bituminous surfacing shall consist of either a wearing course<sup>1</sup> or a binder course<sup>2</sup> with a wearing course depending upon the traffic to be carried.

Audit observed deficiencies in preparation of estimates and issue of technical sanctions in test checked cases. Divisional authorities did not adhere to prescribed rules, norms and procedures in various activities such as traffic census, soil testing, design traffic calculation, pavement designing, *etc.*, as discussed in succeeding paragraphs:

### **Pavement Design**

**3.2** In road works, pavement<sup>3</sup> design is the most crucial part of the estimation. Required pavement composition and thickness of a road entirely depends upon design traffic in terms of standard axels<sup>4</sup> and subgrade strength assessed in terms of California Bearing Ratio (CBR)<sup>5</sup>.

### **Estimation of Design Traffic**

**3.3** The recommended method by Indian Road Congress (IRC) considers design traffic in terms of the cumulative number of standard axles (8,160 Kg) to be carried by the pavement during the design life. Information required for estimating design traffic includes:

- Initial traffic after construction in terms of Commercial Vehicles per Day (CVPD) calculated by traffic census and traffic growth rate during design life;
- Vehicle Damage Factor (VDF) estimated by axle load survey or default value taken as per IRC norms; and
- Design life and Distribution of commercial vehicle over the carriage way as per IRC norms.

For proper estimation of design traffic, accurate and authentic data from periodical traffic census is required.

Audit scrutiny revealed the following deficiencies in traffic census and estimation of design traffic:

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<sup>1</sup> The top layer of a road that carries the traffic.

<sup>2</sup> A coarse aggregate bound with bitumen between the foundation and the wearing course.

<sup>3</sup> Pavement is a hard surface that is covered in concrete or bitumen, like a road or a driveway.

<sup>4</sup> Standard axle load is defined as a single axle load with dual wheel carrying 80kN (8,160 kg) load.

<sup>5</sup> CBR is a measure of the strength of the subgrade of a road and expressed in percentage of force per unit area required to penetrate a soil mass with a circular plunger of 50 mm diameter at the rate of 1.25 mm/min to that required for corresponding penetration in a standard material.

***Lack of authenticity of traffic census data***

**3.3.1** As the required pavement thickness and composition directly depends on design traffic, the traffic census must be actual and well documented to establish its sanctity and reliability.

IRC-9:1972 envisages that traffic should be counted at least twice every year. Engineer-in-Chief (E-in-C) also issued orders (November 2005) directing the field offices to conduct regular traffic census on the roads and to send the result of the same in the first week of January every year which were to be kept compiled and secured by Traffic Study and Survey Division of the Department. Further, directions were issued (February 2016) to field offices for sending traffic data in soft copy to the Road Asset Management Division to update the traffic data on *Srishti* Website.

Audit observed that regular traffic census was not conducted by any of 27 test checked divisions. Further, traffic data used for designing the crust of roads was not sent by any division to the E-in-C office, and not updated on *Srishti* website. Further, scrutiny of the traffic census data used by the divisions to assess the design traffic for calculating required crust thickness revealed that exactly same type and same number of vehicles were shown plying on different roads by eight divisions out of 27 test checked divisions (**Appendix-3.1**) as depicted in **Table 3.1** below:

**Table: 3.1 Identical traffic shown on different roads**

Sl. No.	Name of Division	Types of vehicles shown plying in exactly same numbers on different roads
1	PD, Gorakhpur	Identical number of all type of vehicles shown plying on two different roads
2	CD-3, Gorakhpur	Identical number of Trailers, hand carts and horse carts on three roads, and LCVs, tractors, trucks, cycles, rickshaw and bullock-carts (big and small) shown plying on two different roads.
3	CD, Chandauli	Identical number of Trucks, trailers, rickshaws, hand carts, horse carts and bullock carts (big and small) shown plying on two different points of a road.
4	PD, Kushinagar	Identical number of Tractors, cycles and horse cart shown plying on two different roads
5	PD, Deoria	Identical number of LCVs, buses, trucks, horse cart, bullock cart (big and small) and tractors shown plying on two different roads. Similarly identical number of hand carts shown plying on three different roads
6	CD-1, Chitrakoot	Identical number of All type of vehicles shown plying on four different roads
7	PD, Maharajganj	Identical number of Cycle rickshaw, hand carts and horse carts shown plying on two different roads
8	CD-1, Prayagraj	Identical number of cycles, rickshaws, hand carts, horse carts and bullock carts (big and small) shown plying on three different roads. Similarly, identical number of tractors without trailers shown plying on two different roads.

Furthermore, as the traffic census is the most important parameter for widening and strengthening of a road, E-in-C directed (September 2018) that the traffic data submitted for widening and/or strengthening of a road would be acceptable only if traffic census is conducted by a team constituted through office order of the competent authority based on volume of design traffic in terms of Million Standard Axles (MSA). No such order for constitution of team for traffic census was found attached with the Technical Sanction (TS) of any of the test checked 109 works nor it was made available to Audit.

Thus, recording exactly same number of vehicles during traffic census on different roads puts a question mark on the authenticity of traffic census conducted by the departmental officials.

In reply, the Government accepted (October 2023) the audit observation and stated that investigation is being conducted in this regard and action is being taken against the responsible officials.

***Traffic census not conducted as per IRC norms***

**3.3.2 (a)** Paragraph 4.1 of IRC: 9-1972 *inter alia* provides that the traffic count should be made for a full week spread over seven consecutive days and 24 hours of each day.

Audit scrutiny revealed that detailed estimates of 13 works costing ₹ 279.90 crore were not supported by traffic census reports (**Appendix-3.2**). Thus, the competent authorities accorded technical sanction ignoring the basic requirement of traffic data in above cases. Further, in case of three works costing ₹ 180.22 crore (**Appendix-3.3**), traffic census was carried out on only three days in place of required seven days as per IRC norms.

**(b)** Paragraph 3.1 of IRC: 9-1972 envisaged that judicious location of traffic count stations is crucial to the success of a census programme.

Audit, however, observed that:

- Name of the work/road was not mentioned on the traffic summary reports attached with detailed estimates of three works costing ₹ 75.59 crore (**Appendix-3.3**).
- Census point, on which traffic census was conducted, was not mentioned in census report of six works costing ₹ 286.60 crore (**Appendix-3.3**).

Thus, the traffic census on 10 works costing ₹ 389.11 crore<sup>6</sup> was not conducted as per IRC norms.

In reply, the Government stated (October 2023) that the clerical error has been rectified and revised traffic census reports have been attached with the approved estimates of the concerned roads. It was further stated that three-day traffic census has been conducted under special circumstances as per provisions of IRC:9-1972.

Fact remains that technical sanctions were accorded by the competent authorities on the basis of erroneous traffic census reports. Further, reasons/special circumstances were not recorded in any of the three cases to justify the three-day traffic census.

***Light Commercial Vehicles counted for Design Traffic against IRC norms***

**3.3.3** As per IRC specifications<sup>7</sup>, initial traffic after construction in terms of Commercial Vehicles per Day (CVPD) is to be calculated as per present day average traffic based on seven-days-24-hours count made on the identified point of the road. Further, as per IRC: SP-72-2015, a commercial vehicle is

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<sup>6</sup> Sahjanwa Bakhira Marg is appearing two times in appendix 3.3 A (Sl. No. 3) and appendix 3.3 C (Sl. No. 6), and Babatpur-Chaubeypur-Bhagtua-Balua-Bridge Marg is also appearing two times in appendix 3.3 A (Sl. No. 1) and appendix 3.3 C (Sl. No. 3). Therefore, these two roads and their cost have been counted only once.

<sup>7</sup> IRC:37-2012 and IRC:9-1972

defined as a vehicle of gross laden weight of three tonnes or more. For purposes of pavement design, only the motorised commercial vehicles of gross laden weight of 3 tonnes and above are to be considered. The Light Vehicles even when fully laden will have a gross laden weight of less than three tonnes and hence need not to be considered for pavement design.

Audit scrutiny, however, revealed that in five road works pertaining to two divisions<sup>8</sup>, light commercial vehicles were counted in computing CVPD which resulted in avoidable expenditure of ₹ 26.19 crore due to excess crust overlay calculated on the basis of inflated design traffic (**Appendix-3.4**).

In reply, the Government accepted (October 2023) the audit observation and stated that in practical context, overloading is a major problem on all the roads of the State. Keeping in mind the above facts regarding the indicated roads of Varanasi and Jhansi districts, the estimates have been approved by the GoI and the works have been executed accordingly.

***Adoption of indicative values due to not conducting traffic census and axle load survey***

**3.3.4** (i) As per Para 4.2 of IRC 37-2012, the present-day traffic has to be projected for the end of design life at growth rate ('r') estimated by studying and analysing the past trends of traffic growth and demand elasticity of traffic with respect to macro-economic parameters and expected demand due to specific developments and land use changes likely to take place during design life. If the data for the annual growth rate of commercial vehicles is not available or if it is less than five *per cent*, a growth rate of five *per cent* should be used.

Audit observed that in 109 test checked works, due to not conducting traffic census periodically, the Department simply adopted the Annual traffic growth rate of five *per cent* which IRC norms provide for designing purpose of the roads where data for annual growth rate is not available.

(ii) As per Para 4.4 of IRC: 37-2012, VDF is used for estimation of design traffic in thickness design of pavements. The IRC stipulates that VDF should be arrived at carefully by carrying out specific axle load surveys on the existing roads without any bias for loaded or unloaded vehicles.

Audit observed that in test checked 109 road works axle load survey was not conducted and in the absence of the same the departmental officers simply adopted the indicative value of VDF which was recommended by IRC for small size projects to estimate design traffic for pavement designing of the roads.

Thus, the Department relied upon indicative values instead of taking actual values based on periodical traffic census and axle load survey due to which, possibility of incorrect estimation of design traffic could not be ruled out.

The Department did not offer any comment on the above audit observation. During Exit Conference (October 2023), the Department assured to issue detailed instructions in respect of applicable specifications for designing in widening and strengthening of roads.

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<sup>8</sup> PD, Varanasi and CD-3, Jhansi

**Recommendation 3:**

***The Department should conduct periodical traffic census and axle load survey for calculation of design traffic as per IRC specifications and upload the same on Srishti web portal and use in pavement designing.***

**CBR of subgrade not based on authentic test reports**

**3.4** As per IRC Guidelines<sup>9</sup> for pavement design, the subgrade strength is assessed in terms of CBR of the subgrade soil at the most critical moisture conditions likely to occur *in situ*. For determining the CBR value, the standard test procedure should be strictly adhered to. In this regard, the Engineer in Chief also instructed (September 2008) that detailed estimate should be prepared only after determining the actual CBR before technical sanction.

Where different types of soils are used in subgrade, a minimum of six to eight average CBR values (average of three tests) for each soil type along the alignment will be required for determination of design CBR.

The test for determining CBR must always be performed on remoulded samples of soils in a laboratory. The pavement thickness should be based on 4-day soaked CBR value of the soil, remoulded at placement density and moisture content ascertained from the compaction curve.

As the required pavement thickness depends on CBR of the subgrade, the CBR test must be conducted before preparation of detailed estimate and its procedure should be properly documented.

Audit, however, observed that CBR test reports were not enclosed with the detailed estimates of 38 test checked works costing ₹ 1,100.30 crore (**Appendix-3.5**).

Audit further observed that in 71 test checked works, where CBR test reports were attached with the estimates, written work order of competent authority to a laboratory for conducting soil test, date and time of collection of soil sample, evidence of payment of testing charges, date of receipt of test report were not found in any of the test checked cases except work order to laboratory in respect of one work<sup>10</sup> in PD Agra.

Further, following procedural deficiencies were noticed in 63 out of the above 71 CBR reports (**Appendix-3.6**):

- Date on which sample provided to lab for testing was found recorded in only 18 cases.
- Test date was found recorded in only seven cases.
- Issue/despatch date of test reports were found recorded in only 39 cases.
- Five to 11 years old test reports were found enclosed in detailed estimate of six works.
- A minimum of six samples of soil were not taken in 45 cases.

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<sup>9</sup> Paragraph 3.4.3 and 3.4.4 of IRC: 37-2001.

<sup>10</sup> Fatehpur Sikri Kagaraul road.



**Case Study 3.1**

As per the IRC specifications, the pavement thickness should be based on 4-day soaked CBR value of the soil.

*Audit observed that in PD, Deoria, soil samples pertaining to four roads<sup>11</sup> for testing CBR were received in Lab on 08.08.2017 and tested on 10.08.2017 as per test reports attached with the estimates. This implies that tests were conducted even before soaking of soil for a minimum time period of four days (96 hours). In reply, the Government stated (October 2023) that samples were collected on 05.08.2017 to 06.08.2017 and were received in laboratory at Lucknow on 08.08.2017 but wrongly recorded as collection date. Thus, the stipulated period of 96 hours had passed before the test.*

*Reply is not acceptable as stipulated period of 96 hours is for soaking of sampled soil in the lab, and not for the duration between sample collection and testing.*

Thus, pavement design of 63 works were approved and TS accorded on detailed estimates based on CBR reports having various deficiencies and in 38 works without availability of CBR reports.

In reply, the Government stated (October 2023) that in the cases where the CBR tests were not conducted, CBR value of adjacent roads with same type of soil were considered. Now, directions have been issued to all the divisions to prepare estimates after conducting CBR test and attach the test report with the estimates.

Reply is not acceptable as CBR and design traffic are the parameters for deciding the pavement thickness of a road. Engineer in Chief also clearly instructed (September 2008) that CBR test must be conducted before preparation of the detailed estimate for technical sanction. During Exit Conference the Department assured to issue instructions in this regard.

**Recommendation 4:**

***CBR test of subgrade soil as per norms should be ensured before granting technical sanction and complete chronology regarding CBR test should be documented.***

**Authentic and reliable evidence of existing crust not attached with estimates**

**3.5** The details of length, width, crust thickness, type of crust and other important information about every road were required to be updated on *Srishti* portal of the Department by the respective divisions having jurisdiction of the road.

As calculation of required pavement composition depends on the existing crust thickness, the sanctity and reliability of existing crust thickness shown in the estimates are very crucial and hence authenticated documentary evidence of the same is required to be attached in the estimates.

However, Audit observed that documentary evidence to establish the correctness of existing crust thickness and its composition was attached only

<sup>11</sup> 1. Sirsiya Pratappur Mairava Road, 2. Lar Chunki Bhatpar Bhingari road, 3. Pakdi-Bangra-Bangruva-Mishrauli Road and 4. Salempur Majhauri Mairava Road.

in estimates of 14 works (13 *per cent*) costing ₹ 426.33 crore (**Appendix-3.7**) out of test checked 109 works.

Scrutiny further revealed that for computation of required crust overlay, existing crust thickness of four out of these 14 existing roads were considered less than that recorded in the attached document thereof with the estimate as detailed below in **Table 3.2** below:

**Table 3.2: Details of existing crust considered for designing vis-a-vis that mentioned in the documents**

Sl. No.	Name of the Road	Name of the division	Existing crust as per document attached with estimate (mm)	Existing crust taken in pavement design (mm)
1	Mahavankhor Netwar Bazar Campierganj	CD-3, Gorakhpur	320	290
2	Sarnath Raunakhurd via Munari	PD, Varanasi	270	250
3	Babatpur Chaubepur Bhagtua Balua	PD, Varanasi	440	330
4	Leva Ilia	CD, Chandauli	380	360

Thus, requirement of crust overlay for strengthening of existing roads in 95 works (87 *per cent*) costing ₹ 2,963.93 crore was determined without any authentic supporting documents of existing crust thickness and its composition.

In reply, the Government stated (October 2023) that at present the road history and crust thickness of all the roads is updated on the *Srishti* portal and the crust thickness is being checked from the same. Thus, all the data of crust thickness in this regard is reliable.

Reply is not acceptable, as the data on *Srishti* portal regarding road history and crust thickness was not updated regularly as discussed in **Paragraph 2.2**. Further, in four test checked cases mentioned above, for computation of required crust, the existing crust thickness was considered less than that mentioned in the documents. Hence, the existing crust thickness taken in designing of roads was not reliable.

#### **Incorrect IRC specification adopted in computation of required crust overlay**

**3.6** As per Rule 7 (10) of CRF Rules, 2014, the standard design and specification of the works to be proposed shall follow the relevant guidelines, codes, IRC specifications as directed by the Central Government. IRC specifications provide that for rehabilitation of in-service pavements, overlay<sup>12</sup> design shall be done as per Falling Weight Deflectometer (FWD) method (IRC: 115-2014) or Benkelman Beam Deflection (BBD) test method (IRC: 81-1997).

E-in-C also directed (September 2008) that strengthening/ rehabilitation work on the existing roads should be done as per BBD test method and further directed (September 2016) to overlay design by FWD method in place of BBD test method.

<sup>12</sup> Layers required to be laid over existing road.

Audit noticed that all the test checked roads were in-service roads and were widened and/or strengthened from CRF. However, departmental officers designed the pavement of all the test checked 109 roads adopting IRC specifications for designing of new flexible pavement (IRC: 37-2012/2018) based on quality (modulus) of new material instead of IRC specifications for strengthening/rehabilitation work on the existing roads of old/distressed material whereas, quality of old/distressed material cannot be equivalent to quality of new material.

In reply, the Government stated (October 2023) that widening of a road is considered as new road and designed accordingly whereas for strengthening of an existing road, required crust overlay is calculated by BBD/FWD test methods. Where both widening and strengthening of a road is required, there is an obligation to match the crust requirement calculated by both methods (as new road and for strengthening). Therefore, the road is designed as new road based on the CBR of the part of the road to be widened assuming same CBR value in the existing part of the road and overlay calculated by adjusting the existing crust. Further, it was also stated that as the modulus of the material used in widening portion (in different layers) are known and accessible exactly as per the codes, the overlay can be designed easily and accurately.

Reply is not acceptable as the Department had not designed the crust overlay as per BBD/FWD method where only strengthening of road was done. Further, in cases where widening and strengthening both were done, crust requirement were not calculated by both methods<sup>13</sup>. Moreover, modulus of the new material used in widened portion is higher and could not have been used for the distressed/old material of the existing road. During Exit Conference (October 2023) also, the Department assured to issue instructions in respect of applicable specifications for designing in widening and strengthening of roads.

### Technical Sanction of Detailed Estimates

3.7 Paragraph 318 of FHB Vol-VI envisages that for every work proposed to be carried out, proper detailed estimate must be prepared for technical sanction by competent authority before commencement of the work. Technical sanction assures that the proposals are structurally sound, and the estimates are accurately calculated and are based on adequate data.

#### *Adherence of Timeline in issuing Technical Sanction*

3.7.1 Engineer-in-Chief directed (January 2002) to ensure that technical sanction to the detailed estimates were issued by the CEs within 45 days (within 60 days *w.e.f.* 29.10.2020) from the date of receipt of administrative and financial sanction. E-in-C further directed that if technical sanction was not issued within prescribed time schedule, the responsible official would be held liable for the delay.

Audit scrutiny revealed that TS to the detailed estimates of the 42 works (40 *per cent*) out of test checked 109 works were accorded by CEs with delay ranging between one and 126 days (**Appendix-3.8**) as detailed in **Table 3.3** below:

<sup>13</sup> As new road using new material as per IRC: 37-2012/2018 and required overlay as per deflection measured on old road (made up of old/distress material) as per IRC:81 1997 or IRC: 115-2014

Table 3.3: Details of delay in TS

Sl. No.	Delay in days	No. of works
1	01 to 15	22
2	16 to 30	10
3	31 to 90	05
4	90 and above	05

Source: Sanction orders of GoUP and technical sanctions issued by CEs

It is worth mentioning here that in case of two works<sup>14</sup>, the competent authority accorded TS on the estimates on the same day of issue of financial sanction by GoUP whereas in other cases, delays were noticed as depicted in the table. Delayed TS results in consequent delay in start of the work.

In reply, the Government accepted (October 2023) the fact and stated that sometimes it takes more time to collect and analyse all types of data to prepare a detailed estimate, due to which delay arises. The Department also assured that all estimates will be approved within the stipulated time limit in future.

### **Proposed cost of works sent to GoI not based on estimates**

**3.7.2** Based on proposals received from public representatives and field requirements, road works are proposed. Accordingly, preliminary Estimates (PE) of the proposed works are prepared. Depending upon the availability of funds and priority of the work, the Department takes decision whether to recommend it to the GoI for administrative approval under CRF or not. After administrative approval of GoI, financial sanction/expenditure sanction is accorded by the GoUP after scrutiny of estimate/proposal with approval of the Finance Department.

During scrutiny of records, Audit observed huge differences in proposed/sanctioned cost from the cost as per PE as well as TS in five test checked road works as detailed in the **Table 3.4** below:

Table 3.4: Difference in sanctioned cost of works from PE and TS cost

(₹ in crore)

Name of Road	Cost as per PE	Cost as per proposal sent to GoI/Financial Sanction Cost	Cost as per TS
Chandauli Baburi	14.66	27.81	15.70
Ahirauna Chakia Ilia	11.85	28.88	13.59
Leva Ilia	27.10	37.95	32.09
Dharsauna Niyar	14.57	19.07	15.91
Sarnath Rauna Khurd	15.10	26.92	16.15
<b>Total</b>	<b>83.28</b>	<b>140.63</b>	<b>93.44</b>

Source: Sanction orders, preliminary estimate and detailed estimate

Audit observed that though the estimated cost of these five works as per PE was only ₹ 83.28 crore, GoUP sent proposals for ₹ 140.63 crore (169 per cent of PE) to GoI which were approved by GoI and after that GoUP issued financial sanctions for the same amount. Further, to execute these works, detailed estimates were prepared and got technically sanctioned by the competent authority for ₹ 93.44 crore (66 per cent of financial sanctions).

Thus, proposals sent for obtaining approvals/sanctions from GoI and GoUP were not based on PE of the works. This indicated lapse on the part of

<sup>14</sup> Nagina- Raipur- Kotkadar- Kotdwar Marg and Rehad- Kehripur- Badigarh- Suwawala- Surajnagar Marg of CD-2, Bijnor.

authorities towards preparation of authentic proposals for administrative approval and financial sanction of works which were far away from estimated cost as per PE.

The Government reply (October 2023) did not specifically address the issue of higher cost of the works than the PE proposed to GoI. However, it was stated that technical approval on detailed estimate has been given by the competent authority as per the actual requirements of the work site, in which there is some variation from preliminary estimate due to site conditions and traffic requirements. Presently detailed estimates are being prepared at initial stage itself and approval of the work is being obtained on the same estimate.

Reply of the Government is not acceptable as cost of the proposed works sent for obtaining sanction from GoI and GoUP was significantly higher than the preliminary estimates though there were no major difference in the cost as per PE and cost as per TS of the concerned works.

### **Conclusion**

**Periodical traffic census was not conducted by Department to ascertain traffic growth rate. Axle load surveys were also not conducted to ascertain the value of VDF for pavement designing of roads. Instead, indicative values were adopted to estimate design traffic in absence of reliable data. Soil tests (CBR) to determine the subgrade strength were not conducted by the divisions as per IRC norms and technical sanctions were accorded without examining the CBR test results.**