DIRECTORATE GENERAL BORDER ROADS

TECHNICAL INSTRUCTION NO 4
(REVISION – 2022)

PREPARATION OF DETAILED PROJECT REPORT (DPR) AND APPROXIMATE PROJECT ESTIMATE (APE)

अजय भट्ट
AJAY BHATT

सत्यमेव जयते

आज़ादी का अमृत महोत्सव

रक्षा एवं
पर्यटन राज्य मंत्री
भारत सरकार
Minister of State for
Defence and Tourism
Government of India

MESSAGE

The revised DGBR Technical Instructions are unique as they combine technical content and codes with practical advice on practice of specific subjects. These Technical Instructions have definite data/content which explicitly bring out tools, process and methodology to be followed for various road construction and infrastructure development associated activities.

The literature is a repository of technical and ground experience amassed by the BRO, working over six decades in inhospitable terrain with harsh climatic conditions as well as latest technical advancements in the field of road communication infrastructure development. I personally find these technical instructors informative, exhaustive and practical in approach. These will mitigate the need for ground executers to refer various books/ codes where working on various aspects of road construction and will go a long way in assisting the coming generations of BRO executives.

Jai Hind !

Ajay Bhatt

(Ajay Bhatt)

Dated : 20 Dec, 2021
New Delhi

डा. अजय कुमार
रक्षा सचिव
Dr. Ajay Kumar
Defence Secretary

सत्यमेव जयते

आज़ादी का अमृत महोत्सव

भारत सरकार
रक्षा मंत्रालय
Government of India
Ministry of Defence

FOREWORD

1. I am pleased to note that the Border Roads Organisation (BRO) has revised its twenty seven Technical Instruction, after a gap of 10 years having updated technical content and IRC codes. These Technical Instructions will positively prove to be very useful and ready reckoner for the BRO ground executives while steering them towards the correct methodology and processes to be followed for diverse road construction and associated activities.

2. Since the past six decades, BRO has been developing road infrastructure in the remote regions of the nation. It has contributed immensely in nation building and ushered in prosperity and development in the border areas. A robust mechanism to channelize the road construction activities is an essential planning process and therefore, the revised Technical Instructions will facilitate in dissemination and application of engineering knowledge with updated codes and provisions, to enable the executives to construct roads with the latest specifications as laid down by IRC.

3. I congratulate Team BRO for their stupendous efforts put in for revision of the twenty seven Technical Instructions which will further strengthen their technical proficiency.

(Ajay Kumar)

New Delhi,

March 3, 2022.

श्रमेण सर्वम साध्यम्

ले. जनरल राजीव चौधरी, वी एस एम
महानिदेशक सीमा सड़क एवं कर्नल कमांडेंट
सीमा सड़क संगठन

Lt Gen Rajeev Chaudhry, VSM
Director General Border Roads &
Colonel Commandant
Border Roads Organisation

FOREWORD

1. HQ DGBR Technical Instruction Number 4 (Revision 2022) lays down the procedure and guide lines to be followed for preparation of Detailed Project Reports and Approximate Project Estimates for road projects in BRO.

2. The Technical Instruction Number 4 has now been updated and revised incorporating the current standards and specifications laid down by Ministry of Road Transport & Highways (MoRT&H) and Indian Road Congress (IRC). The specific requirement of roads under BRO, have also been kept in view while formulating the Technical Instruction.

3. The successful completion of a road project depends on proper planning for which an accurate project report and realistic assessment of quantities are vital inputs. The guidelines contained in this Technical Instruction will help to achieve these objectives and should be followed for all road projects in BRO.

4. This Technical Instruction will come into force with immediate effect.

Station: New Delhi

Dated: Mar 2022

(**Rajeev Chaudhry**)
Lt Gen
Director General Border Roads

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TECHNICAL INSTRUCTION NO 4

PREPARATION OF DETAILED PROJECT REPORT (DPR) AND APPROXIMATE PROJECT ESTIMATE (APE)

1. INTRODUCTION

1.1 Preparation of detailed project report on a technically sound proposal with realistic estimation of quantities, cost and time of construction substantially influences the quality, performance and completion cost of a project. Avoidance of problems during construction and its service life hinges heavily on the accuracy and completeness of detailed project report of a road.

1.2 The need for revision of DGBR TI No.4 (1993) dealing with project estimates had been felt since long so as to stream line the procedure for preparation of a detailed and comprehensive project report and also to have uniformity in whole organization by adopting a standard format.

1.3 This TI will be effective with immediate effect.

2. PREPARATION AND PRESENTATION OF DETAILED PROJECT REPORT

2.1 The ground data collected during the detailed recce, survey and investigations together with the approval of final alignment where-ever applicable and other works proposed will be presented in a proper sequence and with clarity. Report will be divided in three parts under the following headings which when read together, will constitute the complete project documents.

(a) Detailed Project Report including recce report
(b) Approximate project estimate
(c) Detailed drawings

2.2 **Project Report**

2.2.1 The project report is one of the most important constituents of the project documents and will provide a precise and unambiguous appreciation of the proposal. The information's provided will be dealt with under following heads:-

(a) Preliminary.
(b) Road Features.

(c) Road Designs and Specifications.

(d) Drainage Facilities including Cross-Drainage Structures.

(e) Materials, Labour and Equipments.

(f) Rates.

(g) Construction Programme.

(h) IRC:SP-19-2001– Manual for Survey, Investigation and Preparation of Road Projects shall be followed.

2.2.2 There should be an Executive Summary with following components at the start of the project report:

(a) Project background and introduction.

(b) Project description.

(c) Key technical specification of various elements such pavement type and composition, special permanent structures like landslide mitigation structure, major bridges, tunnels surfacing works etc.

(d) Socio Economic profile of the project area.

(e) Environmental Impact Assessment.

(f) Social Impact Assessment.

(g) Rehabilitation and Resettlement Principles, entitlement matrix.

(h) Stakeholder's consultations and disclosure.

(j) Analysis of alternatives.

(k) Project Impacts.

(l) Rehabilitation and Resettlement Budget.

(m) Preliminary Cost Estimate.

(n) Economic analysis.

(o) Conclusion and Recommendations.

(p) Financial analysis.

2.2.3 **Preliminary.** This will cover:-

(a) Name of the work and its broad scope to give general idea of the scheme as a whole.

(b) Sponsoring agency and allotment of funds, indicating reference to the communication from the sponsoring agency for the project and the provision of funds for the work.

(c) History, geography and climate etc.

(i) Previous history of the road and its present condition (in case of existing roads) will be explained as regards to defense needs, economic activity, population served and other modes of transport facilities available etc. In case of existing roads to be upgraded or fornew roads special aspects such a flooding, water logging pattern etc. will be highlighted.

(ii) The general topographical and geological features of the area.

(iii) Rainfall with annual average intensity and distribution during the year, range of temperature during summer and winter months, snow fall data with annual averages, peak intensities, monthly distribution, fog conditions and exposures to sun etc.

(d) The necessity of the project/work and the circumstances which demand execution of the project on priority, if any.

2.2.4 **Road Features.** IRC:SP:20-2002 (Manual on Route Location, Design, Construction and Maintenance of Rural Roads (Other District Roads and Village Roads) shall be adhered to for route selection, alignment etc.Description under this head will cover:-

(a) **Route Selection.** The route may be selected considering the effect of proposed route on the overall transportation pattern of the area with respect to other facilities like railways etc. In case of new roads, the merits and demerits of alternative routes and reasons for selecting the proposed route will be brought out. To the extent feasible and practicable, survey by deploying Drones or desk study using satellite imagery be carried out to arrive at the decision of route selection. Satellite imageries (both spatial and temporal) of green field alignment provides useful information regarding behavior of terrain with respect to time indicating if any major landslides have happened in the past or if there is any change in course of rivers along the proposed alignment. After the proposed route is selected, LIDAR survey be carried out to help in finding other basic design parameters like hard rock stretched, gradient, radii of curves etc.

(b) **Alignment.** The general alignment of the road and section by section details with reference to topographical and geological features,

obligatory points such as bridge sites, saddle, important population centers, existing and prospective industrial centers etc. to be indicated. Also points of general importance like high embankments, heavy cutting, hard rock stretches, gradients, radii of curves, sight distance, nature of soil along the alignment, exposure to sun, any possibility of tackling the construction from different points at a time to be included.

(c) **Environmental factors.** Bring out beneficial as well as detrimental impact of the proposed works on the environment in terms of pollution, soil erosion, drainage pattern, landscaping. Discuss the planning and design measures proposed to minimize/ eliminate the adverse effects. As environmental impact assessment of highway project has assumed great importance, measures to prevent soil erosion and land degradation for road development in hilly areas have to be analyzed and these should be incorporated in the APE. Whether case for environmental clearance has been taken up with concerned authorities and its latest position should be given. Measures to prevent soil erosion, deforestation and land degradation in road development as well as about erosion control/compensatory afforestation for the construction of road are given in Appendix 'A' and 'B' respectively.

(d) **Road land, road way, carriage way and other cross-sectional elements.** Discuss the proposal regarding right of way, acquisition of land and structures along road way, carriage way width etc. In the case of existing roads, compare the cross-sectional elements with the existing width.

(e) **Traffic.** Discuss the type of traffic surveys conducted for various sections, the date collected and the anticipated future growth. Present the design traffic figures separately for each element of the project, e.g. width of carriage way, pavement intersections, railway crossings etc. For existing roads, discuss the road accident data with special reference to the known accident prone locations. Traffic census shall be carried out in accordance with IRC:9-2015 (Traffic Census on Non-Urban Roads).

(f) **Terrain and soil conditions**

(i) Bring out the geology of the area and avoid unstable area while selecting the alignment

(ii) Type of soil encountered along the alignment.

(iii) Road length passing through different types of terrain, rocky stretches, avalanche prone areas and slide/slip prone areas.

(iv) Cliffs and gorges.

(v) General elevation of the road indicating maximum and minimum heights negotiated by main ascents and descents.

(vi) Total number of ascents and descents.

(vii) Vegetation – extent and type.

(viii) Marshy and water logged areas

(g) **Seismic data**

(i) Magnitude and frequency of occurrence of earthquakes

(ii) Seismic Zone of the area

(iii) Extent and severity of the past damages.

(h) Details of perennial and intermittent natural channels to be crossed and requirement of training works for protecting the road formation. Also give details of existing bridges etc.

2.2.5 **Road Designs and Specifications**

(a) **Road Design**. Bring out the special features of road design e.g. fixation of grade line vise-a-visa HFL/water table, high embankments, treatment of sections in cutting, design of road junctions, geometric deficiencies in the case of existing roads, remedial measures for land slide prone areas etc. Attach design calculations where necessary. Discuss any deviations from the prescribed standards with reasons for the same. IRC:SP:73-2018 (Second Revision) - Manual of specification for two laning of highway with paved shoulder may be followed for geometric standard of two lane roads.

(b) **Pavement Design**. Give existing soil investigation data for pavement design in a tabular form including Benkelman Beam Deflectiontest, if required in case of existing roads. Discuss methodology of collecting these data and bring out the pavement design proposals with respect to the alternatives considered. If stage development of pavement is considered economical, considering existing/likely future traffic, this will be clearly stated and pavement design will be adopted accordingly giving economics both for stage

and final development. The renewal cycle of resurfacing will be kept in mind in stage development. Pavement design should be in accordance with IRC:37-2018 (Fourth Revision) - Guidelines for the Design of Flexible Pavements and IRC:SP:48-1998 (Hill Road manual) should be followed for hill zones. While designing pavement due care be given to see that modern material and construction methodology such as use of cementitious material for sub-base and base course, improving soil CBR characteristic using appropriate geo-cell structures or geo-synthetics are made use of wherever ground condition warrants and it is technically beneficial both in terms of cost and time for completion of the Project.

(c) **Masonry work other than cross-drainage works.** Bring out the proposals for retaining walls, breast walls, pitching, parapet walls, railings etc. Attach design calculations wherever required. IRC:40-2002 (Second Revision) - Standard Specifications and Code of Practice for Road Bridges, Section IV – (Brick, Stone and Cement Concrete Block Masonry) (Second Revision) should be followed for brick & stone masonry.

(d) **Specifications**. Give reference to the standard specifications such as IRC:SP-42-2014 (First Revision) - Guidelines of road Drainage in accordance with which the works are proposed to be executed. Highlight where any modifications are proposed or special specifications are advocated with technical justification.

(e) **Design of Bridges**. Give detailed justification for proposed bridge scheme based on hydraulic survey as per relevant IRC codes of practices. Give design dimensions of various elements such as abutment, pier, pier cap, super structure, bearing etc. Method of construction such as cast-in-site and precast, staging or balanced cantilever construction be clearly explained. Construction sequence and site arrangements required should be clearly brought out. Provisions of safety measures be explained. Provision or otherwise of 'Demolition Chamber(DC)' be indicated wherever applicable as per extant practice/guidelines and give specifications of DC.

(f) **Design of Tunnels**. Give detailed justification for proposed tunnel alignment based on SSI and other topographic surveys and studies of satellite imageries. Give design and specification of tunnel section, portal structure, ventilation and lighting scheme, tunnel

support system etc. Give details of safety measures adopted for tunnel operation. Give construction sequence. Give PERT/CPM network diagram for project monitoring using Microsoft Project or Primavera Software. Give rock classification along the tunnel length and type of support structure proposed. Guideline of IRC:SP-91-2019 "Guidelines for Road Tunnels (First Revision)" shall be followed.

2.2.6 **Drainage facilities including cross-drainage structures**

(a) Discuss the investigations carried out for designing the drainage measures and bring out the salient points in respect of HFL, water table, ponded water level, seepage flow, etc.

(b) Give details of the surface/sub-surface drainage measures proposed e.g. longitudinal side drains, catch water drains, sub-surface drains, blanket courses, etc. Attach design calculations/ drawings as necessary.

(c) Highlight if any special measures are proposed to check soil erosion and to assist soil conservation.

(d) Discuss the proposals regarding cross drainage structures such as temporary bridges and culverts. Give details of the proposed structures in a tabular form with reference to the standard designs adopted or the detailed drawings enclosed.

(e) In case of improvement to existing roads, list out the cross-drainage structures proposed to be improved/widened/reconstructed with details of improvement and justification.

(f) State whether the structures to be built to a standard design if so, give reference to the relevant drawings.

(g) Some roads are very often affected by erosion and subsidence on account of intermittent/perennial flow of streams. This aspect will be discussed and brought out with details of training works required for safety of roads.

(h) Whenever the road alignment runs along a river, stream or canal, and special protective works are required for safety of road formation/structure or the traffic, such locations will be identified and requirement of special protective works will be incorporated in the APE.

(j) Glacial deposits/moraine encountered will be discussed with their likely effect on alignment.

(k) For design and specification of drainage/ cross drainage work IRC:SP:42-2014 (First Revision) - Guidelines of road Drainage should be followed.

2.2.7 **Materials, Labour and Equipments**

(a) **Materials**. Present the result of soil and materials survey with reference tosections of the road, bringing out clearly the sources from which the materials are to be obtained, and their suitability for use in the works. Attach borrow area charts, quarry charts, results of tests on materials etc. Discuss the facilities for transport of materials. How these are to be provided ? The quality standards and source of material for other major construction stores such as cement, steel and bitumen be spelt out. The testing procedure and periodicity be brought out in the report to ensure that proper quality of material goes into the work. In addition material to be used in false work of Bridge construction also be covered in detail along with its design and specifications as per relevant IRC guidelines.

(b) **Labour**. Discuss the requirement of labour for the work, whether it is to be imported, skilled labour needed, temporary shelters and other facilitiesetc.

(c) **Equipments**. List the equipments required for the project, additional equipments required to be provided etc.

2.2.8 **Rates**

(a) Give reference to the schedule of rates adopted alongwith its year. Indicate whether the schedule is correct or any correction / amendment has to beapplied.

(b) Bring out the items for which appropriate rates are not available in the schedule and for such items give reference to analysis of rates attached to theestimate.

2.2.9 **Construction Programme**

(a) Mention whether the work is proposed to be executed departmentally or through contract, period proposed for completion of the project and the constraints which could upset the planning

schedule. Usually construction period of a portion of road should not exceed 2 to 3 years. Incase the period is likely to exceed, the project will be split and APE initiated for sector that can be completed in 2 to 3years.

(b) Draw up a construction schedule, either in the form of a bar chart or on thebasisof Critical Path Method (CPM). Use of Microsoft Project or Primavera software for preparation of CPM chart is advisable.

2.2.10 **Miscellaneous.** List out the miscellaneous items of work like:-

(a) Availability of accommodation and suitable locations for construction of road side camps.

(b) Diversion routes and haul roads.

(c) Sources of water supply and other amenities.

(d) Traffic control devices e.g. signs, pavement markings, guard stones, kilometer Sub-kilometer stones etc.

(e) Tourist facilities such as parking/picnic lay byes, way side amenities.

(f) Availability of landing grounds, dropping zones.

(g) Scope of starting work from several points.

(h) Induction/transportation of units.

(j) Alignment approval on map by civil or Army/GS/sponsoring agency.

(k) Aspects needing co-ordination with civil/military authorities i.e. security, law and order problems and clearance from forest department etc.

(l) Annual fund requirement.

(m) Cost acceptance by sponsoring agency in case of deposit works.

(n) Any other useful information.

2.2.11 **Check lists/Questionnaires.** Check lists/questionnaires, enclosed at Appendices 'C' to 'F' should be made use of, to ensure that each Project report is complete in all respects. These check lists with answers should be appended.

(a) Check list for preparation of technical proposal of road project involving new road construction such as road links, bye passes, approaches to major bridges, major re-alignments etc. - Appendix 'C'

(b) Check list for preparation of technical proposals of widening/ strengthening/ improvement of existing roads - Appendix'D'

(c) Check list to accompany the original estimate for construction/ improvement of new/existing roads - Appendix 'D'

(d) Check list of major activities involved in survey and investigations for a road project – Appendix 'F'

2.3 **Drawings**

2.3.1 Drawings will depict the proposed works in relation to the existing features, besides other information's necessary for easy and accurate translation of the proposals in the field. Foreasy understanding and interpretation, the drawing will follow a uniform practice with regard to size, scales and the details to beincorporated.

2.3.2 Drawings will be of adequate size to accommodate a reasonable length of road or a structural unit in full details. At the same time, these will not be inconveniently to necessitate several folds. Recommended size may be 594 mm x 420 mm corresponding to the size A2 of lS:696-1960. A margin of 40 mm will be kept on the left hand side of the-drawings to facilitate stitching into a folio.

2.3.3 The drawings usually required for a road project include the following:-

(a) **Locality map cum site plan**

(i) This is a combination of a key map and index map drawn on single sheet. This will be the first sheet in folio of drawings for a particular section of the road. However, where the length of the section is substantial, it will become necessary to separate out the locality map and the site plan, the former accommodated in one sheet and later in a series ofsheets.

(ii) The locality map (same as key map) will show the location of the road with respect to important towns and industrial centers and the existing means of communication in the neighborhood so as to give a birds eye view of the proposed work. The map will be to a scale of 1:2,50,000.

(iii) Tire site plan (same as index map) will show the project road and its immediate neighborhood covering the important physical features such as hills, rivers, tanks, railway lines etc. Itwill be to a scale of 1:50,000.

(iv) The sheet containing the locality map cum site plan will have a legend to explain the abbreviation sand symbols used in subsequent drawing sheets.

(b) **Land Acquisition plan.** These will be prepared on existing village maps or settlement maps, giving the details of property boundaries and their survey/ khasra numbers. If for any reason, detailed land acquisition plans are not possible, then rough plan will be prepared. Inter-alia the plans will show the final centerline of the road right-of-way limits, building lines, existing buildings, walls, monuments etc. affected by the road alignment, type of land i.e. irrigated, wet, dry, barren, forest etc. and the nature of crops.

(c) **Plan and Longitudinal Section**

(i) Plan and L-section for 1 km length of road will be shown on a single drawing sheet as far as possible. The plan will be at the top and longitudinal section at the bottom. The scale will generally be 1:2,500 for the horizontal and 1:250 for the vertical. But this may be changed suitably as per requirement.

(ii) The plan will show the final centre line of the road, right-of-way limits, road way of the existing road where applicable, existing structures, drainage courses, intersecting roads, railway lines, electric and telephone lines/ cables, design details of horizontal curves, benchmarks position, transition and intersection points, location of cross section contours, north direction etc.

(iii) The longitudinal section will show the profile of the proposed road, the general ground and the existing road where applicable. In addition, it will show details such as the gradients location and setting out data for vertical curves, superelevation, details of horizontal alignment, temporary bench marksetc.

(d) **Detailed cross sections.** The cross sections will be shown along continuous chainages. The area of cut and/or fill will be indicated with type of soil composition in that X-section. These will be taken

at a interval of 25 m as per existing practice and drawn to a scale of 1:500.

2.4 **Project Estimates**

2.4.1 The items of work will be carefully listed, the quantities determined accurately and the rates applied correctly. Over/under assessment of quantity of earth work and permanent works will be avoided. A certificate to the effect that 25% of X-section of each km have been checked by OC RCC personally and 100% by recce officer, will be enclosed alongwith the APE. OC unit will further check all the provisions made in the estimate and certify their correctness and necessity both in size and location. Excess provision of drainage/protective works could lead to avoidable inflation of per km costof road.

2.4.2 As on date Govt. approval exists for issuing sanction for trace cut at a flat rate of Rs.5500/-per km and for survey of existing road at the rate of Rs.800/-per Km. After selecting the final alignment of the road trace cutting be carried out. Project Report including preparation of various drawings will then be prepared. L-Section and X-Sections be drawn and detailed quantities of various types of work involved for construction of road to Cl-5(N)/Cl-9(N)/ Cl-9(E)/NHSL/NHDL specifications computed.

2.4.3 Project estimate will then be priced based on relevant DGBR Standard Schedule of Rates (SSR).

2.4.4 The project estimate will be prepared as AE Part-I and Part-II as per the attached forms at Appx 'G' & 'H'.

2.4.5 The estimate costing upto Rs.5.0 Cr and from Rs.5.0 Cr and above will be authenticated by minimum level of Staff Officer (SO) as under :-

(a) UptoRs. 5.00 Cr - Abstract of quantities by SO_3 and AE Part-I & II by SO-I/SO-II.

(b) OverRs.5.00 Cr– Abstractofquantitiesby$S0_2$andAEPart-I by SO-I/SO-II& AE Part-IbyColonel/SE (C).

2.4.6 Project report and statement of case for all the APEs will be signed by the ChiefEngineer.

2.4.7 The quantities catered for in the APE will be compared with the average quantities in adjoining roads of similar specifications and reasons for variationselaborated.

2.4.8 **Miscellaneous Provisions**. The following miscellaneous items should be incorporated in the project Estimate:-

(a) Provision for road side accn @ 2% and quality control @ 1% of the cost of original work.

(b) Road lift charges for constructional stores ex rail head to work site.

(c) Extra road lift charges for constructional materials beyond 4 Km lead.

(d) Provision of Royalty Charges.

(e) Provisions for land acquisition, forest clearances & wild life clearances, if any.

(f) Provision for contingency, annual escalation in prices and miscellaneous charges as accepted by Govt.

(g) Other relevant provisions.

3. CONCLUSION

3.1 This Technical Instruction covers the general points to be kept in view while preparing Detailed Project Report (DPR)/ Approximate Project Estimate (APE) for road works/Bridge works/ Tunnel works. There could be some additional factors involved for works in High Altitude Areas and for areas close to International Borders etc. These will be incorporated in the estimate with detailed justification. The aim will be to prepare a comprehensive project report giving a complete perspective of the project which is a vital necessity for proper planning and execution of works.

3.2 List of I.R.C. Publications pertaining to the Subject is placed at Appendix-J.

Appendix 'A'

MEASURES TO PREVENT SOIL EROSION AND LAND DEGRADATION IN ROAD DEVELOPMENT IN HILLY AREAS

1. Project Conception and Planning

1.1. The length of new roads to be constructed should be bare minimum so that disturbance to the natural surroundings is least. A Master Plan of entire development of hill region should be prepared showing integrated road network of all kinds of roads to the extent possible and practicable covering the planning at macro and micro levels. It is necessary that the main road should touch the cluster of villages, and separate feeder roads, bridal paths, foot tracks, etc., may be provided as connections. The specifications of such connections will depend upon the importance of the village.

1.2 All road construction activities should be coordinated through a single agency within the State or at Centre so that all cares are exercised to have proper planning, implementation and funding of the projects.

1.3 All road projects should be planned, designed and executed in accordance with the standards and specifications laid down by the Indian Roads Congress.

2. Alignment Selection

2.1 While selecting new road alignment, attention must be paid to avoid areas prone to landslides, soil erosion and other damaging features. It should be made obligatory to associate geotechnical engineers, geologists, forest and soil conservation experts, economists and other specialist right from the inception stage to ensure selection of most suitable alignment.

2.2 Road alignment should avoid large scale cuttings and fillings and follow the lie of the land as far as possible. Use of tunnels to avoid deep cuts should be considered where feasible and economical.

2.3 To the extent feasible, roads should be aligned away from streams and torrents except where these are to be crossed. Since the greatest damage always occurs along water Course, special attention is necessary to create protection belts of forests on both sides.

2.4 Before finalizing the alignment, erosion potential of each alternative should be carefully examined, and the one involving least disturbance to the natural ground should be preferred.

3. Design

3.1 Where the road is in cutting, half cut and half fill type section which involves least disturbance to the natural ground should be adopted subject to considerations of economy and road stability being satisfied.

3.2 The cut slopes should be made stable for the type of strata in the initial construction stage itself by adoption of appropriate slopes with benches, etc., including the use of stabilizing structures like breast walls, pitching, etc.

4. Construction

4.1 Area for clearing and grubbing should be kept to the minimum subject to the technical requirements of the road. The clearing area should be properly demarcated to save desirable trees and shrubs and to keep tree cutting to the minimum.

4.2 Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise temporary erosion control measures should be provided between successive construction stages. Under no circumstance, however, should very large surface area of erodible earth material be exposed at any time by clearing and grubbing.

4.3 The method of balanced cut and fill formation should be adopted to avoid large difference in cut and fill quantities.

4.4 The cut slopes should be suitably protected by breast walls, provision of flat stable slopes, construction of catch water and intercepting drains, treatment of slopes and unstable areas above and underneath the road, etc. This must be planned in advance and specific provisions made in the project estimate.

4.5 Where rock blasting is involved, controlled blasting techniques should be adopted to avoid over-shattering of hill faces.

4.6 Excavated material should not be thrown haphazardly but dumped

duly dressed up in a suitable from at suitable places where it cannot get easily washed away by rain, and such spoil deposits may be duly turfed or provided with some vegetative cover.

5. Drainage

5.1 Drainage of the water from hill slopes and road surface is very important. All artificial drain must be linked with the existing natural drainage system for which separate detailed engineering survey may be carried out and planning done. Before the road is opened to traffic, proper drainage system including suitable interceptor and catch water drains must be completed. This is caused because of negligence in providing proper drainage system and much will be saved in subsequent road maintenance.

5.2 The surface drains should have gentle slopes. Where falls in levels are to be negotiated, check dams with silting basins should be constructed so that soil is not eroded and carried away by high velocity flows.

5.3 Location and alignment of culverts should be so chosen as to avoid severe erosion at outlets and siltation at inlets.

5.4 The cross-drainage structures should discharge safely on the valley side, and in this connection, all necessary precautions/safeguards should be taken to ensure that the discharging water does not cause erosion even when they flow for long periods. For this purpose, all necessary river training and erosion control works like pitching/paving of the channel and outfall points, drop walls, flexible apron, etc., should be considered and provided for as a part of initial design andconstruction.

5.5 Along with other road components, due attention should be paid to the maintenance of drainage and soil conservation works. Drains, catch pits etc. should be cleared of all debris and repaired where necessary before the onset of the rainy season. Eroded areas should be promptly made up and provided with vegetativecover.

6. Grassing and planting

6.1 Deforestation of road construction works should be bare minimum and strict control must be exercised in consultation with the forest authorities. Equivalent amount of new trees must be planted as integral part of the project within the available land and if necessary, separate additional land may be made in the project estimate.

6.2 Depending on availability of land and other resources, afforestation of roadside land should be carried out to a sufficient distance on either side of the road. The selection of plant species will depend on climate, altitude and soil conditions, but preference should be given to deep rooted trees and plants. For preparing the detailed scheme of afforestation, persons having knowledge of soil conservation or forestry should desirable be associated.

6.3 Vegetative cover should be established on all cut/fill slopes through any one of the techniques described IRC: 56-2011 "Recommended Practice for Treatment of Embankment Slopes for Erosion Control (First Revision)". The activity of establishing vegetation on barren slopes should be treated as part of the regular maintenance operations on all hill roads.

6.4 Strip forests suitable for the site conditions for a minimum distance of 30m on either side of the road boundary should be provided. These shall be raised and maintained by forest authorities. No felling except of dead or dying trees should be permitted in this area.

7. **Consultations**

7.1 Local Geological Department should be consulted to avoid unstable strata while fixing road alignment.

7.2 It will be advisable, at least for important roads, to have consultation with the officers of the Forest Department at stages of route alignment selection, surveys and investigations, etc. so as to ensure that the selected alignment has minimum potential for soil erosion and that the project designs and estimates provide forthe necessary soil erosion control measures. The idea is that with such joint consultation pursuits practiced for some selected roads, the PWD Engineers would get conversant and should be able to take care of such requirements by themselves for other road projects in general.

7.3 For any seriously problematic areas where are not likely to be successful, specialist organizations but also the necessary measures against soil erosion so that these can be built into the projects with adequate financial provision.

8. **Project Estimate**

8.1 The road construction project estimates should provide for not only the requisite scale of investigations but also the necessary measures against

soil erosion so that these can be built into the project with adequate financial provision.

8.2 For treatment of unstable areas, say 50 may above and 30m below the road level, depending on the site conditions, cost of necessary corrective measures should be provided in the project estimates. This may even be in the form of certain percentage of total cost but based on assessment of treatment works possibly needed.

9. **Training.** Training of road engineers in hilly areas should be intensive and practice oriented. On every major on-going project, treatment facilities should be created.The Institutes having road research facilities may be associated for organizing class room, field training and solving specific problems, if any. The training should lay emphasis on preservation of ecology, forests,environment, etc., to avoid denudation offer tiles oil of the hill slopes and check the causes leading to landslides,etc. For efficient handling of the project, only experienced persons with proven ability should be selected.

Appendix 'B'

POINTS ABOUT EROSION CONTROL IN THE CONSTRUCTION OF ROADS IN HILLY AREAS

1. Does the road construction project estimate provide for the necessary measures against soil erosion?
2. Have soil maps and aerial photographs studies and investigations made to locate areas or sections with high erosion potential?
3. Has erosion potential been considered for each alignment?
4. Have geological maps been studied or local Geological Department consulted to avoid unstable strata?
5. Does the selected alignment follow the lie of the land and avoid large scale cutting?
6. Has use of tunnels to avoid deep cuts been investigated?
7. Is the road alignment susceptible to damage/erosion by streams and torrents?
8. Is consultation/co-ordination with other departments like Forest Department necessary? If so, have they been consulted?
9. Will special erosion control measures be required to protect adjacent properties?
10. How will adjacent and nearby streams, ponds and lakes be affected by project construction?
11. Does the road cross-section involve a lot of disturbance to the natural ground?
12. Are the design cut slopes stable for the type of strata?
13. Are slope stabilizing structures like breast walls, pitching, etc., required?
14. Does the cut hill face require any special treatment to prevent slips?
15. Has the area for clearing and grubbing been clearly demarcated?

16. Has a work schedule been worked out for the different construction operations?

17. What erosion control works are required before clearing and other work is started?

18. Are any temporary erosion control measures required between successive construction stages?

19. Have sediment traps, benches, catch water drains, side drains, sodding, ditch paving, slope protection works and other erosion control items been identified on the plans and provided in the contract?

20 Have the location and alignment of culverts been fixed with due consideration to erosion at outlets and siltation at inlets?

21. Have the necessary erosion control measures been taken at the outfalls of culverts?

22. Has the proper disposal of surplus excavated material been thought of and provided for?

23. What action has been taken to establish vegetative cover on cut/fill slopes and plantings on the disturbed roadside land?

24. Are the existing drainage facilities maintained in good order?

25. Have any inadequacies in planning, design and construction been identified and reported to higher authorities?

26. Does any of the design measures require modification in the light of field conditions?

27. Does any of the problems require consultation with specialist organizations like CRRI, GSI., etc.?

Appendix 'C'

CHECK LIST 'A'

TECHNICAL PROPOSALS OF ROAD PROJECTS INVOLVING NEW ROAD CONSTRUCTION SUCH AS NEW ROAD LINKS, BYE – PASSES, APPROACHES TO MAJOR BRIDGES, MAJOR RE-ALIGNMENTS ETC.

1. **Preliminary**

1.1 Name of work.

1.2 Authority and plan provision.

1.3 History, terrain and climate.

1.4 Horizontal and vertical profiles of existing facilities and other deficiencies.

1.5 Broad scope of work.

2. **Land Acquisition and Utilities**

2.1 Land Acquisition required (width and length) and action taken to ensure its availability.

2.2 Acquisition of structures etc. involved.

2.3 Re-location of utility services and action taken in the matter to ensure the same, prior to taking up the project.

3. **Traffic**

3.1 Traffic Studies undertaken.

3.2 Latest traffic data for the section.

3.3 Traffic projections.

3.4 Design Traffic (in terms of no. of vehicles of various types, PCUs, and cumulative million standard axle repetitions over the design period).

4. **Road Location/Alignment**

4.1 Obligatory Points.

4.2 Compatibility with Master/Regional/Town Plan.

4.3 Alternatives considered with merits and demerits.

4.4 Route selection and description of selected alignment; reference to approval by competent authority, if any.

4.5 R.O.B's/Major/Minor Bridges involved and action taken for the preparation of proposals thereof.

4.6 Areas needing special treatment.

4.7 Environmental features.

5. **Road Features**

5.1 Width of carriageway, shoulder, median etc. together with cross falls.

5.2 Subgrade level, HFL (Existing and anticipated due to any future irrigation works), Average height of embankment.

5.3 Geometric design.

5.4 Parallel Service roads, if any.

6. **Soil Investigations**

6.1 General soil test data for embankment and sub-grade.

6.2 High embankments – investigations and test data.

7. **Pavement Designs, Specifications and Shoulder Treatment**

7.1 Design CBR.

7.2 Pavement design and composition.

7.3 Specifications.

7.4 Shoulder treatment.

7.5 Typical Cross-Section.

8. **Drainage**

8.1 General drainage pattern, HFL, Water-Table, Seepage Flows etc.

8.2 Surface, catch water and longitudinal side drains proposed, if any.

8.3 Sub-surface drains, blanket course etc.

8.4 Internal pavement layer drainage.

9. **Cross-Drainage Structures**

9.1 Waterway.

9.2 Type of Structures.

9.3 Broad features - clearance above HFL etc.

9.4 Culverts details.

10. **Road Intersection**

10.1 Number of intersections.

10.2 Type of intersection and the category of the other roads involved with traffic details.

10.3 Interchange, if any, with justifications.

11. **Railway Crossings**

11.1 Location of crossing and the number of lines (BG/MG) being crossed at each location.

11.2 Justifications for provision of ROB/RUB.

12. **Materials, Labour and Equipments**

12.1 Prospecting of borrow areas for soil properties for embankment as well as subgrade & lead involved.

12.2 Quarries for aggregates, its characteristics and lead involved.

12.3 Labour availability, amenities.

12.4 Important equipment proposed for the work with their capacities.

13. **Miscellaneous**

13.1 Protective works such as pitching, retaining walls etc.

13.2 Rest Houses, Temporary quarters, way side amenities, truck parks etc.

13.3 Road side plantation, turfing, landscaping etc.

13.4 Guard rails, informatory signs, traffic control devices, if any.

13.5 Toll Plaza.

13.6 Diversion and haul roads.

13.7 Site amenities.

14. **Rough Cost**

14.1 Rough cost of work.

15. **Justification of Splitting of Work, if Proposed.**

16. **Pre-qualification of Contractors: Requirement Status.**

17. **Statements/Charts.**

18. **Drawings.**

19. **Programme of Construction.**

20. **Special Status, if any.**

Signature of OC Unit	Signature of TF Commander	Signature of CE Project

Appendix 'D'

CHECK LIST 'B'

TECHNICAL PROPOSALS OF WIDENING/STRENGTHENING/ IMPROVEMENT OF EXISTING ROADS

1. **Preliminary**

1.1 Name of work.

1.2 Authority and Plan provision.

1.3 History, terrain and climate.

1.4 Horizontal & vertical profiles of existing facilities and other deficiencies etc.

1.5 Broad scope of work.

2. **Land Acquisition and Utilities**

2.1 Need for additional land (width and length) and action to ensure its availability, if any.

2.2 Acquisition of structures etc. required.

2.3 Re-location of utility services and action taken in the matter to ensure the same, prior to taking up the project, whenever required.

3. **Traffic**

3.1 Traffic studies under taken.

3.2 Latest traffic data for section.

3.3 Traffic projections.

3.4 Design Traffic (in terms of no. of vehicles of various types, PCUs and cumulative million standard axle repetitions over the design period).

4. **Road Features**

4.1 Improvement curves, grades etc.

4.2 Improvement to sight distance.

4.3 Widening of pavement.

4.4 Need for raising.

4.5 Need for shoulders (paved), parallel service roads etc.

4.6 ROB/Major/Minor Bridges involved and action taken for preparation of proposals thereof.

4.7 Areas needing special treatment.

4.8 Environmental features.

4.9 HFL and water table along the road.

5. **Soil Investigations**

5.1 Soil characteristics of subgrade soil.

5.2 General soil test data.

5.3 Other investigations, if any.

6. **Pavement Designs, Specifications and Shoulder Treatment**

6.1 Thickness, composition, width of existing pavement and its condition kilometer wise.

6.2 Design CBR and Benkelman Beam Deflection techniques.

6.3 Pavement Design and composition of pavement for widening and/or strengthening.

6.4 Profile Corrective Course.

6.5 Specifications for pavement courses.

6.6 Shoulder treatment.

6.7 Typical cross-section.

6.8 Existing shoulders details and proposed treatment.

7. **Drainage**

7.1 Conditions of existing drains, water table, seepage flows etc.

7.2 Need for new drains - surface, catchwater and longitudinal side drains, blanket course etc.

7.3 Need for sub-surface drains.

7.4 Internal pavement layer drainage condition and requirement.

8. **Cross-Drainage Structures**

8.1 Condition of existing culverts.

8.2 Assessment of waterway and additional needs, if any.

8.3 Culverts to be reconstructed and their type.

8.8 Culverts to be widened.

9. **Road Intersections**

9.1 Improvement to existing intersections, category of other roads involved.

9.2 New Intersections, where required.

9.3 Interchange, if any with justification.

10. **Railway Crossings**

10.1 Improvement/Up-gradation of existing crossings-their locations with justification; number of railway lines, (BG/MG) crossed at each location.

10.2 Widening, if required.

11. **Materials, Labour and Equipments**

11.1 Prospecting of borrow areas for soil with soil properties for embankment as well as subgrade and lead involved.

11.2. Quarries for aggregates, its characteristics and lead involved.

11.3 Sources of materials, water and arrangement for transportation.

11.4 Labour availability and amenities.

11.5 Important Equipments proposed for the work with their capacities.

12. **Miscellaneous**

12.1 Protective works such as pitching, retaining walls etc.

12.2 Rest Houses, Temporary quarters, wayside amenities, truck parks etc.

12.3 Roadside plantation, turfing, landscaping etc.

12.4 Guard rails, informatory sign boards, traffic control devices, if any.

12.5 Diversion, haul road and traffic arrangement during work on existing roads.

12.6 Site Amenities.

12.7 Toll Plaza.

13. **Rough Cost**

13.1 Rough cost of work.

14. **Justification for Splitting of Work, if Proposed.**

15. **Pre-qualification of Contractors – Requirement Status.**

16. **Statements/Charts.**

17. **Drawings.**

18. **Programme of Construction.**

19. **Special Status, if any.**

20. **General**

20.1 Status of land plans and ownership.

20.2 Use of departmental machinery, where stipulated, with brief particulars.

20.3 Roughness measurements, if available.

Signature of OC Unit	Signature of TF Commander	Signature of CE Project

Appendix 'E'

CHECK LIST 'C'

CHECK LIST TO ACCOMPANY THE ORIGINAL ESTIMATE FOR CONSTRUCTION/IMPROVEMENT OF NEW/EXISTING ROADS

Sr No.	Item	Yes/No (Tick)	Remarks
1.	Is the estimate accompanied by all the needed drawing for execution of the project?	Yes/No	
2.	Have separate estimates/sub-estimates been enclosed for bridges, over-bridges & under bridges falling in the section under consideration?	Yes/No	
3.	Has the economic analysis been carried out?	Yes/No	
4.	Whether all the technical parameters as approved in the technical proposals have been incorporated in the detailed estimate?	Yes/No	
5.	Does the estimate provide for		
	(a) High embankment section	Yes/No	
	(b) Protective works	Yes/No	
	(c) Drainage measures as per detailed designs, where required?	Yes/No	
6.	(a) Has the land acquisition been completed?	Yes/No	
	(b) Whether land to accommodate high embankment as per approved design has been acquired?	Yes/No	
7.	Have the utility services been relocated, where required?	Yes/No	

Sr No.	Item	Yes/No (Tick)	Remarks
8	(a) Is the estimate based on latest standard schedule of rates (indicate the year of updation)?	Yes/No	
9.	(a) Does the estimate stipulate use of Govt. equipment(s)?	Yes/No	
	(b) If yes, are its usage charges provided for in the estimate?	Yes/No	
10.	(a) Does the project report indicate the detailed physical and financial Phasing of construction?	Yes/No	
	(b) Does the phasing take into account the probable date of fixing the agency and availability of Departmental equipment to hire to the contractor where stipulated?	Yes/No	

Appendix 'F'

CHECK LIST 'D'

CHECK LIST OF MAJOR OPERATIONS INVOLVED IN THE SURVEY AND INVESTIGATIONS FOR A ROAD PROJECT

1. **Reconnaissance Survey**

   (a) Map study/aerial photographs and satellite imagery.

   (b) Aerial reconnaissance.

   (c) Ground reconnaissance.

2. **Preliminary Survey**

   (a) Collection of general information's about traffic, soil, drainage etc.

   (b) Establishment of reference bench marks.

   (c) Traverse survey.

   (d) Fly levels and cross – sections.

   (e) Map preparation.

3. **Determination of Final Centre Line.**

4. **Final Location Survey**

   (a) Staking of final centre line.

   (b) Referencing Horizontal Intersection Points, Intermediate Points of Transit etc.

   (c) Establishment of permanent bench-marks.

   (d) Longitudinal sections and cross-sections.

5. **Traffic Surveys for development projects**

   (a) Study of data from records.

   (b) Traffic counts, O-D surveys etc.

   (c) Traffic projections.

(d) Collection of traffic particulars for railway level crossings and road junctions.

(e) Analysis of accident records.

6. **Soil and Material Surveys**

(a) Study of available information's.

(b) Soil investigations for low embankments and demarcation of borrow areas.

(c) Special investigations for high embankments.

(d) Detailed soil investigations for flexible/rigid pavement.

(e) Survey and evaluation of naturally occurring aggregates.

(f) Manufactured aggregates/items.

(g) Water for construction purposes.

7. **Drainage Studies**

(a) HFL and ponded water level

(b) Depth of sub-soil water table.

(c) Special investigations for cut-sections and seepage flows.

(d) Hill side water seepage problems/catch water drains.

8. **Culverts**

(a) Site selection.

(b) Collection of hydraulic and foundation data.

9. **Remote Sensing Techniques**

9.1 Aerial photographs and satellite imagery provide a wealth of details of large areas of the earth's surface. Properly applied remote sensing techniques permit the rapid, economical and dependable evaluation of regional terrain conditions including topography, structure, land forms etc. These techniques are very useful in areas of difficult accessibility and climatic restrictions. Remote sensed data, specially aerial photographs, have been proved to be very useful in identification, delineation and

investigation of landslides, avalanches and glacier flows over large at areas in rugged Himalayan terrain. The stereoscopic view of the aerial photographs provides a viewer details of the present land scape,which in turn is suggestive of past events. On this basis, the boundary of the landslide/avalanche/glacier can be precisely marked. Identification of areas susceptible to land slides/avalanches can be made by studying the distressed conditions of slope,which are already present or may be induced in future.This type of study is essential in planning, reconnaissance and preliminary stage of surveys for any developmental project like route alignment,bridge location,dam sites.

9.2 Further information could be had from Indian Institute of Remote Sensing,4, Kalidas Road, Post Box No 135, Dehradun (Pin Code – 248001)

10. **Computer Aided Design of Road Alignments.** Computer-aided design of road alignments are being done now. Digital Mapping Centre, Survey of India, Dehradun has got necessary facilities in the field. In this method, a digital terrain model of the area is evolved applying the techniques of photo grammetry.The digital data thus collected is then used for developing three-dimensional model of the area, contour plans, etc. Graphic packages used to mark road alignment on the contour plan. Th realignment marked is then super imposed on the terrain model for further analysis and extracting X-section and L-sections along the proposed alignment. Other ground features, soil details etc. could also be superimposed on the model. Thus a completed sign of road alignment could be carried out using the computerized techniques. This selected alignment could be transferred on the ground with the help of planet able survey. Computer-Aided-Design of old alignments would be of great help in selection of alignments in the difficult/inaccessible areas.

Appendix 'G'

APPROXIMATE PROJECT ESTIMATE

PART-I

Name of Area/State :

Name of Project :

Name of Work :

Sr No.	Description of work		Amount (Rs.)
1.	Compensation/Land Acquisition		
2.	Formation Works		
3.	Permanent works		
4.	Bailey Bridges		
5.	Surfacing Works		
6.	Sum of Sl. No.1 to 5.		A
7.	Credit for Retrieved Stores	(-)	B
8.	Add 2% for Roadside Accn		
9.	Add 1% for Quality Control		
10.	Add 5% for contingencies		
11.	Add for Escalation		

Sr No.	Description of Work	Escalation	Total cost
1.	Formation Cut/Pmt Works		
2.	Surfacing Works		
3.	Bridges		

Appendix 'H'

APPROXIMATE PROJECT ESTIMATE

PART-II

Name of Area/State :

Name of Project :

Name of Work :

Sr No.	Description of Work	SSR Item No.	Brief Specifi-cations	A/U	Quantity	Rate (Rs.)	Amount (Rs.)	Remarks
1	Land Acquisition							
2	House Compensation							
3	Compensatory Afforestation							
4	Formation Works:-							
	(i) Jungle Clearance							
	(ii) Earth Work							
	(iii) Unlined Drain							
5.	Permanent Works							
	(i) Retaining Walls							
	(ii) Breast Walls							
	(iii) Toe Walls							
	(iv) Sausage Walls							
	(v) Cause Ways							
	(vi) RCC Culverts							
	(vii) Lined Drains							
	(viii)Parapet Walls							
	(ix) Boundary Pillars							
	(x) KM Stones							
	(xi) Extra Lead							
	(xii) Road Lift							
6.	Bailey Bridges							
7.	Permanent Works Road Lift							
8.	Credit for Retrieved Stores							

Appendix 'J'

LIST OF IRC PUBLICATIONS PERTAINING TO PROJECT REPORTS AND APPROXIMATE PROJECT ESTIMATES (APEs) FOR REFERENCE

1.	IRC:9-1972	Traffic census on Non-urban Roads (First Revision).
2.	IRC:37-2018	Guidelines for the design of flexible pavement (Fourth Revision).
3.	IRC:40-2002	Standard Specification and Code of Practice for Road Bridges (Second Revision).
4.	IRC:52-2019	Guidelines for the Alignment Survey and Geometric Design of Hill Roads (Third Revision).
5.	IRC:SP-19- 2001	Manual for Survey, Investigation and Preparation of Road Projects (Third Revision).
6.	IRC:SP-20-2002	Rural Roads Manual.
7.	IRC:SP-42-2014	Guidelines of Road Drainage(First Revision)
8.	IRC:SP-48-1998	Hill Road Manual.
9.	IRC:SP-73-2018	Manual of Specification & Standards for Two Laning of Highways With Paved Shoulder (First Revision).
10.	IRC:SP-91-2019	Guidelines for Road Tunnels (First Revision)