



श्रमेण सर्वम् साध्यम्



# BORDER ROADS ORGANISATION

# VISION 2047

**25 YEAR STRATEGIC PLAN**

अमृत काल

**...WE WILL EITHER FIND A WAY OR MAKE ONE...**





श्री राजनाथ सिंह  
रक्षा मंत्री

### संदेश

1. सीमा सड़क संगठन ने अपने अस्तित्व के पिछले छह दशकों में चुनौतीपूर्ण परिस्थितियों में खुद को स्थापित किया है और देश की रक्षा तैयारियों और सीमावर्ती क्षेत्रों के सामाजिक-आर्थिक विकास में महत्वपूर्ण योगदान दिया है। मुझे यह जानकर प्रसन्नता हो रही है कि बीआरओ ने अगले २५ वर्षों के लिए अपने लिए एक स्पष्ट विजन दस्तावेज तैयार किया है।
2. "विजन बीआरओ@२०४७" एक ऐसा दस्तावेज है जो बीआरओ की उत्कृष्टता की निरंतर खोज को समाहित करता है और भविष्य में प्राप्त करने योग्य मील के पत्थर के साथ एक दिशानिर्देश तैयार करता है। यह दस्तावेज उस वर्ष में आ रहा है जब देश आजादी के अमृत महोत्सव के माध्यम से आजादी का ७५वाँ साल मना रहा है और राष्ट्र के १०० वर्ष पूरे करने के दौरान महत्वपूर्ण उद्देश्यों को प्राप्त करने के लक्ष्य को संबोधित करता है। इस दस्तावेज में अगले २५ वर्षों के लिए स्पष्ट रूप से पहचाने गए लक्ष्यों और उद्देश्यों को पूरे संगठन द्वारा एक सामूहिक प्रयासों के माध्यम से रेखांकित किया गया है।
3. मुझे विश्वास है कि उत्कृष्टता प्राप्त करने के संगठन के इतिहास को देखते हुए, "विजन बीआरओ@२०४७" दस्तावेज, बीआरओ की विशेषज्ञता और दक्षता के क्षेत्रों के विस्तार के लिए एक स्तंभ के रूप में कार्य करेगा। "विजन बीआरओ@२०४७" गुणवत्तापूर्ण बुनियादी ढांचे के निर्माण के रूप में कारगर साबित होगा जो कि आत्मनिर्भरता प्राप्त करने के राष्ट्र के संकल्प को पूरा करेगा और हमारी स्वतंत्रता के शताब्दी वर्ष में भारत को वैश्विक कद प्रदान करेगा। मैं 'टीम बीआरओ' को अपनी शुभकामनाएं देता हूँ और मैं आश्वस्त हूँ कि वे "श्रमेण सर्वम् साध्यम्" के अपने आदर्श वाक्य द्वारा निर्देशित, अपने राष्ट्र निर्माण के प्रयासों में अडिग रहेंगे।

जय हिंद!

स्थान : नई दिल्ली

दिनांक : 27 सितम्बर 2022

  
(राजनाथ सिंह)



श्री अजय भट्ट  
रक्षा राज्य मंत्री

संदेश

1. सीमा सड़क संगठन ने अपने गठन के विगत छः दशकों में देश के सीमावर्ती क्षेत्रों को कनेक्टिविटी प्रदान करने में जो महत्वपूर्ण भूमिका निभाई है, वह सराहनीय है। देश के सुदूर एवं सीमावर्ती दुर्गम क्षेत्रों में सड़कों, पुलों, सुरंगों तथा हवाई पट्टियों का निर्माण कर बीआरओ ने देश के सामाजिक और आर्थिक विकास को बढ़ावा दिया है और कठिन एवं विषम परिस्थितियों में भी परियोजनाओं के निर्माण का कुशल नेतृत्व किया है।
2. बीआरओ द्वारा अपनी कुशलता एवं कर्तव्यपरायणता का परिचय देते हुए तैयार किया गया "विजन बीआरओ@२०४७" दस्तावेज भविष्य में राष्ट्र की विकास यात्रा में महत्वपूर्ण योगदान देने हेतु संगठन द्वारा अपनाए जाने वाले उद्देश्यों एवं लक्ष्यों को परिभाषित करता है। आजादी के ७५वें वर्ष में तैयार किया गया यह दस्तावेज संगठन द्वारा आने वाले २५ वर्षों में प्राप्त करने के लक्ष्य को संबोधित करता है एवं आधुनिक भारत की बुनियादी ढांचे की आवश्यकताओं की ओर ध्यान केन्द्रित करता है।
3. मुझे पूर्ण विश्वास है कि बीआरओ द्वारा तैयार किया गया यह दस्तावेज आने वाले समय में संगठन को उसके लक्ष्यों एवं उद्देश्यों को सही समय में पूर्ण कर इसको नयी बुलन्दियों पर पहुंचाने एवं देश को संवृद्धता की ओर अग्रसित करने में पथ प्रदर्शक के रूप में कार्य करेगा। मैं बीआरओ को उसके इस उत्कृष्ट कार्य के लिए एवं भविष्य के समस्त प्रयासों के लिए हार्दिक शुभकामनाएँ एवं सफलता की कामना करता हूँ।

**जय हिंद!**

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**(अजय भट्ट)**



श्री गिरिधर अरमाने, भा.प्रशा.से.

रक्षा सचिव

### प्रस्तावना

१. बुनियादी ढांचे का निर्माण राष्ट्र के विकास का मजबूत स्तंभ रहा है और राष्ट्र ने इस संबंध में बड़ी प्रगति की है। सीमा सड़क संगठन ने भारत के सुदूर एवं सीमावर्ती क्षेत्रों में इस अभियान का नेतृत्व किया है। राष्ट्रीय सुरक्षा एवं प्रभावित क्षेत्रों के सामाजिक-आर्थिक विकास को बढ़ावा देते हुए इस संगठन ने वास्तव में वहां कार्य किया है जहां किसी अन्य संगठन ने जाने का साहस नहीं किया है और कठिन एवं चुनौतीपूर्ण परिस्थितियों में भी बुनियादी ढांचे का निर्माण किया है।

२. एक समृद्ध विरासत, गौरवपूर्ण परम्परा तथा सौंपे गए कार्यों को कुशलता पूर्वक करने का उत्साह "विजन बीआरओ@२०४७" दस्तावेज़ के स्तंभ हैं। लगन एवं निपुणता से तैयार किया गया यह दस्तावेज़ अगले २५ वर्षों के लिए स्पष्ट समय सीमा द्वारा परिभाषित किये गये लक्ष्यों के साथ एक मार्गदर्शक के रूप में सिद्ध होगा। तार्किक रूप से संरचित, विजन बीआरओ@२०४७ शक्तियों, चुनौतियों, अवसरों एवं खतरों के व्यापक अध्ययन तथा विश्लेषण पर आधारित है। यह नई क्षमताओं को प्राप्त करने, उन्हें पूर्ण करने तथा उनके विकास की दिशा में एक समग्र अभियान की नींव रखता है।

३. बीआरओ ने "विजन बीआरओ@२०४७" दस्तावेज़ के माध्यम से एक व्यापक एवं सुनियोजित 'बुनियादी ढांचा निर्माण कार्यक्रम' के जरिए राष्ट्रीय क्षमता में वृद्धि तथा सक्षम विकास की यात्रा शुरू करने के लिए एक स्पष्ट आह्वान किया है। मुझे विश्वास है कि संगठन इस पथ प्रदर्शक दस्तावेज़ के माध्यम से अपने निर्धारित लक्ष्यों को प्राप्त करेगा और उससे आगे निकलकर २०४७ में राष्ट्र के बढ़े हुए वैश्विक कद में महत्वपूर्ण योगदानकर्ता के रूप में उभरेगा।

जय हिंद!

स्थान : नई दिल्ली

दिनांक : 15 नवम्बर 2022

गिरिधर  
गिरिधर अरमाने



राजीव चौधरी, वीएसएम  
डीजीबीआर

### संदेश

१. "विज्ञान बीआरओ@२०४७" हमारे सामूहिक संकल्प "...या तो हम रास्ता खोज लेंगे या बना लेंगे..." की अभिव्यक्ति है। अपने गठन के बाद छह दशकों में संगठन ने सभी बाधाओं और प्रतिकूल परिस्थितियों के बावजूद राष्ट्र को कई उपलब्धियां प्रदान की हैं। हमारे कर्मयोगियों के धैर्य एवं दृढ़ता की वजह से देश के दूर-दराज, दूरस्थ, निर्जन एवं दुर्गम स्थानों को सड़कों के माध्यम से जोड़ा गया है और स्थानीय लोगों को आजीविका प्रदान की है। हमने राष्ट्रीय सुरक्षा चुनौतियों के दौरान आगे बढ़ते हुए और सीमित समय में उत्कृष्ट परिणाम देकर रक्षा तैयारियों से कभी समझौता नहीं किया है। बीआरओ द्वारा बनाई गई सड़कें, पुल, सुरंग और हवाई पट्टियां न केवल सीमेंट, रेत, स्टील और पत्थर जैसी निर्माण सामग्रियों से निर्मित हैं अपितु इसमें हमारे कर्मयोगियों का खून और पसीना भी शामिल है जिन्होंने अपना कर्तव्य निभाते हुए सर्वोच्च बलिदान दिया है।

२. अपनी परियोजनाओं को उच्चतम मानकों के अनुरूप बनाए रखने के लिए, संगठन ने अपने कार्यों के प्रदर्शनों की सूची में उत्तरोत्तर वृद्धि की है और प्रासंगिक चरणों तथा प्रौद्योगिकी का संचार किया है। अटल सुरंग, उमलिंग ला दर्रे में सड़क तथा जोजिला दर्रे का शीघ्र खोलना हमारी हाल ही की कुछ उपलब्धियां हैं जो कि अपेक्षाओं से अधिक करने के प्रति हमारे संकल्प को दर्शाती हैं। एक संगठन के रूप में हम देश के सामाजिक-आर्थिक विकास में प्रत्यक्ष अथवा अप्रत्यक्ष रूप से योगदान देते हुए अन्य राष्ट्रीय कार्यक्रमों जैसे कि आत्मनिर्भर भारत अभियान, मनरेगा के साथ बीआरओ का संमिलन तथा सड़क सुरक्षा अभियान में सबसे आगे रहने के लिए प्रयासरत है। राष्ट्रों के समूह में अपनी सही नेतृत्व भूमिका निभाने के लिए अनिवार्य है कि हम बीआरओ को एक गतिशील एवं कुशल बुनियादी ढांचे के विकास की संस्था के रूप में रूपांतरित करें तथा देश की व्यापक राष्ट्रीय शक्ति और वैश्विक प्रतिष्ठा को बढ़ाने के लिए कार्य करें।



3. "विजन बीआरओ@२०४७" एक तार्किक और श्रमसाध्य प्रक्रिया के माध्यम से तैयार किया गया दस्तावेज है जो कि भविष्य में राष्ट्र की विकास यात्रा में योगदान देने हेतु हमारे संगठन द्वारा अपनाए जाने वाले उद्देश्यों को परिभाषित करता है। निर्माण अनिवार्यताओं की पहचान पर आधारित यह दस्तावेज प्रशासनिक दक्षता सुनिश्चित करते हुए तकनीकी क्षमताओं को और अधिक बढ़ाने की दिशा में एक समन्वित प्रयास है। यह सुनिश्चित करने के लिए स्पष्ट मापदण्डों और उद्देश्यों की पहचान की गयी है जिस से कि यह संगठन २०४७ के अपने लक्ष्यों को प्राप्त करने के लिए सही दिशा में अग्रसर रहे। समग्र और व्यापक विकास को सुविधाजनक बनाने के लिए तकनीकी संचालित बुनियादी ढांचे का निर्माण प्रमुख फोकस क्षेत्र बना हुआ है, साथ ही यह भी सुनिश्चित करता है कि सामान्य जनमानस के साथ जमीनी जुड़ाव की अनदेखी न हो। संगठन को राष्ट्रीय दृष्टि, लक्ष्यों और उद्देश्यों के लिए प्रतिबद्ध रहने की आवश्यकता है, जिस से केवल बीआरओ के प्रत्येक कर्मयोगी के अटूट समर्थन एवं संकल्प के माध्यम से प्राप्त किया जा सकता है, जिस से बीआरओ और हमारे देश को दुनियाँ में सर्वश्रेष्ठ बनाया जा सके।

४. हमारा आदर्श वाक्य 'श्रमेण सर्वम् साध्यम्', हमारा प्रकाश स्तंभ और मार्गदर्शक बना रहेगा और हम अपने संकल्प "... या तो हम रास्ता खोज लेंगे या बना लेंगे..." के माध्यम से २०४७ के निश्चित लक्ष्यों के साथ कार्य करते रहेंगे।

**जय हिन्द! जय बीआरओ !!**

स्थान : नई दिल्ली

दिनांक : 15 नवम्बर 2022

**(राजीव चौधरी)**

लेफ्टिनेंट जनरल

डीजीबीआर और कर्नल कमांडेंट बीआरओ





# CONTENTS

**CHAPTER I: BACKGROUND**

**01**

**CHAPTER II: STRUCTURES  
AND PROCESSES**

**09**

**CHAPTER III: TECHNOLOGY AS  
A CAPABILITY ENABLER**

**33**

**CHAPTER IV- MODERN VEHICLES  
EQUIPMENT AND PLANT**

**79**

**CHAPTER V - BRO VIDESH**

**91**

**CHAPTER VI: OBJECTIVES**

**95**

**CHAPTER VII- SHORT TERM  
OBJECTIVES ( 2022-2030)**

**101**

**CHAPTER VIII- MID TERM  
OBJECTIVES ( 2030-2037)**

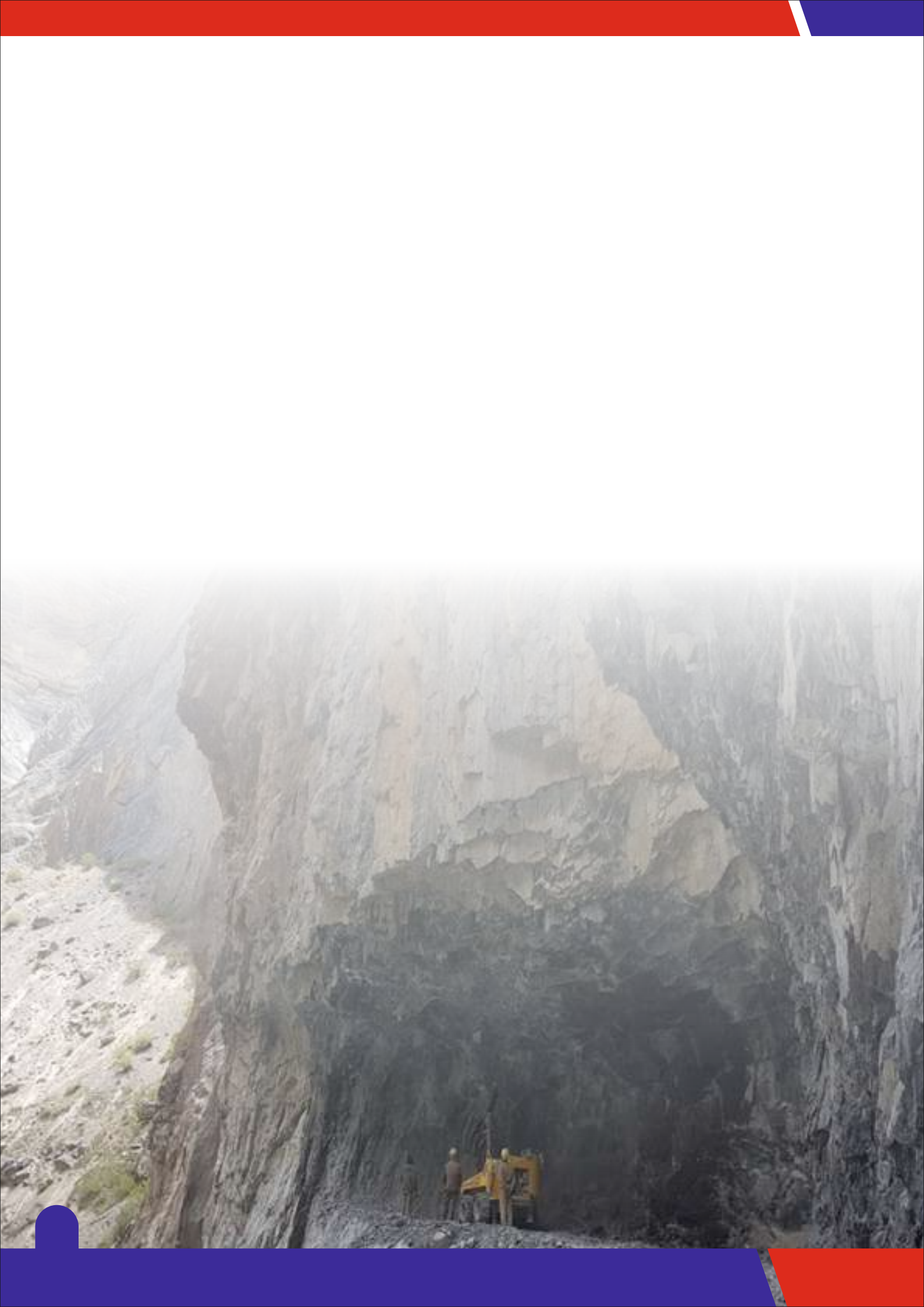
**111**

**CHAPTER IX- LONG TERM  
OBJECTIVES ( 2037-2047)**

**117**

**CONCLUSION**

**122**





## CHAPTER I: BACKGROUND

1. The Border Roads Organisation (BRO) is a one of its kind uniformed engineering force in the world, dedicated to providing last mile all weather connectivity to India's security forces deployed along the IB, LC and LAC. Raised in 1960, with two Projects, one each for Northern and North-Eastern borders, the Organisation has grown to 18 Projects consisting of 34 Task Forces. BRO has distinguished itself as an elite construction agency that has built more than 60,000 kms, 848 permanent bridges, 19 airfields and 18 kms of tunnels across the most treacherous terrain and inhospitable weather conditions.

2. The history of BRO is a **saga of valour, commitment and devotion to duty**, having been awarded **23 Kirti Chakras, 218 Shaurya Chakras, 16 PVSMs, 43 AVSMs, 25 Sena Medals, three Sarvottam Jeevan Raksha Padaks and 17 Uttam Jeevan Raksha Padaks**. Formed under the Border Roads Development Board (BRDB) programme of the Ministry of Transport, BRO was eventually placed under the Ministry of Defence vide Cabinet Secretariat Notification No F No 1/21/23/2014-cab dated 09 Jun 15. The presence of BRO as of date is as shown on the map.



## DEPLOYMENT OF BRO PROJECTS



3. The Motto of BRO is “***Shramena Sarvam Sadhyam***” (*Everything is Achievable through Hard Work*) and has been the guiding light in shaping the organisational ethos.

### Role and Charter of BRO

4. The role and charter of BRO is defined as under: -

- (a) **In Peace (In Support of the Indian Armed Forces).**
  - (i) Develop and maintain the operational road infrastructure of General Staff in the border areas.
  - (ii) Contribute to the socio-economic development of the Border States.
- (b) **In War (Under Operational Control of the Indian Armed Forces).**
  - (i) to develop & maintain roads to keep lines of communication open in original and re-deployed sectors.
  - (ii) To execute additional tasks as laid down by the Government contributing to the war effort.



### **BRO in a 'New India'.**

5. The geo-strategic challenges and complexities, as a consequence of emerging new world order, coupled with an aggressive environment along with India's land and maritime borders, has necessitated a need for a re-assessment of India's capability to safeguard its strategic interests and territorial integrity alike. A strong India needs a strong economy that is founded on inclusive growth sustained through socio-economic development and self-reliance (Atma Nirbharta). While BRO has been working behind the scenes in shaping the security architecture and socio-economic landscape in border areas for the last 62 years, it is felt that BRO can play a greater role in making India prosperous, militarily strong, globally relevant and influential. Towards this end, it is imperative to layout a roadmap that will guide BRO to grow and complement the national effort in achieving the vision of a '**New India**', by the year 2047, when India celebrates 100 years of Independence.

### **Strategic Needs of India**

6. The world today is going through a major transformation militarily and economically with Russia and China challenging the domination enjoyed by the USA after the collapse of the Soviet Union. The world stands divided in its support, some by choice and balance by coercion, whether economic or otherwise.

7. While India's choices have always been governed by its policy of strategic autonomy purely dictated by its national interest, simply stated, India's relationship with the world has been dictated by **three** overarching **strategic needs**, namely, **bringing economic prosperity to its people, building military capability to ensure peace on its belligerent borders** and **shaping global perception through various actions of diplomacy and soft power projection**. These strategic needs still stand to guide the present and future of India.

8. The importance of infrastructure development in fulfilling the above strategic needs cannot be over-emphasized. Interestingly, BRO is one such organisation that



has been meaningfully contributing to all the above strategic needs by building roads, airfields and other infrastructure in India and friendly foreign countries. However, it is felt that BRO has the potential to play a greater role that covers a wider spectrum of infrastructure development in border areas, including island territories, coastal areas, Naxal affected and isolated regions, UN missions, war-torn and under-developed countries and constructing transnational multi-modal economic corridors with other emerging economies, regional and extra regional.

### **Border Area Infrastructure**

9. Border area infrastructure development can be categorised into military and civil infrastructure. While each may have a specific purpose, they are not exclusive as far as the overall development of border areas is concerned. This strong interdependence is because people of the border areas will always be important stakeholders in the defence of the country.

### **Military Infrastructure Development.**

10. **BRO is deployed in 19 states, four Union Territories including Andaman & Nicobar Islands** and has contributed by constructing more than 60,000 kms of roads, 848 bridges, 19 runways and 18 kms of tunnels in the last 60 years for facilitating the deployment and operational preparedness of armed forces. However, the gambit of military infrastructure development has enhanced manifold, especially, in light of induction of strategic assets, better battle field transparency and precision interdiction capability and enhanced lethality. **There is no infrastructure agency better placed than BRO to understand the complex requirements of the Armed Forces and exhibit a desired sense of urgency to deliver time critical projects.** Apropos, BRO is best suited to diversify its capability and transform itself into a multifaceted construction agency to keep pace with the expectations of the Armed Forces.

### **Civil Infrastructure Development.**

11. While the military infrastructure development will remain the prime



responsibility of the organisation, **BRO Karmyogis also enjoy tremendous goodwill** with their strong and visible presence in various border states, insurgency prone areas and UTs. It is this goodwill and the competency of BRO that needs to be capitalised upon by the Government for the success of various flagship projects aimed at improving the socio-economic conditions in border areas and bringing them into the mainstream.

### **BRO in Naxal Affected Areas**

12. Development of infrastructure in Naxal affected areas of the country has not kept pace in comparison with the development undertaken in border areas. While the importance and sensitivity of border areas are well understood, however, equal opportunities for integration and economic growth have also to be extended to Central and Eastern India to counter the menace of Naxalism. The presence of BRO in these areas is not new. BRO was intimately involved in the development of the country's coal belts in Bihar, Orissa and Karnataka under the Coal Fields Reconstruction Programme.

13. Apart from BRO there is no other road construction agency that has the experience to deliver in hostile and disturbed areas. Thus, **there is a case in point to enhance the mandate of BRO for spearheading the construction of roads, airfields and helipads in Naxal infested areas of Chhattisgarh, Maharashtra, Orissa, Telangana and Andhra Pradesh so that the Government's reintegration (inclusive development) plans in these areas can be implemented with surety of success in a time bound manner.** BRO has executed multifarious projects in these areas earlier, and the organisation is best poised to undertake infrastructure development projects in these states as a symbol of nation building.



### **BRO in Andaman & Nicobar and Lakshadweep Islands**

14. The importance of Andaman & Nicobar and Lakshadweep islands in the country's security calculus has taken a new dimension after China's assertive behaviour in the IOR. BRO was the flag bearer for the development of these islands when **Project Yatrik** was established in 1971 and diverse works like the construction of roads, buildings, airfields and naval engineering works were undertaken by BRO over 20 years. Today, BRO has a minimal presence on the island in the form of an Independent Task Force; the scope of employment has been largely conservative. To support the Andaman & Nicobar Command (ANC) in the conduct of large scale maritime operations and building force projection capability, there is a requirement for an integral engineering force like BRO which can act in both advisory and executive capacity to the military organisation on the archipelago and be the lead agency in coordinating infrastructure development of all military assets.

15. The **proposal is to set up one or two BRO Projects with specialised units/sub-units to undertake holistic development of the island territories** by undertaking the following works: -

- (a) Road construction including inter-island connectivity through elevated corridors and undersea tunnels.
- (b) Runways and heliports with hardened shelters for enhanced war stamina of air assets.
- (c) Naval engineering works like jetties, harbours and shipyards.
- (d) Protection works against tsunamis, cyclones and sea erosion.
- (e) Beach obstacles.
- (f) Tunnel defences and underground structures for force and logistics preservation.



## **BRO for Humanitarian Assistance during Disasters**

16. Providing humanitarian assistance and disaster relief is intrinsic to BRO by virtue of its deployment in disaster prone areas of the country and its intimate understanding of the land and its people. The yeoman service rendered by BRO in bringing immediate succour to affected people and carrying out post disaster rehabilitation is well documented. Ipso facto, BRO has been the first responder in areas of its operational deployment.

17. While the National Disaster Management Plan (NDMP) is a comprehensive document that aims to maximise the ability of the country to cope with disasters at all levels, the role envisaged for BRO is largely restricted to earthquake, landslide and avalanche mitigation. There is **scope for the role of BRO to be enhanced duly figuring in the universal presence of BRO and its well-established and time-tested capability to respond with speed.**

18. An institutional mechanism that provides greater coordination between NDMA, SDMA and BRO is proposed to be established at the level of HQ DGBR and HQ CE Projects to align assistance rendered by BRO within the framework of NDMP. To further enhance the capability of BRO in providing immediate disaster rescue and relief, it is proposed that a **disaster relief fund with a budget ceiling of Rs 50 Crores be allocated to Projects on need basis.**

19. **Infrastructure Planning in Disaster Prone Areas.** Infrastructure planning in disaster prone areas needs to be done keeping in mind the potential hazards specific to a particular area. The **Vulnerability Atlas of India** prepared by the Ministry of Housing and Urban Affairs is a very comprehensive and detailed document and must be taken into consideration. Similarly, the National Landslide Risk Management Strategy enunciated by NDMA has earmarked the responsibility of generating **user friendly landslide hazard maps** to the Geological Survey of India.



## Social Responsibilities of BRO

20. As a socially responsible organisation, BRO has been committed to the socio-economic development of the local populace. It has always been furthering the Government's cause to bring prosperity to the border and remote areas by providing accessibility and livelihood, including furthering the tourism potential of remote areas. BRO's recent collaboration with the Ministry of Rural Development to drive the success of **MGNREGA** in border areas and the Government's approval of **75 BRO Cafes** in the remotest borders of the country to promote tourism are some of the visible initiatives launched by BRO.

21. **Vision BRO @ 2047 - '25 Year' Roadmap.** This document lays down a roadmap that will guide BRO for the next 25 years to achieve desired organisational objectives. The document is a product of a realistic assessment of past and present performance, intense deliberations, shared views and consensus within the rank and file. BRO seeks an enhanced role for itself in nation-building and aims to diversify its core competencies in the field of infrastructure development. The document has been christened '**Vision BRO@2047**', coinciding with its fruition in the 100<sup>th</sup> year of India's independence.



## CHAPTER II: STRUCTURES AND PROCESSES

1. BRO is a modern and transnational construction organisation that is committed to meeting the strategic requirements of the Indian armed forces. The organisation plays a vital role in upscaling of the infrastructural development. BRO develops communication on behalf of following Ministries: -

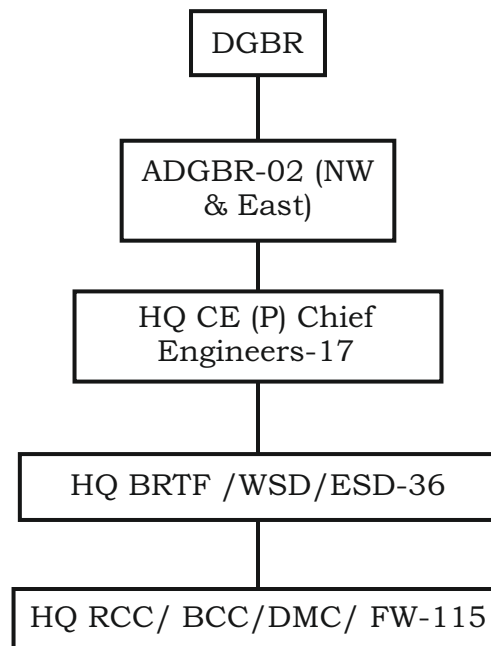
- (a) Ministry of Defence.
- (b) Ministry of Road Transport & Highway.
- (c) Ministry of Home Affairs.
- (d) Ministry of External Affairs.
- (e) Ministry of Rural Development.
- (f) DoNER
- (g) PSU/other Agencies as Deposit Works.

### Organizational Structure

2. As per the current structure, BRO has 17 Projects headed by an officer of the rank of Brigadier / Chief Engineer (Civ). Each Project consists of two/ three Border Road Task Forces (BRTFs) headed by an officer of the rank of Colonel/Superintendent Engineer (Civ). Each BRTF consists of two/three Road Construction Companies (RCCs)/ Bridge Construction Companies (BCCs). RCC/BCC is headed by an officer of the rank of Lt Colonel / Major / Executive Engineer (Civ). Further RCC/BCC consists of several platoons headed by an officer of the rank of Captain/Assistant Executive Engineer (Civ) / Assistant Engineer (Civ).



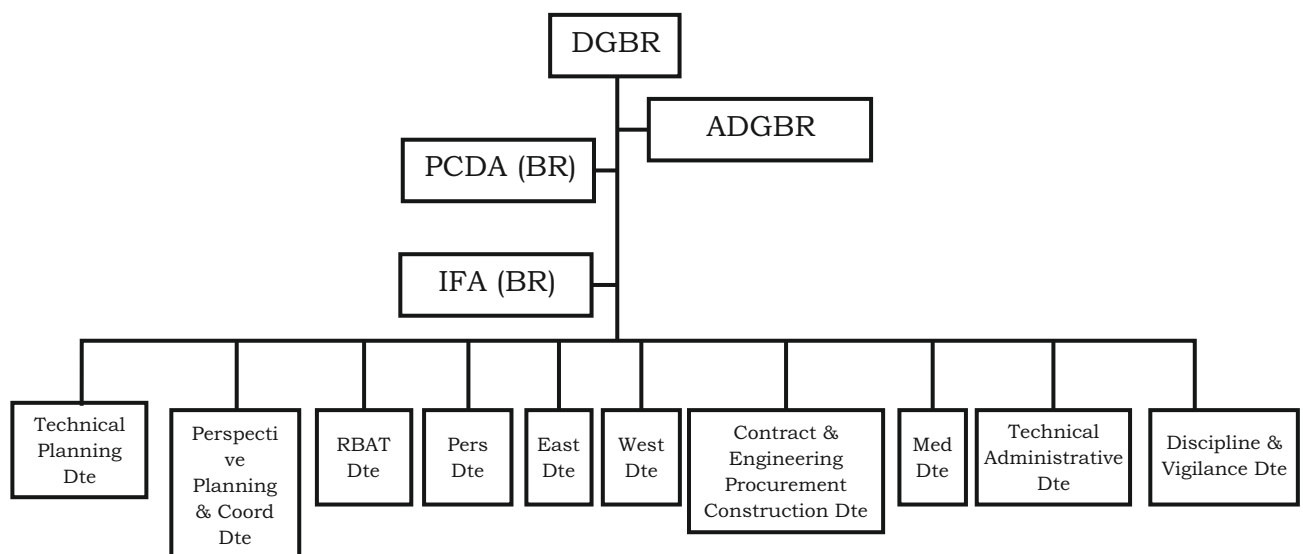
(a) The overall Organization structure of BRO is as under: -



(b) For quality assurance, there are 03 Regional Technical Examiners located at Guwahati, Dimapur and Jammu functioning under MoD (BR).

(c) At present, BRO has one training center, GREF Center at Pune and one R&D establishment at Shillong.

(d) The current organization structure of HQ DGBR, is as below:





### Director General Border Roads

3. The Director General of Border Roads is the executive head of Border Roads Organisation. He is responsible for giving advice on technical matters. The Director General Border Roads is responsible for:-

- (a) Planning and execution of projects entrusted to the General Reserve Engineer Force and coordination of all technical matters and progressing of projects entrusted to P.W.D. / C.P.W.D.
- (b) Technical soundness of designed specifications adopted in the construction of projects.
- (c) Scrutiny of all estimates before they are put upto the Board for sanction.
- (d) Preparation and submission of periodical budget estimates and obtaining funds from Government.
- (e) Administration, planning and control of man-power, resources etc. of BRO.





## Chief Engineers

4. The Director General of Border Roads exercises control over the BRO through Chief Engineers, functioning in specified areas. Chief Engineer is responsible for:-

- (a) The detailed planning of projects and the submission of estimates.
- (b) Ensuring that the project estimates submitted are in accordance with the specifications prescribed from time to time and the designs are sound and economical.
- (c) Proper and expeditious execution of sanctioned projects according to technical sanctions and for carrying out periodical inspections. He is also responsible for ensuring that no departure from Regulations, approved specifications or orders of superior authority is permitted without the approval of the competent authority.
- (d) Economical utilization of resources in manpower and equipments.
- (e) Using funds placed at his disposal in the best.





5. The Chief Engineer may issue appropriate technical and administrative instructions to subordinate formations under his control. He will keep in close touch with the local army and civil authorities.

#### **Task Force Commanders**

6. Task Forces consisting of various type of units are placed at the disposal of Chief Engineers. A part from the execution of works and maintenance services entrusted to them, Commanders Task Forces, are responsible for the due observance of rules and regulations, efficient and economical administration of funds allotted to them and for the proper and up-to-date maintenance of documents and records prescribed in the different procedures.

#### **Core Competencies of BRO**

7. In the last 62 years, BRO has immensely contributed towards nation building by constructing robust road infrastructure in border areas and, in doing so, has paved the way for the social and economic transformation of these areas. The unprecedented success achieved by BRO is a result of its professional work culture, sound technical expertise and devotion to the national cause.

8. The genesis of BRO was to give thrust to road infrastructure in Northern and North-Eastern border areas of the country, while at the same time being a quasi-military force that would continue to perform its tasks during active hostilities under the operational control of the Armed Forces. In the course of its journey, **BRO has delivered much more than just building roads and bridges. The Force distinguished itself in carrying out engineering support tasks in all the wars fought since its raising including the Indian Peace Keeping Operations in Sri Lanka.** Many brave men were recognised for displaying conspicuous bravery and many have laid down their lives in the service of the nation. Quality works executed by BRO with speed and efficiency established the tenacity, endurance and versatility of the organisation and brought immense popularity and rising expectations. BRO soon diversified into other fields of civil engineering works, constructing various types of buildings and allied services, civil amenities and airfields all across the country



including the Andaman & Nicobar Islands. BRO was called upon to execute specific economic, social and administrative infrastructure projects like the construction of the National Highway from Nava Sheva to Panvel, the Container Yard area of Jawaharlal Nehru Port, providing connectivity for the development of coal belts of Bihar, Orissa and Karnataka, construction of roads along the Indira Gandhi Canal in Rajasthan, accommodation for Manipur Police, Navodaya Vidyalaya and hospitals etc. However, after the Kargil War and emerging collusive threats along the Northern borders, BRO had newer responsibilities to shoulder. As a result, the organisation took on fewer projects outside its core competency. Thus, in the last 20 years, the focus of BRO has been on improving the military infrastructure through the construction/ upgradation of roads, bridges, airfields, helipads and tunnels.

### **Core Values**

9. BRO takes pride in having built its edifice on the strength of its core values, which have stood the test of time and mirror its identity, ethos and culture. Even though the organisation envisions a broader role, it reposes its faith in these values to realise the vision and achieve its mission objectives: -

- (a) Take bold decisions.
- (b) Provide freedom to function.
- (c) Nurture junior leadership.
- (d) Execute quality works with speed.
- (e) Ingenuity as a way of life.
- (f) Earn goodwill.
- (g) Respect local culture and the environment.

### **Performance Scan**

10. The last two years have been extremely challenging for the world because of the Covid-19 pandemic. For India, the situation was made more complex due to emerging

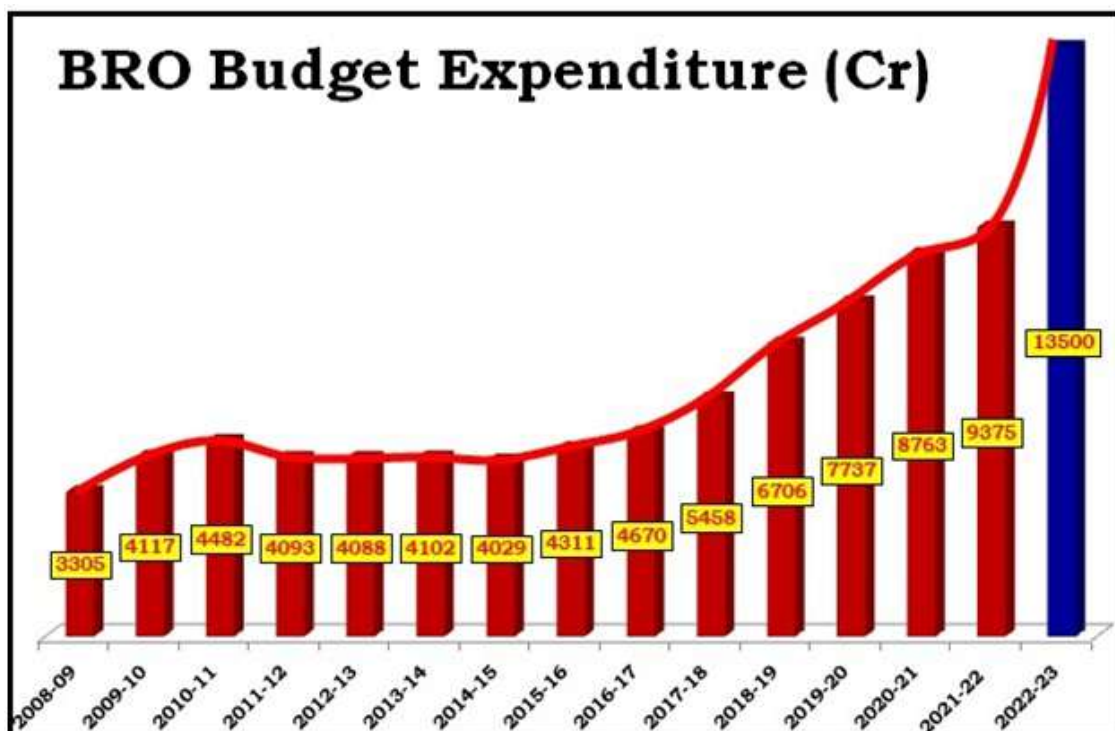


operational contingency on the northern borders. While the country was in lockdown and had to deal with enforced restrictions, BRO had no time to fear the pandemic. It fully complemented the Armed Forces in achieving the desired level of operational preparedness.

11. The operationalisation of Atal Tunnel to connect Manali to Ladakh, strategic road connectivity to DBO and Depsang Plains, early re-opening of Zojila Pass over the last two years, the commencement of work on Sela Tunnel for providing all weather connectivity to Tawang, completion of the highest motorable road over Umling La Pass for strategic connectivity to Demchok, completion of the road to Leipulekh and upgradation work on the Chardham roads are important milestones achieved by BRO.

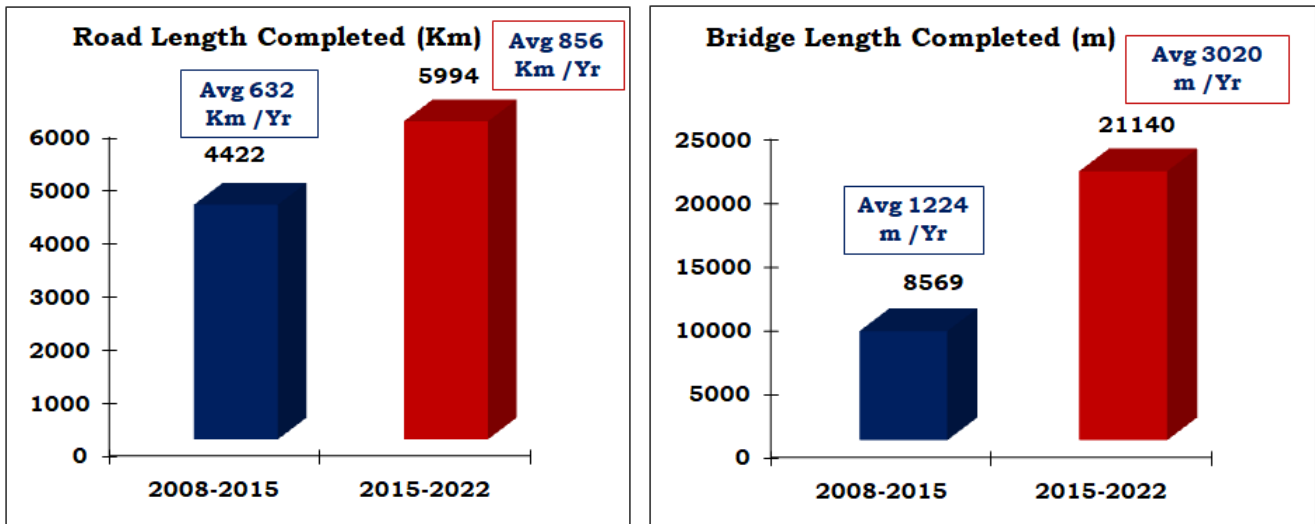
#### Financial Outlay and Growth.

12. In the last 10 years, the financial outlay of BRO has more than doubled from Rs 4,093 Crores to Rs 9,375 Crores, with a **15% steady growth year on year**. In **2022-23**, it is **planned to achieve financial targets of Rs 13,500 Crores**.





13. BRO has constructed 5994 Km of Roads since Apr 2015. These include 33 ICBRs having length of 1467.87 Km and other major strategically important roads having length of 4526.13 Km. A Grand Total of 102 (87 Brs and 15 Rds) Infrastructure Projects were dedicated to the Nation by BRO in 2021.



14. The trajectory of growth and in turn the results delivered are reflective of the existing capacity of the Force. However, to sustain this performance and also play a greater part in fulfilling the strategic needs of the nation envisaged in the previous chapter, existing capacities will have to be optimised and newer capabilities based on infusion of world-class technology and equipment, raising the technical threshold of the workforce, improved working environment and effective organisation structures have to be embraced.

15. Like any other vibrant organisation, BRO too cannot be oblivious to the present and future environmental realities that have markedly influenced its journey thus far and will continue to do so in future. Thus, it is imperative to have a clear understanding of the internal and external environment in which the BRO is operating and will be required to navigate to uphold its relevance and realise its growth avenues.

16. Having made its mark over the last six decades towards nation building, the BRO is now poised to make gigantic leaps into new domains of infrastructure creation. It is



therefore imperative that the organisation undertakes a concerted and focused drive to develop new competencies and enhance its capabilities in the existing domains. State-of-the-art technologies, high quality results and time bound completion of tasks must be the edifice on which all future works need to be premised. In doing so, a SCOT analysis of the organisation is a must to give further direction towards competency and capability building.

### **SCOT Analysis**

17. The four important aspects which make up BRO are its personnel, structures, tasks and technology. The clarity to envision the future will determine the degree of effectiveness and efficacy that an organisation can aspire for, and it is incumbent on the leadership to provide that vision and direction based on a certain set of governing principles.

18. SCOT analysis will assist BRO to find answers to the following questions:-

- (a) How is BRO presently poised?
- (b) What are the expectations of the environment?
- (c) Is BRO geared to meet these expectations?
- (d) What is it that shall bridge the gaps?

### **Strength & Challenges**

19. **Strength.**

- (a) Uniformed and disciplined workforce for departmental execution.
- (b) Strong organisational ethos.
- (c) Wealth of institutional experience.
- (d) Directive style of leadership and delegation of powers at all levels.
- (e) Technically competent junior leaders.
- (f) Institutionalised technical training.
- (g) Presence in remote regions along the borders.
- (h) Endurance, tenacity and versatility.
- (j) Integrated resources and supply chain management.
- (k) Goodwill and popularity amongst locals.



20. **Challenges.**

- (a) Harsh working conditions- terrain and climate.
- (b) Sub-optimal utilisation of departmental resources, at places.
- (c) Antiquated planning processes.
- (d) Time overruns.
- (e) Ensuring quality of work in the face of constrained environment.
- (f) Deficiency of junior leaders and key tradesmen.
- (g) Lack of promotion avenues.
- (h) Unstable family life.

**Opportunities and Threats**

21. **Opportunities.**

- (a) Changing security landscape in India's neighbourhood.
- (b) Government's thrust on socio-economic development and enhanced financial outlays of Central and State Governments towards infrastructure development.
- (c) India's global outreach initiatives.
- (d) Development of technology and equipment in the field of construction and infrastructure development.
- (e) Availability of skilled manpower under the Skill Development Programme.
- (f) Improvement in CI/CT environment.

22. **Threats.**

- (a) Other job opportunities.
- (b) Seeing BRO through the narrow prism of GS roads.
- (c) Rising competition with other Government construction agencies.
- (d) Procedural and bureaucratic delays in land acquisition and environmental clearances.
- (e) Below par performance of contractors.
- (f) Frequent disruptions due to landslides, avalanches, erosion of roads due to rivers and floods, road closure and resultant damages during monsoons and winters.



## Capability Building: Identifying Capability Enhancers

### 23. Maximizing Strengths.

- (a) Strengthen esprit-de-corps and instil a sense of pride in uniform.
- (b) Nurture junior leadership.
- (c) GREF officers and personnel be provided junior, middle and higher levels of leadership and management skills in military and other reputed schools of instruction.
- (d) Provide avenues for growth of technical knowledge through higher studies and exposure to newer technologies in India and abroad.
- (e) Resources and supply chain management to function in mission mode at all times.
- (f) Commanders at all levels to fully exploit their delegation of powers to maximise gains.
- (g) Timely and due recognition of hard work, courage and commitment.
- (h) Always lend a helping hand and assist civil society in distress.

### 24. Overcoming Challenges.

- (a) Cater for the best living amenities and facilities.
- (b) Optimally utilise departmental resources without being restrained by vintage norms. Apply innovative measures in the planning and execution of works to scale up resource availability and works output.
- (c) Harness departmental capability and expertise in RSTC and preparation of DPRs.
- (d) Set up an in-house technical oversight department to monitor the quality of works at all stages of execution.
- (e) Undertake timely recruitment to ensure zero deficiency in authorized manpower. Continue with concerted advertisement and PR campaigns targeted at premier engineering colleges, ITI and skill development centres to attract technically sound and enterprising junior leaders and skilled tradesmen.
- (f) Strive for parity in pay and allowances and promotional avenues of GREF personnel. Extend exposure opportunities through deputations in other similar construction organisations and Indian Armed Forces including Indian Coast



Guard.

(g) GREF officers and personnel to be provided better and assured medical facilities in field as well as in peace. Their families be provided 'Separated Family' facilities along with access to better educational avenues. The rank and file should also be encouraged to enrol their children into Sainik Schools.

25. **Exploiting Opportunities.**

- (a) Ensure world-class maintenance of existing roads.
- (b) Four laning of all NHs in border areas. In doing so, ensure all weather connectivity with tunnels, avalanche mitigation and landslide containment structures. Improve ride quality by constructing tunnels, via-ducts and elevated corridors.
- (c) Connect all district HQs in border areas with double lane highways. Similarly, connect all Brigade headquarters with all-weather NHDL roads.
- (d) Provide last mile NHSL connectivity and construct medium lift helipads for all Platoon defended localities.
- (e) Construction of all-weather four lane 'peripheral border highway' from Rajasthan to Tripura within 50-100 km of IB, LC& LAC.
- (f) Upgrade all existing bridges to Class 70 specifications.
- (g) Construct underground as well as hardened structures for critical, strategic and logistics assets to enhance the overall war waging stamina of the Armed Forces.
- (h) Augment India's soft power projection by construction, reconstruction and rehabilitation works under the umbrella of UN and bilaterally with friendly foreign countries. Such opportunities are galore in Africa, Middle-East, Central Asia and South East Asia.
- (j) Support the Government's technical and economic handshake with



India's neighbours by constructing trans-border economic corridors.

(k) Enhance effectiveness by inducting state-of-the-art world class equipment. Exploit the Information Technology highway to raise work efficiency and optimise overall organisational efficacy.

## 26. **Negating Threats.**

(a) Offer attractive pay, allowances, facilities and terminal benefits to attract technically educated manpower to serve under peculiar service conditions. Create a positive aura of the organisation, instil pride and raise self-esteem through timely recognition in terms of awards and foreign assignments.

(b) Capitalise on the experience and versatility of BRO to diversify its role in the field of infrastructure development. Re-vitalise BRO's commitment to nation building. To affect this diversification, re-structure and re-orient the organisation into specialised units and subunits for roads, bridges, viaducts, tunnels, airfields, building works & civil amenities, pipeline engineering, marine works and disaster mitigation engineering.

(c) Navigate the turf wars with similar construction agencies like NHAI, NHIDCL, and central and state PWDs through healthy competition and develop a distinct culture of discipline, speed, responsiveness, transparency, ethical conduct, unmatched quality, respect for local and environmental norms and post-construction support services.

(d) Establish sound synergy with District & State administration, as also, Ministry of Environment and Forests to expedite land acquisition and environmental clearances.

(e) Optimise use of departmental resources and build up the capability to optimise departmental execution and work through execution contracts.



- (f) Refine and strengthen the contractual processes to deter casual players from participation. Explore possibilities of single tender/ limited tender enquiries on established and reliable agencies for critical works of national and strategic importance. Non-performing contractors are to be prohibited from further participation.
- (g) Landslide containment works, avalanche mitigation & control structures, river training works etc to be integrated into all future road planning at the DPR stage itself. Avoid disaster prone areas by constructing viaducts, elevated corridors, tunnels and long-span bridges.
- (h) Construct tunnels across all passes to ensure all weather connectivity and smooth flow of traffic.



**CAPABILITY DEVELOPMENT IN A NUTSHELL**

<b>Core Competencies</b>	<b>Capability Enhancers</b>	<b>Future Capabilities</b>
<ul style="list-style-type: none"><li>• Roads</li><li>• Bridges</li><li>• Airfields</li><li>• Tunnels</li></ul>	<ul style="list-style-type: none"><li>• Diversification of core competencies - cross domain and multi disciplinary expertise</li><li>• Infusion of modern technology and equipment</li><li>• Raising the technical threshold</li><li>• Responsive organisation structures</li><li>• Synergy and coordination with central and state governments</li></ul>	<ul style="list-style-type: none"><li>• Tunnelling</li><li>• Underground structures</li><li>• Viaducts and long span bridges</li><li>• Airports and Heliports</li></ul>



27. The relevance of BRO in future years will depend on its capability to significantly contribute to fulfilling India's strategic objectives. There are high expectations from the organisation in light of its glorious past and present day performance. To live up to these expectations, BRO will have to re-orient, re-balance, adapt and exert itself to create more opportunities for cementing its relationship with India's growth story. To guide and drive the organisation with an intense sense of purpose and concentrated direction, inspire its workforce to be motivated, focused, productive and foster deeper collaboration and synergy with the beneficiaries of its work, BRO has derived for itself a vision and mission that will symbolise its spirit, culture and ethos over the next 25 years.

#### **Vision**

28. Border Roads Organisation will be the Nation's most reputed, **multifaceted, transnational, modern and premier** infrastructure development organisation committed to meeting the **strategic objectives** of the Nation and rapidly enhancing the Nation's **socio-economic development** through **domestic and global** outreach.

#### **Mission**

29. To meet the **strategic objectives** of the **Nation** through the **creation and maintenance** of **state-of-the-art infrastructure** conforming to **global standards** through **cost effective** resource application.

30. To conform to **globally certified** quality assurance norms and execute **multi-faceted infrastructure projects** in a **time-sensitive** and **cost-efficient** manner.

31. Optimise potential and expertise to undertake infrastructure projects in a **diversified sphere of construction** activity **pan India and overseas**, in accordance with **Politico-Military and Foreign Policy Initiatives**.

32. To remain a **relevant and credible** executing organisation through diversification in scope and deliverables adapting to changing **strategic requirements**



and engineering practices.

33. To remain a **relevant and credible** executing organisation through **diversification in scope** and **deliverables**.

34. To attain leadership in the development, adoption, assimilation and use of **state of the art technology**.

35. To create the environment for **networked, real-time, accuratedecision making** and **project monitoring systems** through optimising use of **information technology and artificial intelligence**.

36. Focus on **core competencies and meritocracy**; ensure the highest level of skill and proficiency in construction activity.

37. To sustain a **sense of values** in the Organisation that will ensure a high level of self-esteem in each individual and immeasurable synergy in the Organisation.

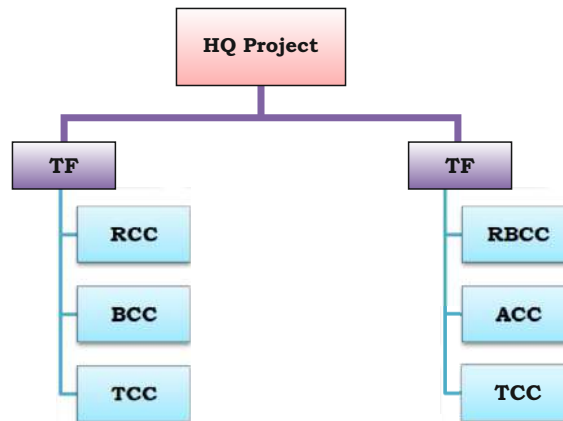
38. To help enrich the **quality of life** of the community and ensure all round growth.

### **Need for Organisational Restructuring**

39. **Specialised Structures.** Future prospects of BRO in evolving as an efficient multi-disciplinary construction agency in line with our Vision goals would necessitate restructuring and would demand creation of specialist structures at the level of Projects and Task Forces. Each Project/Task Force will have to be **tailor made** specifically for the execution of engineering tasks in its area of responsibility. Grouping and re-grouping within a Project or between Projects based on the nature of task will be a norm rather than an exception. To illustrate with an example, a Project deployed in Ladakh and undertaking diversified construction activities like roads, bridges, tunnels & airfields, as can no longer be orbatted with RCC/BCC alone. It will require dedicated entities for each of the above construction fields. Specialised structures on the lines of RCC will have to be created



for carrying out various construction activities like TCC (Tunnel Construction Company), PCC (Pipeline Construction Company), ACC (Airfield Construction Company) etc. A suggested structure of a HQ Project capable of executing multifarious developmental activities is as given below:-



#### Legend

- TF - Task Force
- RCC - Road Construction Company
- BCC - Bridge Construction Company
- TCC - Tunnel Construction Company
- ACC - Airfield Construction Company
- RBCC - Road & Bridge Construction Company

#### Self-Sufficient Platoons.

40. Each specialist construction company will further comprise of self-sufficient platoons capable of working independently and can also be **re-grouped to form composite construction companies**. Such an organisational architecture which augments resources on required basis will ensure flexibility, versatility, mobility, economy in effort and speed of execution.

#### Raising New Projects.

41. New Projects will have to be raised to match the future role and ambitions of the organisation which would include undertaking construction activities in our island territories and also in foreign lands. To support India's global outreach initiatives, BRO



visualises itself playing a major role in post-conflict reconstruction efforts in war-torn countries. Also, the organisation is capable of executing infrastructure development in neighbouring countries contributing to their economic growth.

- (a) **Island Works. Project Yatrik to be re-raised** in Andaman & Nicobar Islands with a dedicated entity for Lakshadweep Islands. The Project was initially raised in 1971 and was closely associated with development of the Andaman & Nicobar Islands for 24 years, which included construction of roads, building works like schools, administrative blocks, living accommodation, radio propagation and research station, satellite earth station, naval airstrips & helipads.
- (b) **BRO Videsh.** Three Projects to be raised for goodwill missions for economic infrastructure development in friendly foreign countries. These Projects to be christened **BRO Videsh I to III** (apart from Bhutan, Afghanistan, Myanmar & Tajikistan). BRO has had a rich experience in executing construction works starting in early 1970s in Ghana, Libya, Yemen and Iraq and was also an integral part of IPKF operations in Sri Lanka.
- (c) **HQ.** The above four Projects to be placed under a newly raised **ADG (Foreign & Islands)**.

### **Optimising Departmental Capacity.**

42. The strength of the organisation to execute infrastructure development works in remote, rugged and challenging terrains lies in its inherent departmental capacities which are a function of both manpower and equipment. Today, BRO has an authorised manpower of 37,994 personnel with an **existing deficiency of 28%** (10,687 personnel across all groups) and hence manning level is being maintained at 72%. While optimisation of manpower is a requirement, drawing parallels between BRO and other Government construction agencies like MES, PWD, NHAI, NHIDCL, etc may not be correct. Works executed by BRO in intense CT/CT environment and during the recent Northern Borders contingency, compounded with COVID lockdowns, would not have been possible without integral departmental capacity.



43. Notwithstanding the above, BRO has already embarked on a healthy combination of works being executed both departmentally and through contract/ EPC mode. The sole aim of such a combined approach is to adequately exploit the competencies now available with the private industry to enhance overall output.

44. Today, given the departmental manpower deficiency of 28%. the ratio of work being executed departmentally and through contract/EPC is 40:60. If the manpower deficiencies are made up, then it will further enhance the departmental work output which would ensure that critical and strategic works are executed with security and speed to meet the operational requirements.

45. Optimisation of departmental resources will be a key focus area as part of organisational restructuring. This will entail embracing new technologies for better efficiency and improving teeth to tail ratio.

(a) **Technology Driving Structures.** To streamline and harmonise the infusion of latest technologies in the organisation it is proposed to set up a '**Design School**', a '**Technology Consultancy Wing**' and **rejuvenate the existing R & D Wing**. It will be the responsibility of these structures to keep abreast with technological advancements, render appropriate advice and organise training in India and aboard.

(b) **Improving Teeth to Tail Ratio.**

(i) **Transit Depots/Camps and Staging Camps.** These sub-units were raised for logistics duties at a time when the logistic supply chain apparatus in country was not robust. With the improvement in road, rail and air networks, the relevance of these structures need a review. Savings in manpower can add to the strength of the core cadre.

(ii) **Base Workshops & Store Division.** There is a case in point to adopt a more efficient model such that workshops and base repairs are integral to Projects/Task Forces. Empowering and strengthening the field workshops, as well as outsourcing to OEMs for in-situ repairs, wherever feasible, will drastically reduce MTTR and associated logistics. Savings in manpower can then be appropriated to raise field workshops and SSTC



with each Task Force.

**(iii) Restructuring of Pioneer Companies.** Pioneer Companies have no independent role to perform and are employed in a piecemeal manner with construction companies. A more efficient arrangement will be to do away with pioneer companies and to **post pioneers on the strength of construction companies.**

**(iv) Integral Medical Cover.** Considering the tiered deployment of various sub units in difficult and isolated locations, it becomes imperative to have integral and echeloned medical cover.

**(v) Review of Non-Core Cadres.** Strength of Non-core cadres to be reviewed and the savings so accrued be utilised to increase the strength of core-cadres including identification of new cadres in light of proposed diversified role of BRO.

### **Study to Review Organisation Restructuring.**

46. A study is proposed to be undertaken under the aegis of MoD to review the restructuring of BRO, including HR policies. Endeavour will be to table the findings and recommendations to the MoD by 01 Jan 2023, with an aim to **affect the re-organisation of BRO by 01 Jan 2024 and complete the exercise by 30 Jun 2025.**

### **Human Resource Development**

47. A well trained, motivated workforce with adequate opportunities for professional growth will deliver results beyond imagination. With changing times, greater attention needs to be paid to the HR aspects of the workforce. In this regard following aspects are to be addressed :-

**(a) Cadre Review.** Undertake a **comprehensive cadre review by 2025** to meet the organisational challenges. Streamline timely completion of all periodical Cadre reviews and amendment of Recruitment Rules through holistic approach as per evolving requirements of the organisation.

**(b) Deputations.** Formulate a policy to ensure **cross attachment of officers and junior engineers** to various organisations including Army, NHAI, NHIDCL, IRCON, Railways, NHPC and other premier organisations for cross domain



experience.

- (c) **Promotional Aspects.** Undertake necessary actions to ensure **timely conduct of DPCs** so that promotions are given to deserving officers and personnel in a time bound manner.
- (d) **Training.** Revise the training policy for GREF as well as Army officers in Border Roads with opportunities for enhancement of qualifications from reputed institutes in India and abroad.
- (e) **Special Skills.** Technological advancements in the field of infrastructure development will require personnel with specialist skills. Recruitment and training to be carried out accordingly.
- (f) **Recruitment.** BRO is presently having huge deficiencies in manpower which is critically affecting its efficiency. Timely recruitment in a transparent and scientific manner will boost the critical strength.
- (g) **Pay and Allowances.** Parity in Pay and allowances of GREF personnel with other Government institutions operating in similar areas especially in high altitude and CI/CT.
- (h) Consider lateral entry of Private and Foreign experts in the Mid and Higher level posts (SE and above) for strengthening the technical, administration and management skills at various levels.
- (j) Creation of new posts for EPC contracts, foreign projects, cyber security, data analysis, AI and ML fields.
- (k) Identification of specialists in various field jobs for effective utilization of human resources to maintain a contented and motivated workforce.
- (l) Discipline, vigilance and legal issues require domain experts to handle complex issues in a more professional manner.

### **Training.**

48. BRO while undertaking diversification and specialist projects needs to overhaul the existing training practices and policies. Training continuum needs to absorb infusion of IT and online training in its curriculum. The focus of training will be on the



following aspects: -

- (a) Creation of a specialised work pool having expertise in EPC, designing of structures, bridging, tunnelling, construction of roads, airfields/ALGs/helipads, project management and implementation, safety measures and disaster management, rescue operations, modern vehicles, equipment and plant in engineering cadre.
- (b) HR specialists and psychological counsellors in administrative cadre.
- (c) Development of management aptitude and re-skilling in all cadres.
- (d) Provision of higher educational opportunities in IIMs, AIIMS and other colleges of national repute for all officers and pursue courses in Foreign Universities/Institutes for all cadres.
- (e) Offer internship programmes to Undergraduate/PostGraduate/Research students from Reputed Institutes/Universities from within and outside the country.
- (f) Engaging Study Groups from reputed consultancies for future HR developments in the Organisation.
- (g) Permanent establishment of an Expert Group/ Think Tank for strategic planning and implementation.
- (h) Memorandum of Understanding (MoU) with reputed Institutes like IITs, IIMs etc for specialised courses to meet the organisational requirements.
- (j) BRES cadre officers to be encouraged to take up courses in Construction Management/Financial and contract management/ MBA/ System Analysis etc.

### **Welfare.**

49. BRO is obliged to look after its highly professional, technically competent and dedicated Karmyogis. In this regard following actions will be taken to address two core issues for better satisfaction levels:-

- (a) **Provision of Accommodation.** Most of the BRO units are located in difficult/ far flung areas with substantial manpower serving in high altitude areas which have basic minimal accommodation while the families stay at respective selected places of residence as negligible separate family accommodation is available. BRO will focus on the following aspects :-



- (i) Ensure carbon neutral, energy efficient and comfortable accommodation for troops as well as CPLs at all levels from RCC upwards.
  - (ii) Adequate family accommodation at various stations for all ranks. Create associated infrastructure for single and married accommodation to enhance the quality of life.
  - (iii) Create adequate separate family accommodation to ensure families are comfortable and children continue their education in good schools while personnel are posted in difficult areas.
  - (iv) A separate unit to be raised like GE (I)/ AGE to focus on maintenance of accommodation works of BRO.
- (b) **Health Care.** Inhospitable working conditions in BRO with minimal medical facilities have adversely impacted the health of its personnel there by impacting individual/organisational efficiency adversely and creating man management issues. Following actions will be taken in this regard:-
- (i) Create sports infrastructure including open gyms at all levels to improve physical fitness standards.
  - (ii) Emphasise on preventive medication including regular medical checks as per laid down norms.
  - (iii) Improved health care facilities by procuring state of the art lifesaving equipment including ambulances at all levels.
  - (iv) Create pool of BFNA trained manpower for first aid and lifesaving.
  - (v) Cashless Medical treatment in government and private hospitals.
  - (vi) Engagement of Psychological counsellors for mental wellbeing of personnel and their dependants.
  - (vii) Improved medical insurance for GREF personnel.
  - (viii) Registration of CPLs in government sponsored insurance schemes.
  - (ix) Employment of Tele medicine services to facilitate reach to remote locations.



## CHAPTER III: TECHNOLOGY AS A CAPABILITY ENABLER

### General

1. Border Roads Organisation conceived primarily as a road building agency in the early sixties, has over the years spread its wings and diversified into a large spectrum of construction and development works comprising road projects, defence works, bridging and tunnelling, airfields and many other areas. The area of responsibility of the BRO encompasses high altitude, mountainous and heavily forested terrain along the country's Northern and Western fronts in addition to the desert terrain of Rajasthan as well as areas in the island territories of Andaman and Nicobar islands.

2. The infrastructure development drive of the BRO has resulted in high quality projects involving construction of roads and tunnels across the Nation's border regions. Having made its mark over the last six decades towards Nation Building, the BRO is now poised to make **gigantic leaps into new domains of infrastructure creation**. It is therefore imperative that the organisation undertakes a concerted and focused drive to develop new competencies and enhance its capabilities in the existing domains. State of the art technology, high quality end results and time bound completion of tasks must be the edifice on which all future works need to be premised on.

### Technological Advancements in Road Construction

3. **Road Construction.** BRO is mostly deployed near IB/LC/LAC which are far flung areas devoid of resources and the units and subunits are mostly located in hilly and high altitude areas (HAA). Over last sixty years by virtue of working in these remote areas BRO has developed mastery in construction of roads in these hilly and high altitude area. Going forward, we need to build on the expertise gained by incorporating lessons learnt so far and adopting modern technologies. In addition, there is a need to understand effects of weather and terrain on East and West Projects separately due to inherent differences and should be addressed accordingly.

4. **Project Execution Capability in Hilly Areas.** Over 75% of BRO's road construction Projects are in hilly areas including high altitude. There is a need to adopt methodology and techniques with good and latest sound engineering practices which will increase the capability of execution in Hilly and high altitude areas. Our aim is also to execute the work with safety and to provide a safe and comfortable journey to the road users.



5. **Challenges of Road Construction in Hilly Areas.** Some of the challenges in construction of roads in hilly and high altitude areas are as follows:-

- (a) Stability against geological disturbances.
- (b) Land degradation, soil erosion and environment concerns.
- (c) Seasonal gushing water flows and need for effective drainage system.
- (d) Road blockage due to land slide in monsoon and due to snowfall in winters.
- (e) Accident due to snow avalanches and landslides.
- (f) Difficulty in maintenance of roads to give a smooth riding surface to road user.
- (g) Difficulty in carrying out hill road survey due to tough hilly terrain and less oxygen in the area.
- (h) Slow setting of cement due to low temperature resulting in less progress in concrete work.

6. **Strategies for Road Construction in Hilly and HAA.** BRO would embrace latest technologies to overcome the challenges of the hilly and HAA to cover various stages of road construction as per details given below:-

(a) **Planning and Survey Stage.** The most important part of any road construction is to carry out proper survey and fix the alignment which will fulfil all the engineering geometrics and other parameters which are required for a good and safe road. To carry out fast, proper and correct survey and prepare a Detailed Project Report (DPR), we must use **advance surveying instruments** viz. LIDAR, DGPS, Reflector Less Total Station (Laser Total Station) which will enhance the capability of our road construction. CARTOSAT Satellite imageries along with advanced road design software like Open Roads, AUTOCAD Civil 3D and other Cartographic software should be used for optimisation of best suited hill road alignments. Some of the emerging technologies in the field of survey for adoption by BRO functionaries are as given below:-

- (i) **Employment of Drones/ UAVs.** Modern drones and UAVs facilitate quick and accurate survey across difficult terrain covering large areas in a short time with minimal human intervention into hazardous environments and combine land surveys, photogrammetry, 3D mapping and topographic surveying to take measurements of desired area.



(ii) **3D Mobile Mapping Systems.** 3D Mobile Mapping Systems are compact mobile devices which scan the environment with either cameras or laser scanners and data sets are geo referenced. The key advantage of these 3D mobile mapping systems is the speed at which they can acquire scan data. They are flexible and allow creation of 3D models from a wide variety of environments.

(iii) **AI Enabled Software.** AI-enabled Software removes manual oversight and allows surveyors to take full advantage of scalable parallelisation of processing using cloud computing to overcome large datasets. Partnered with 5G, the efficiency is further increased. The barrier between the office and the field is eroded and data can be shared as soon as it is captured. Site visits are reduced and remote collaboration made easier.

(iv) **Road Geometrics Design Software.** Road Design Software model-centric approach integrates different data types and disciplines to provide end-to-end detailed road design capabilities thereby reducing highway design time with a complete tool set for survey, drainage, utilities and roadway detailed design in one application. The software produces traditional 2D deliverables and advance 3D modelling. Some of the features in such software are as given below:-

**(aa) Geometric Road and Corridor Design.** Geometric corridor design is a simple and intuitive user interface helps in visualizing the road design in 3D, plan, profile and section views simultaneously.

**(ab) Cross-Section and Template Control.** The cross-section template is an essential building block for corridor design. The template editor allows assembling typical sections using a library of customizable components. It accounts for ditches, pavements, sub-base materials, varying lane width, cut slopes, variable height hill slopes, curbs and side-walks.

**(ac) Culvert Design.** Culverts can also be designed in more detail using multiple alignment functionality.



**(ad) Earthwork Volumes and Costs.** With earthwork costing data, one can get earthwork and material volumes as well as the sub-grade construction costs and design can be adjusted based on cost. Costs can be compared for design alternatives.

**(ae) Watershed and Hydrology Tools.** One can easily determine catchment areas of the TIN model and create corresponding features. The automatic calculation of watershed areas is based on a regular grid. The user can choose the grid cell size. An additional drainage area feature allows users to determine the drainage area associated with a specific point, useful in culvert and bridge design projects.

**(b) Permanent Works Stage.** In permanent works the main component is the use of cement and due to cold climate, there is a delay in the setting of cement which hampers the progress of work. By use of suitable methodology and techniques the progress of permanent works can be increased in the following manner:-

(i) **Use of Precast Material.** Basic problem in hilly and HAA is the setting of cement due to cold weather. Precast blocks, beams, girders etc can be used for the construction of retaining walls, breast walls, culverts, bridges etc so that work can continue even during winter season and be executed very fast which ultimately increases our capability to execute more work.

(ii) **RCC Precast Box Culverts.** Box culverts are used for cross drainage in highways and in storm water drains. Typically, they are cast in-situ. We can use casting machine to manufacture box culverts in sections and supply them to construction sites for easy installation with minimal disruption to traffic. Supply Order for supply of 61 precast culverts has been placed by Project Himank.



(iii) **Precast Concrete Breast Walls.** These are constructed by casting concrete in a reusable wall mould or form which is then cured in a controlled environment, transported to the construction site and lifted into place. The main function of the precast walls is to speed up the construction process.



**Precast Concrete Breast Walls**

(iv) **Pre-cast Trench Drains.** Pre-cast trench drains are made in a factory in large metal forms with a pre-determined channel width, depth and slope. The advantages of pre-cast trench drains are uniform superior quality product, better speed of construction and minimal impact of weather on construction. Pre-cast trench drains made of polymer concrete are even more sturdy and reliable than cast-in-place trenches.



**Precast Drains**



- (v) **Use of Inter Linked Chain (ILC) / Gabion Wall.** ILC / Gabions compactly filled with rocks or soils enable erecting erosion control structures to stabilize steep slopes and prevent erosion at any time of the year. In addition, the carbon footprint of CO<sub>2</sub> emissions from a Gabion wall is 80% lower as compared to a concrete retaining wall of the same height.



**Gabion Wall**

- (c) **Surfacing Work Stage.** Present trend of surfacing work is to start with the preparation of sub-grade and laying of GSB, WMM, Bituminous layer which is not always possible in hilly and HAA regions and areas receiving extensive rainfall, throughout the year. The basic reason behind it is low temperature because bituminous work cannot be executed in winter and laying of GSB, WMM etc is time consuming. Thus, there is a need to adopt other methodologies and techniques which can increase the pace of work manifold so that work can be executed throughout the year. In addition, to further improve the life of bituminous work there is a need to incorporate bitumen with certain additives to strengthen both its quality and life. This can be achieved in the following ways:-

- (i) **Use of Plastic Waste in Bituminous Pavement.** This is one of the innovations that is completely home-developed. As per the process, plastic waste is first shredded and heated at 165°C. This is then added to the bituminous mix, which is also heated at 160°C. This mix is then used



for blacktopping roads. Field performance studies have found the process to be advantageous as the roads constructed using this mix have higher resistance to deformation, increased durability, improved fatigue life and better stability and strength. Moreover, the process is also a way to dispose of plastic waste in a way that is less harmful to environment. BRO has already used this technology in:-

- (aa) Resurfacing of 4.5 Km on Phuentsholing-Thimphu Road under Project Dantak in Bhutan.
- (ab) 2.5 Km resurfacing on Balipara-Charduar-Tawang road under Project Vartak and 1.0 Km resurfacing on Roing-Koronu-Paya road under Project Udayak in Arunachal Pradesh.
- (ac) Resurfacing of 5.22 Km on Hnathial-Sangau-Saiha Road under Project Pushpak in Mizoram.
- (ad) 2.0 Km Resurfacing on Hapoli-Sarli-Huri Road under Project Arunank in Arunachal Pradesh.



**Laying of Bituminous Layer using Plastic Waste on Roing-Koronu-Paya Road in Arunachal Pradesh**

**(ii) Cementitious Sub-Base/Base Courses.** Cement Treated Base (CTB) is a type of soil cement mixture of native soils and or manufactured aggregates with measured amounts of Portland cement and water that hardens after compaction and curing to form a strong, durable, frost resistant paving material. BRO has already constructed large number of roads using this technology in Ladakh, Uttarakhand, Sikkim and Arunachal Pradesh.



**Cementitious Sub-Base/Base Course**

(iii) **Use of Geo Cells.** Cellular Confinement Systems (CCS) or Geo cells are often used to stabilize the material of road sub grade and for lateral distribution of loads to minimize deformations and settlements. The BRO has been utilising Geo Cells in various stretches to increase the elastic modulus of sub base and base courses.



**Road Construction with Geo Cell Technology**



(iv) **Self-Healing Asphalt.** In order to reduce pots and cracking of roads, scientists are developing ingenious and unconventional methods to improve durability. Rather than improving the strength of the road, scientists are focussing on asphalt with the ability to heal itself once damaged. Some of the materials used by scientists around the world in developing self-healing asphalt are as under:-

(aa) **Steel Fibres.** Adding steel fibres to asphalt ensures that once it is worn out and cracks/potholes appear it only needs repair. Iron molecules are heated remotely by introducing a fast-changing magnetic field. Once heated by induction, the steel fibres immediately release heat to the mortar, which melts briefly. This causes the asphalt to reset to its original structure.

(ab) **Iron Oxide Nano-particles.** Iron Oxide Nano-particles in self-healing asphalt heat up upon exposure to a magnetic field. In place of induction machines, maintenance vehicles outfitted with magnetic coils are used to introduce heat that starts the healing process. Once heat is transmitted to the bitumen, it softens and fills the cracks.

(ac) **Capheal: Sunflower Oil Microcapsules.** The method involves inserting sunflower oil microcapsules into asphalt, which reduces the binder's viscosity and helps the asphalt heal. Once tiny cracks appear, the microcapsules burst and soften the asphalt around them and help in binding. This method fixes cracks before they grow.

(v) **Cold Mix Bituminous Emulsion.** Majority of the Indian roads are flexible pavements, where bitumen is used as a common binder. The one major advantage of a flexible pavement is that their surfaces can be milled and recycled during repair and maintenance phase. In India, for decades, Hot Mix Asphalt with bitumen aggregate has been used as Pavement mixes. However, with technological advancement and focus on sustainable development, usage of cold mix bituminous emulsion is picking up pace around the world and in India as well. Some of the major advantages of cold mix bitumen are energy savings, pollution-free environment and safer working conditions for labourers at construction sites as there is no requirement of high temperature while mixing and laying of bitumen.



(vi) **Use of Admixtures.** Admixtures can be used for stabilization of locally available soil which increases bearing capacity of the pavement sub-grade/sub-bases. Stabilised soil can be laid in multiple layers also.

(vii) **Use of Inter Linked Concrete Block (ILCB).** Inter Linked Concrete Block is a viable solution which can be laid throughout the year because it is not affected by temperature. ILCBs have been used by BRO on pavement of roads at mountain passes where heavy snowfall takes place and snow clearance operations by tracked Dozers leads to damages to bituminous layers.



**ILCB Pavement on Balipara-Charduar-Tawang Road (Sela Top) in Arunachal Pradesh**

(viii) **Precast Concrete Pavement.** Precast concrete pavement technology is used for rapid repair and rehabilitation of existing pavements. The technology is suitable in high-volume, congested roadways where lane closures and work windows are constrained.

(ix) **Use Of Plastic Board.** The Plastic Board is manufactured by recycling materials like unwanted plastic, water bottles etc which also saves the environment from plastic hazard. Plastic road is lighter than asphalt road and they are hollow which would make laying pipe work, cable etc underneath them easier. Advantages of Plastic Board are that they are lighter in weight, require less maintenance, durability is three times longer and their use produces less CO<sub>2</sub> than in bituminous road.



**Conceptual Photo of Road Construction with Plastic Board**

(x) **Perpetual Pavement Concept.** The perpetual pavement concept is derived from a mechanistic principle that thickly designed hot mix asphalt pavements with the appropriate material combinations, if properly constructed, will structurally outlive traditional design lives while simultaneously sustaining high traffic volumes/loads. Perpetual pavement is designed and built to last 50 years or more without requiring major structural rehabilitation or reconstruction. With perpetual pavements, the potential for traditional fatigue cracking is reduced and pavement distress is typically confined to the upper layer of the structure. Thus, when surface distress reaches a critical level, an economical solution is to remove and replace the top layer.

(xi) **ROMDAS: Road Measurement Data Acquisition System.** ROMDAS has been developed by Data Collection Ltd. (DCL) as a comprehensive, cost effective and modular system for collecting asset and pavement information. The range and flexibility of ROMDAS systems give users the ability to choose the modules they want, based on the specific types of data, survey environment and budget of their project. Typical applications of the ROMDAS system are:-



(aa) **Road Roughness & Longitudinal Profile.** Roughness is usually the first type of data collected when surveying roads as it gives a good overview of the general condition of the road.

(ab) **Bump Integrator.** The bump integrator is low cost and robust. It is designed for use in tough conditions and unpaved roads where more sensitive laser equipment is not applicable. It is a perfect option for any user needing to collect roughness data on roughness of mixed surface roads.

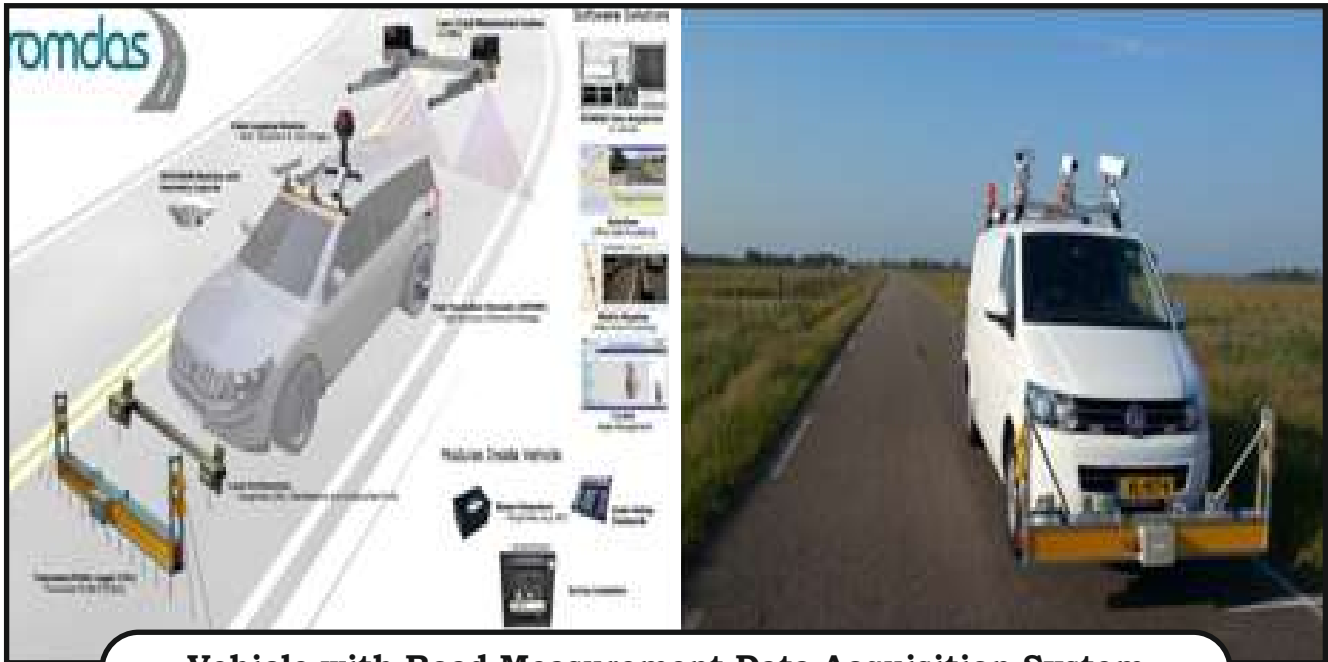
(ac) **Laser Profilometer.** These inertial laser profilers are the modern standard for collecting high-accuracy and repeatable roughness data on good quality roads or highways.

(ad) **Rut Depth and Transverse Profile.** It offers precision LASER sensor equipped Transverse Profile Logger for recording rut depth and transverse profile data. ROMDAS software automatically analyses the profiles to calculate the rut depth in each wheel-path.

(ae) **Video Logging.** Recording images of the road corridor or pavement has been utilized as a quick and permanent reference for office staff. With the advancement of processing software ROMDAS can provide video logging to include features like creating GIS databases using mobile mapping software, recording lists of assets and events referenced to chainage and GPS, crack and defect measurements and image trigger distance for manageable file sizes.

(af) **Road Geometry.** ROMDAS offers an integrated GPS and Inertial Measurement Unit (IMU) to record the geometry of the road at normal traffic speeds. Standard outputs include gradient, cross-slope and radius of curvature.

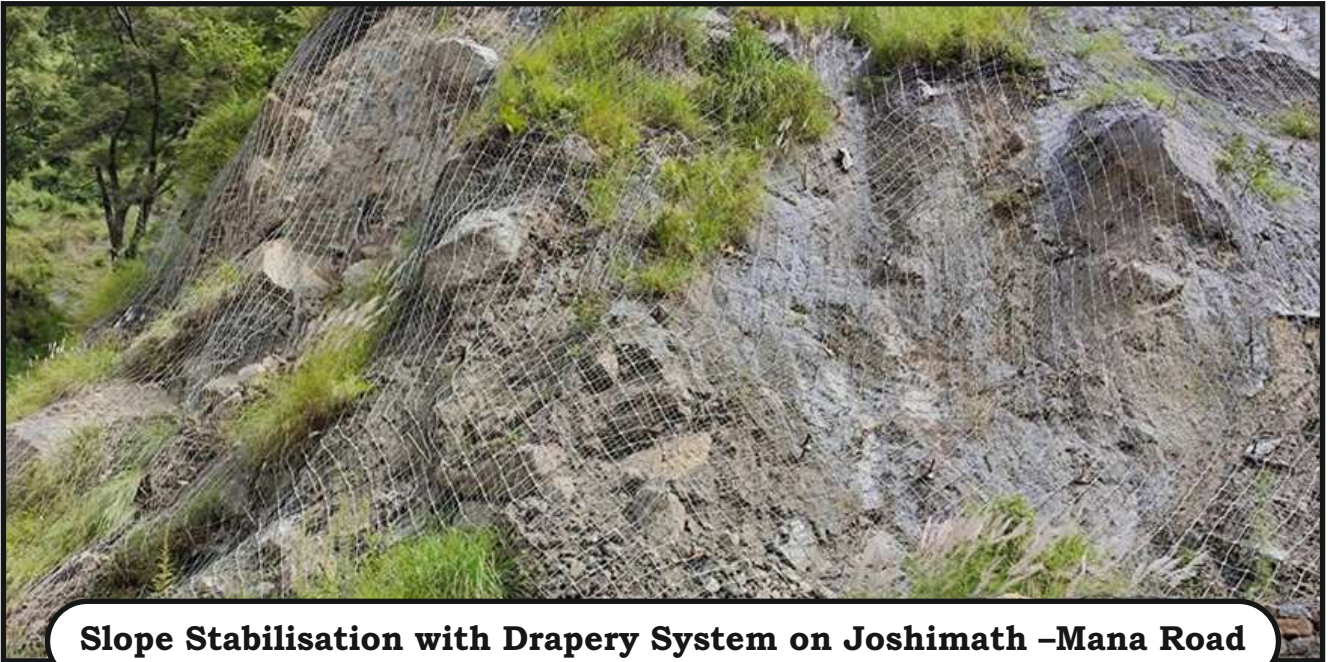
(ag) **Laser Crack Measurement System (LCMS).** The LCMS employs two high powered scanning LASERS and represents the latest developments in the field of data collection systems. Recording extremely detailed 3D profiles of the road surface, the LCMS is able to analyse and calculate a wide variety of pavement data to include cracking (including width, depth, length, type and even sealed cracks), rut depth, width and cross-sectional area, pothole detection, concrete joints and faulting, water pooling depths and pavement images automatically overlaid with defects.



**Vehicle with Road Measurement Data Acquisition System**

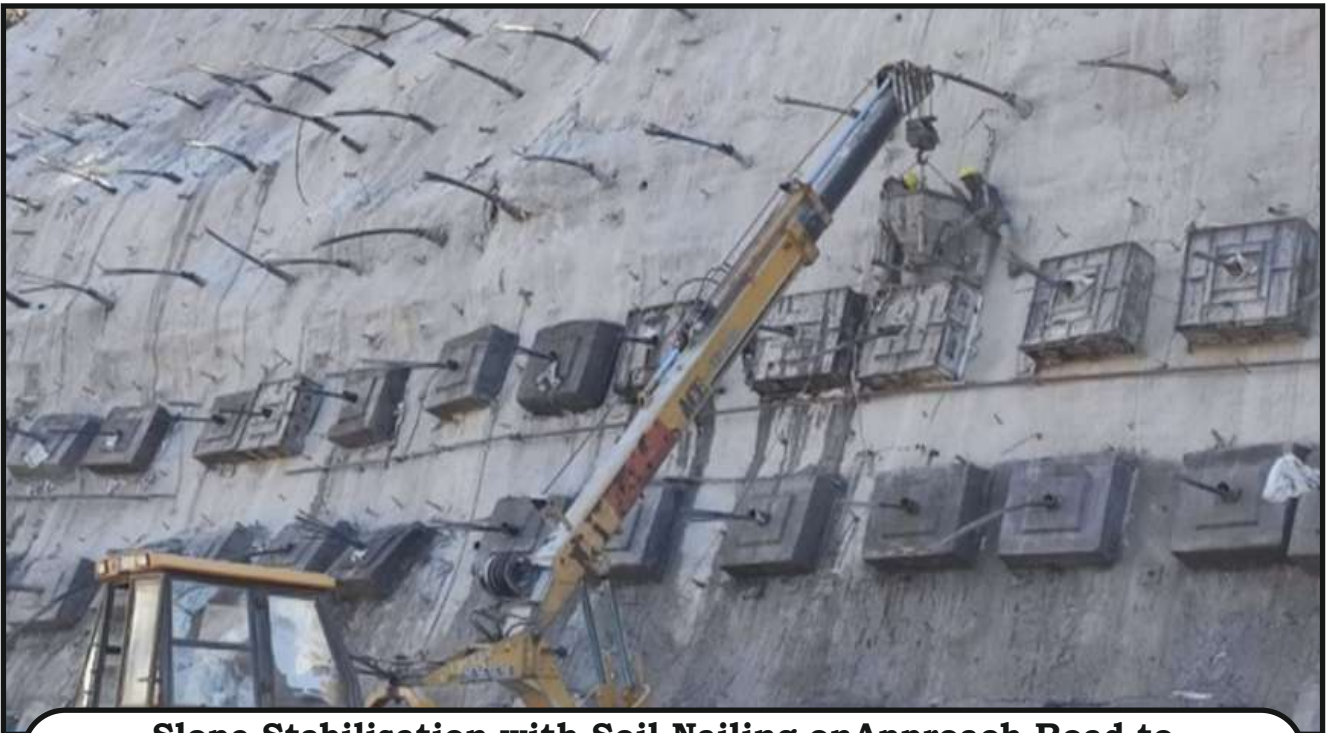
(d) **Landslide Mitigation and Slope Stabilisation.** BRO is constructing and maintaining roads in the most far flung border areas of the nation. Most of these roads are located along the Himalayan Ranges which are a fairly young mountain range and witnesses instability due to tectonic movements, excessive rains and seasonal snowfall. It is due to this geotechnical regime paired with the climatological conditions that most of the roads witness many landslides. A significant number of innovative modern techniques that need to be incorporated for slope stabilisation are as stated below:-

(i) **Drapery System.** These systems help in guiding the falling rocks and control the distance and direction in which the falling rocks travel. They require a debris collection catchment area. Snow load and debris load has to be considered in design. Application is limited to rocks smaller than 1.5m in diameter. The BRO has used Drapery systems in Joshimath – Mana Road in Uttarakhand.



**Slope Stabilisation with Drapery System on Joshimath –Mana Road**

(ii) **Soil Nailing.** It involves reinforcing and strengthening of existing grounds by installing closely spaced steel bars called nails into hill slopes. It can override local weaknesses in the ground through stress redistribution. The BRO has used soil nailing in Approach Road to South Portal of Atal Tunnel in Himachal Pradesh.



**Slope Stabilisation with Soil Nailing on Approach Road to South Portal of Atal Tunnel in Himachal Pradesh.**



(iii) **Geo-Synthetic Mats.** These are three dimensional structures made of Polypropylene, Polythene, Nylon that are used to prevent soil erosion on slopes. These can be integrated with steel mesh increasing the tensile strength of the mat enhancing its erosion protection and shear resistance capacity. The BRO has utilised this technology at various stretches as per the soil stability requirements and soil strata.



**Geo Synthetics at Km 209.50 on Balipara-Charduar-Tawang Road in Arunachal Pradesh**

(iv) **Geo-Grids.** Geo-Grids are soil reinforcement which is used in soil for construction of soil structures at slope angles greater than the soil's angle of repose.

(v) **Jute Geo-Textile.** Jute being a natural fabric, it is biodegradable and environmental friendly. It has good hygroscopic and hydrophilic properties. Jute geo textile laid on slopes provides a cover over soil reducing the probability of soil detachment and at the same time reduces the velocity of surface run-off providing slope stability.



- (vi) **Greening Techniques.** These consist of mulching system and planting long-rooting grass for a reinforced soil system. They increase the stability of slopes and prevent shallow slope failure and erosion.
- (f) **Avalanche Structures and Snow Galleries.** As connectivity improves in higher reaches especially in J&K, Ladakh and Uttarakhand, the pressure of keeping the roads open throughout the year is also increasing. Therefore, requirement of special structures for mitigating the effect of avalanches needs to be explored. Avalanche prone sites need to be documented and necessary structures need to be prepared to avoid any loss of life or infrastructure. A few measures for adoption in this field are as below:-
- (i) **Snow Erodox.** The flexible snow umbrella barrier units are an advanced avalanche protection system used for avalanche control. It is self-stable and has metallic structure with pyramid shape, lesser weight, easy to transport and quick to install.



**Metallic Arresters on Approach Road to South Portal of Atal Tunnel**

- (ii) **Snow Galleries.** A Snow gallery is an exceptional mitigation structure for safe passage on snow avalanche points and slide prone areas. These are constructed on snow bound areas for safety to road users during snow fall, rainfall and other worst climatic conditions.



**Snow Galleries on Approach Road to South Portal of Atal Tunnel**

### **Technological Fillip in Bridge Construction**

7. Construction of bridges is one of the organisation's core competencies, and BRO has gained adequate experience and expertise in this field over the past 60 yrs of its existence. Bridge construction in regions with unforgiving climatic conditions, deep valleys with restricted space, water crossings with steep slopes, peculiar geological features and hydrological parameters of areas coupled with environmental protection aspects has offered many challenges to the organisation which has tested the technical expertise and professional acumen of the Karmyogis. The organisation aspires to embrace the latest technological advancements taking place in the field of Bridge construction and has the vision to be the most professional and technically empowered outfit. BRO in 2047 should have the capability, capacity and competence to undertake the design and construction of complex and challenging structures including long-span bridges and viaducts. Structural health monitoring and maintenance issues will not be restricted to human intervention alone with longer spans and higher structures. BRO should also lead the pack with IoT (Internet-of-Things) enabled and AI-enabled instrumentation systems to keep track of the structural health of all bridges and structures constructed by the organisation.



8. **Integral Bridge Construction Method.** An integral bridge refers to a bridge in which the superstructure and the pier/abutment are integrated and bridges are designed without any expansion joints between spans or between spans and abutments. In addition, there are no bearings as well to transmit force or displacement between the superstructure and substructure. These are structural systems used for long-span bridges constructed with the balanced or free cantilever method. Integrated bridges eliminate problems occurring due to bridge maintenance (absence of bearings and expansion joints) have increased structural efficiency and reduced cost.

9. **Use of New Materials.** Following construction materials are being planned to be incorporated to enhance the bridging capabilities of the BRO.

- (a) Ultra High Performance Concrete (UHPC).
- (b) High performance concrete (HPC).
- (c) Self-compacting concrete (SCC).
- (d) Fibre reinforced concrete (FRC).
- (e) Fibre-reinforced concrete (FRP).
- (f) Self-healing concrete (Also known as smart concrete).

10. **Modular Bridges.** Prefabricated steel modular bridges are an ideal solution to the challenges arising due to site conditions and offer a load class of 70R which would allow unhindered move of strategic assets and other heavy equipment. New technology based on Organic Pre-Stressing System would enable the launching of 125 m single spans with a load class of 70 R. In view of its cost effectiveness and time saving in construction, Border Roads Organisation and Garden Reach Shipbuilders & Engineers (GRSE) Ltd signed a Memorandum of Understanding (MoU) on 15 March 2022 at New Delhi for two-years for fabrication, supply, erection and launching of 27 double lane galvanised modular bridges of 7.5 meters carriageway width with IRC Load Class 70.

11. **Precast Elements for Accelerated Bridge Construction.** The use of prefabricated structural components and the latest design of abutments facilitating pre-casting will be adopted in bridge construction to overcome the peculiarities of terrain and ensure speedy construction.



12. **River Training and Protection Works.** The latest construction technology using Reinforced soil structures, Gabion longitudinal work design, and river/bank slopes stabilization measures would be incorporated in the future in all bridge construction activities.

13. **Rail cum Road Bridges.** To facilitate faster infrastructure development and economic growth in the region the organisation will have to develop the know-how and expertise to undertake the design and construction of Rail cum Road Bridges in the border areas.

14. **Viaducts.** The Viaduct is a specific type of bridge that consists of a series of arches, piers or columns supporting a long-elevated rail or road. The construction of a viaduct is a viable solution to cross large valleys, bypassing the sinking areas thereby reducing the gradient of hill roads. The overall length of the road also gets reduced thus making the project more economical. The construction of Viaducts also reduces formation cutting and avoids ecological disturbances. It also provides a gentle gradient to the road which will enable speedy movement of army vehicles to the border areas. The organisation endeavours to develop the necessary competencies and technological knowledge in the construction of these complex structures.

15. **Long Span Bridges.** BRO has sufficient expertise in the construction of PSC single/multiple span bridges albeit to limited spans. The organisation endeavours to develop technological know-how to undertake the construction of 1000m or even more long-span bridges. Long span bridges have inherent advantages like reduction in overall road length which has its associated advantages of reduced cost of the project and reduced travel time.

16. **Structural Health Monitoring.** BRO would be constructing higher and longer structures, and thus it becomes imperative that technology like sensors and instruments using AI-enabled algorithms/software are deployed for predictive maintenance and structural health monitoring so that timely interventions and decision making can be resorted to leading to a reduction of maintenance cost and preventing any failures. Digital data-driven platforms using advanced analytics and 24x7 monitoring using sensors and IoT-enabled devices will also monitor seismic intensity and ground acceleration.



### **Tunnels: Engineering Marvels**

17. Tunnelling remains an engineering marvel with inherent advantages and its construction for transport routes is becoming increasingly important worldwide. Also, it is more economical than bridges or open cuts (to a certain depth) to carry public utility services like water, sewer and gas. Tunnels avoid disturbing or interfering with surface life and traffic during construction and provide optimum protection for the environment and the landscape. Tunnels permit easy gradient & encourage high speed on strategic routes.

18. BRO has been involved with the construction and maintenance of tunnels for the last few decades. The organisation has in its credit the construction of Atal Tunnel, Theng Tunnel, Sela Tunnel, Nechiphu Tunnel and Chamba Tunnel. These tunnels have been made in the most treacherous and challenging geology. Such conditions necessitate the use of extreme technology and machines. Various techniques used in tunnelling are:-

- (a) Traditional method.
- (b) Cut and Cover Methods.
- (c) Mechanical Drillings.
- (d) Tunnel Boring Machines.
- (e) Drill and Blast.

19. Going forward, BRO will be a leading think tank, repository and a major Tunnelling Agency for the Nation. Experience gained is being documented and filmed. Lessons learned from each of the tunnels constructed so far will be stepping stones for the multi-dimensional and much larger tunnels. BRO will expand the expertise in the current domain and venture into other domains in a time-bound manner, such as:-

**(a) Above Ground Tunnels.** These will be constructed by open cut or cut and cover method. The open cut method often refers to excavation with battered sides such that no lateral support is required. In its simplest form, a trench is excavated, the tunnel structure is built, the trench is backfilled and the surface is restored. Precast tunnel units can also be employed to speed up to construction process. The construction process of the cut and cover method is very similar to that of the open-cut method except that the excavation sides are vertical and temporary support is provided. These include underpasses and subways.

**(b) Tunnels through Mountains.** This is the domain where BRO has



maximum expertise. Tunnels through mountains are built using Drill & Blast Technique or with Tunnel Boring Machine (TBM).

- (i) **Drill and Blast.** This technology is being used in Sela and Nechipu Tunnel Projects which is preferred in Himalayan geology due to its flexibility. BRO will master this method and technology and spearhead tunnelling in North and North-Eastern regions of the Nation and take on many such projects as these will provide uninterrupted round the year connectivity to the most inaccessible parts of India.



**Under Construction Sela Tunnel**

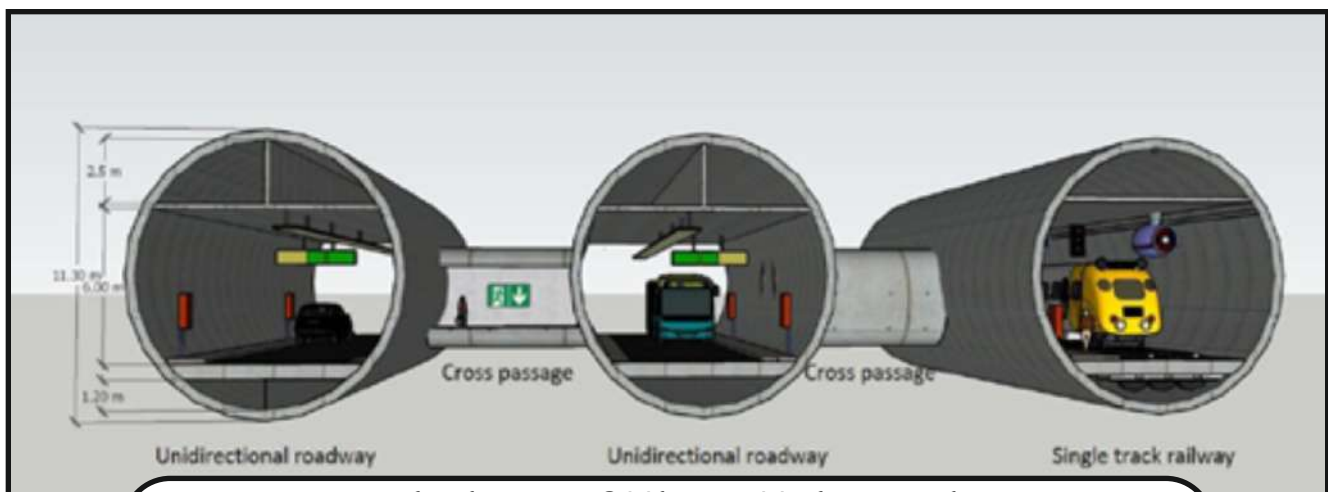


**Under Construction Nechipu Tunnel**



(ii) **TBM.** The technology of tunnelling using TBM is well established and BRO will incorporate this in future projects. The use of TBM technology ensures a faster rate of advance in producing round, smooth and un-shattered bores. In this technique, over break is less than 5%, which is much less than other methods and excavation formation is not weakened by the operation. Hence, less ground support is required. It eliminates the need to work compressed air and the risk of collapse of the excavation face. This method helps in cost reduction for long tunnels (over 2 km).

(c) **Tunnels in Riverine Terrain.** The traditional connectivity across rivers is by bridges. However, near border areas, this may not be the preferred means as they are vulnerable to hostile action by adversaries and are registered targets and can be damaged by air action or missile attacks. In addition, they cannot be concealed during a hot war scenario. Tunnels across rivers present a suitable solution in such situations. BRO has undertaken an onus to resolve such strategic issues and would be executing the construction of a concealed tunnel across the mighty Brahmaputra River, a pioneering feat indeed.



**Conceptual Photo of Three Tube Brahmaputra Rail cum Road Tunnel**



(d) **Marine/ Submerged Tunnels.** Taking a step further, BRO will look forward to going for more complex types of tunnels such as Marine/ Submerged Tunnels or Under Sea Tunnels. A submerged tunnel is a sub-aqueous tunnel constructed by the prefabrication of tunnel units and then submerged and jointed on the seabed. It is usually advantageous to construct a submerged tunnel rather than a bored tunnel below the seabed because a cover of at least 10 m is required for the safe construction of a bored tunnel under the seabed.





## Emerging Technology Specifications for Flexible Pavements

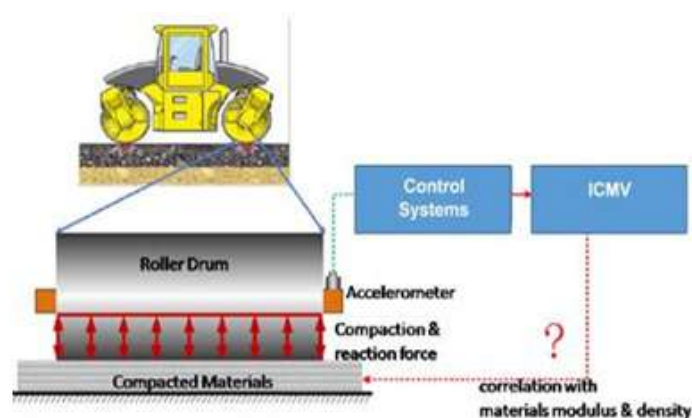
20. Presently, there is a necessity of extending our road network to all types of terrain and environment and switching over to high performance/new/alternate materials and technologies to provide sustainable solutions. To exemplify, bitumen bound layers are normally used in wearing, surfacing, base and binder courses. They may be thick or thin, hot or cold, plant-mixed or site-mixed and so on, but the binding constituent, bitumen has many variants at this time and may include neat or straight run bitumen, cutback bitumen, fluxed bitumen, bitumen emulsion, to name a few. Likewise, there are other options with different materials to be used in different layers of flexible pavements. Some of the promising new technologies are:-

- (a) High performance materials (modified bitumen & multi-grade bitumen).
- (b) Stone matrix asphalt (SMA).
- (c) Warm mix technology.
- (d) Cold bituminous mix and half-warm mix technologies.
- (e) Waste plastic in road construction.
- (f) Self repairing roads.
- (g) Micro surfacing.
- (h) Recycling (RAP in bituminous and granular layers).



21. **Bitumen – Role and Recent Advancements.** Majority of the Indian roads are flexible pavements, where bitumen is used as a common binder. The one major advantage of a flexible pavement is that the surface can be milled and recycled during repair and maintenance phase. In India, for decades Hot Mix Asphalt with bitumen aggregate has been used as a Pavement mix. However, with technological advancement and focus on sustainable development, usage of cold mix bituminous emulsion is picking up pace around the world and in India as well. Some of the major advantages of cold mix bitumen are energy savings, pollution-free environment, safer working conditions for labourers at construction sites, etc. as there is no requirement of high temperature while mixing and laying of bituminous mixes.

22. **Intelligent Compaction Measurement Values (ICMV).** Intelligent compaction (IC) is an equipment-based technology to improve quality control of compaction. IC vibratory rollers are equipped with a high precision global positioning system (GPS), infrared temperature sensors, an accelerometer-based measurement system, and an on-board color-coded display. ICMV is a generic term for a calculated value based on accelerometer measurements on vibratory roller drums. These values are in different forms of metrics with various levels of correlation to compacted material's mechanical and physical properties. The figure below illustrates how ICMV is measured:



Illustrative Image of ICMV



23. However, the complexity of roller material's interaction makes it challenging to produce accurate results and further research is required to enable the use of ICMVs in the road sector. ICMV offers several benefits such as improved depth of compaction, lesser highway repair costs and better density, which would significantly improve the lifecycle cost.

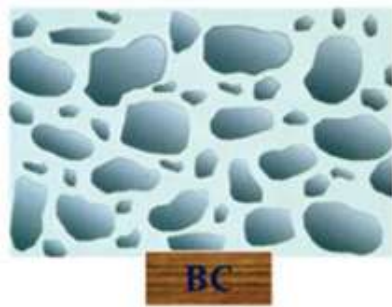
24. **Modified Bitumen.** Though modified bitumen is not a very new concept, the regular usage has been put into practice in recent times only. Certain additives or blend of additives called as bitumen modifiers can improve properties of bitumen and bituminous mixes. Bitumen treated with these modifiers is known as modified bitumen. Modifier can be of the following categories:

- (a) Elastomers
- (b) Plastomers
- (c) Combinations

25. Polymer modified bitumen (PMB)/ crumb rubber modified bitumen (CRMB) should be used according to the specific requirements of the job. The advantages of using modified bitumen are as follows:

- (a) Lower susceptibility to daily and seasonal temperature variations.
- (b) Higher resistance to deformation at high pavement temperature.
- (c) Better age resistance properties.
- (d) Higher fatigue life for mixes.
- (e) Better adhesion between aggregates and binder.
- (f) Prevention of cracking and reflective cracking.

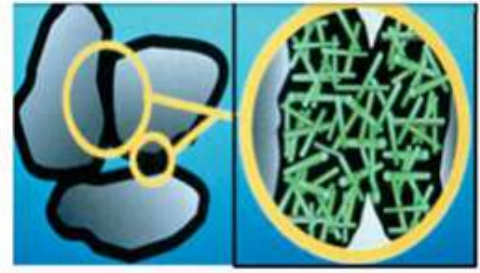
26. **Stone Matrix Asphalt (SMA).** SMA is a gap graded aggregate bitumen mix that maximizes the bitumen content and coarse aggregate fraction. SMA provides a stable stone on stone skeleton that is held together by a rich mixture of bitumen, filler and stabilizing additive. Cellulose fibers prevent draining of excess bitumen and help in forming a matrix to hold the high bitumen in SMA. SMA is a high performance mix for heavy traffic roads prone to rutting.



BC



SMA



Comparison of SMA and BC

27. **Warm Mix Asphalt.** Warm mix technology is an emerging technology, which allows the mixing, lay down, and compaction of bituminous mixes at lower temperatures compared to hot mix. Further, low temperature mixes are classified as Warm Mix Asphalt (WMA) which is produced in the temperature range of 120°C to 135°C and Half Warm Mix Asphalt (HWMA) which is produced in the temperature range of 80°C to 100°C. These technologies have the advantages like:-

- (a) Energy saving.
- (b) Decreased emissions.
- (c) Reduced fuel costs.
- (d) Reduced aging of binder.
- (e) Lower fumes and odor emissions.
- (f) Cool weather paving.
- (g) Compaction aid for stiff mix.
- (h) Extend paving window.
- (j) Generation of carbon credit.

28. Several process have been developed to improve mixture workability allowing lower range temperatures for production. WMA technologies can be classified broadly as those that use water, those that use organic additives or waxes and those that use chemical additives or surfactants.



29. **Microsurfacing.** Microsurfacing is mainly a cold mix technique which uses modified bitumen based emulsion to produce a mix of relatively small sized stone aggregates along with cement filler to produce and lay a thinner surface coat. The technique, however is useful to refresh the surface of an otherwise structurally sound pavement since it cannot provide any additional strength to the structure. It helps to cover very minor undulations and improve skid resistance properties. It is mostly used in urban roads where adding thick layers leads to other problems like need to increasing the heights of footpaths and drainage structures.





30. **Concreting Works in Adverse Climatic Conditions.** Good time management and well thought-through processes are required to successfully complete the project and meet deadlines within the strict schedule. High mountains and a harsh climate – these are challenges for infrastructure construction on the border areas of India where BRO is engaged in road construction activities.

31. For extensive infrastructure projects, resource coordination and time management are crucial. Project management is demanding, as resources must be optimally distributed among the sites to maintain efficiency and productivity, while natural environmental and weather conditions pose a challenge. Concreting in such conditions become a daunting task as the time window available for such works is very limited. Traditionally, concrete cube break tests are the most reliable method to ascertain the strength achieved which is very time consuming in such conditions as sometimes the desired strength to be achieved gets delayed due to effects of weather.

32. **Solution.** By using thermocouples that are cast directly in the structure and connected to a transmitter, the temperature inside the concrete is measured continuously. The data is sent wirelessly to the cloud platform. The softwares automatically calculates maturity and strength based on the historical data and the concrete mix and the strength development process can be followed. The data is accessible from any device, like smart phone, tablet or computer with internet connection via the web portal or app and provides real-time insights into the actual curing status inside the structure for each cast.

33. **Key Benefits.** The following are the key benefits:-

- (a) Easy to use solution
- (b) Real-time data with access from anywhere.
- (c) It ensures that the required strength has been reached while on the other hand, the tough time management for the extensive infrastructure project is met.



34. Permafrost is ground that remains frozen (that is, it stays at a temperature of less than 32°F or 0°C) for more than two years, and in many cases, for hundreds of years. Defined as a ground condition of either soil or rock that remains at or below 0°C for long periods, permafrost is often a very capable foundation but it is very sensitive to changes in thermal conditions. Traditional planning, design, construction and maintenance practices do not always suit permafrost conditions and climate change is adding uncertainty to performance prediction.

35. In India, several cold weather zones exist in Northern and North-Eastern regions of the country where extreme winters with sub-zero temperatures prevail. At such places, more than the traffic load, it is the changing thermal regime of the ground that affects the durability and performance of the bituminous concrete flexible pavements. Bituminous and Cement based construction activities including construction of flexible or rigid pavements for low traffic roads at an altitude of 9000 feet or above undergo different forms of attack from environmental influences such as

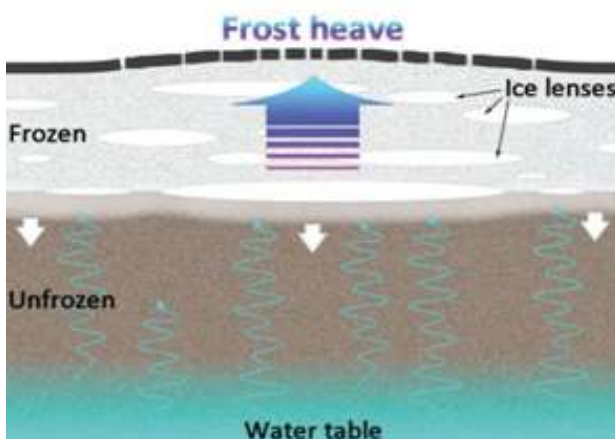


wetting and drying, freezing and thawing. Similarly, extreme temperature variations from acute winter temperature of nearly  $-25^{\circ}\text{C}$  to moderate summer temperature of  $+20^{\circ}\text{C}$ , also significantly alters the thermal regime within the pavement and the ground below it thereby bringing changes in the particle state of the ground. This results in deformations and excessive thermal stresses, which have a detrimental influence on the pavement.



**A Breathtaking view of Kailash Ranges from the Umlingla Pass**

36. Highways damaged by freezing and thawing of permafrost have dips and waves that make a person feel like driving on a rollercoaster. Sinkholes, big cracks in the road or on the shoulders, or pooling water at the bottom of the road or runway embankments get developed. All these can cause problems for travelers and our security forces.



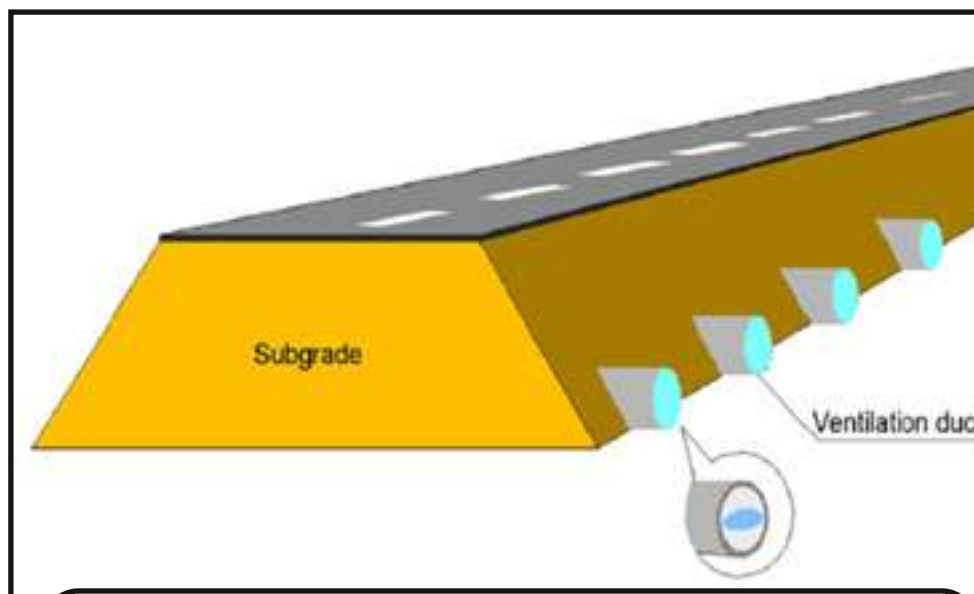


37. The Border Roads Organisation is engaged in construction of roads lying in border areas at high altitudes areas in the Himalayas. Roads across 10 of top 13 Highest Passes in the World are being constructed by BRO. All weather connectivity in these far flung areas is important both from socio-economic and strategic point of view. Several areas lie in permafrost areas where road construction is a mammoth task. Therefore, there is an urgent requirement to adopt innovative technologies which will facilitate construction of stable infrastructure in these areas and withstand the adverse impacts of climate and topography.

### Emerging Technologies

38. Several promising concepts related to the development of transportation infrastructure in permafrost conditions are currently being investigated. These include:

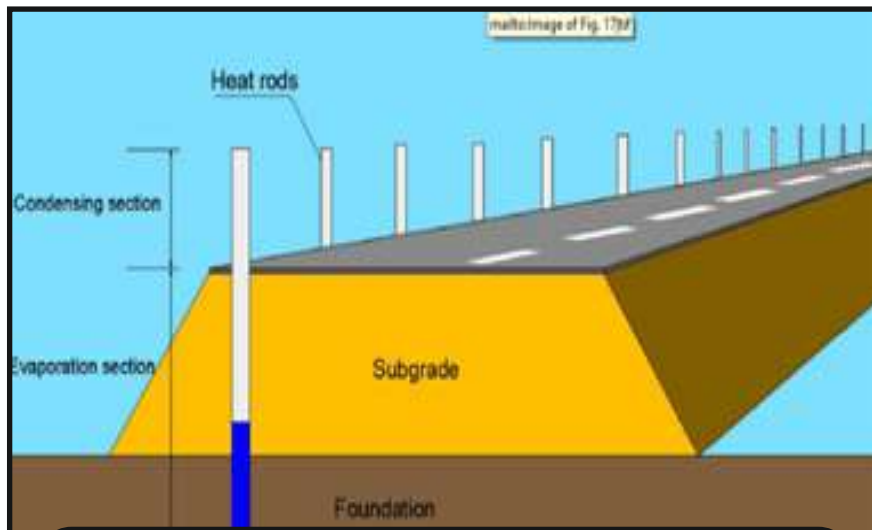
- (a) **Heat Extraction Using Air Convection in Embankments on Permafrost.** This involves cooling embankments in an effort to maintain or cool frozen ground conditions.



**Illustrative Diagram of Heat Extraction**



(b) **Heat Drains.** Snow accumulation on side slopes can lead to permafrost degradation, therefore heat drains have been developed to facilitate heat extraction from the embankment during winter. This method is relatively easy to implement.



**Illustrative Diagram of Heat Extraction**

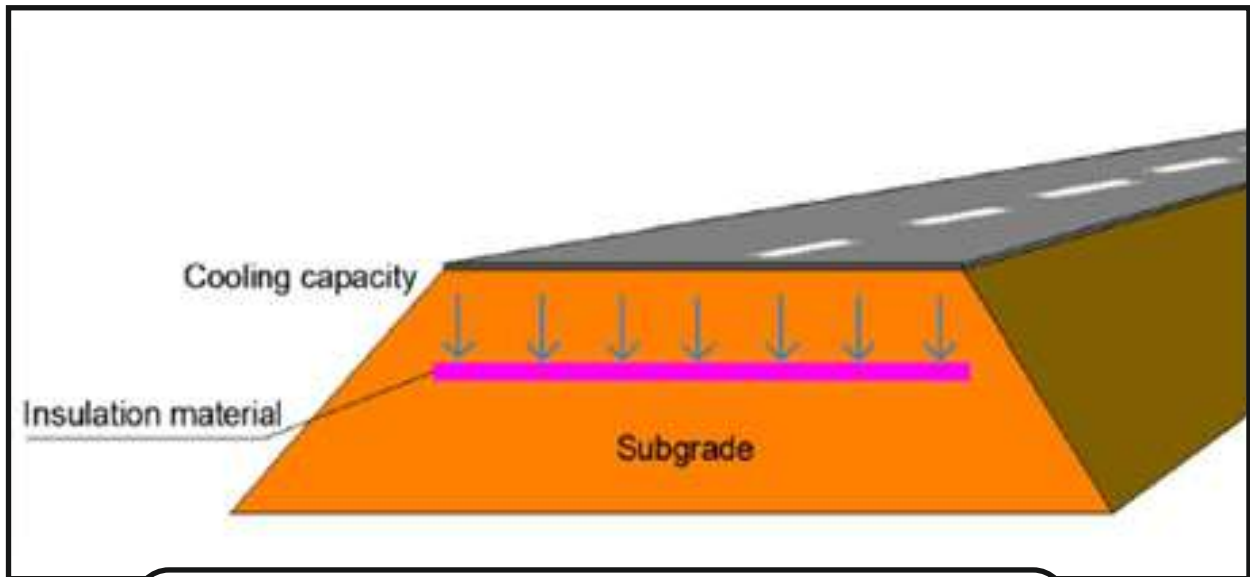
(c) **Ground-Penetrating Radar (GPR).** This technology is being considered for use to determine baseline subsurface conditions for recently constructed gravel roads in permafrost regions as the initial step in performance monitoring programs.



**Representative Image of GPR study in Permafrost**



(d) **Permafrost Insulation.** Insulating the permafrost to mitigate thawing has been shown to be effective. Foamed in place, polyurethane insulation may be a cost effective alternative, with respect to installation and shipping, to rigid board insulation.



**Illustrative Diagram of Permafrost Insulation**

(e) **Soil Stabilization.** In some conditions, soil stabilization has been used to reduce frost action in subgrade soils. Stabilization techniques may be the only alternative when granular or quarry materials are not readily available. Even in sandy environments, geofibres and synthetic fluids for stabilizing marginal soils have been effective.

(f) **Light Coloured Pavement.** Since research has demonstrated that a pavement surface having a high albedo (surface solar reflectivity) minimizes heat transfer to the underlying subgrade, work is being done to develop durable, light coloured pavement for use in permafrost environments. Lightweight cellular concrete products are being considered for the thermal protection of frost-heave susceptible soils under roadways as well as the thermal protection of permafrost.



39. **Subgrade Insulation.** Studies have shown that the insulation material over the subgrade reduces frost penetration into the ground by 50 to 80%, depending upon the insulation material, its thickness and type of soil. This reduces the pressure generated by heaving and thus mitigates damage. Various insulation materials tried in different researches are:-

- (a) XPS.
- (b) Tire Chips.
- (c) Foamed Concrete.
- (d) Foamed Glass Aggregates (FGA).
- (e) Combined Layer of XPS Board & Modified Soil.

40. Although the combined layer has been found to be the most effective insulation method, but as an individual material, the XPS has been found to be the most effective insulation material for subgrades.



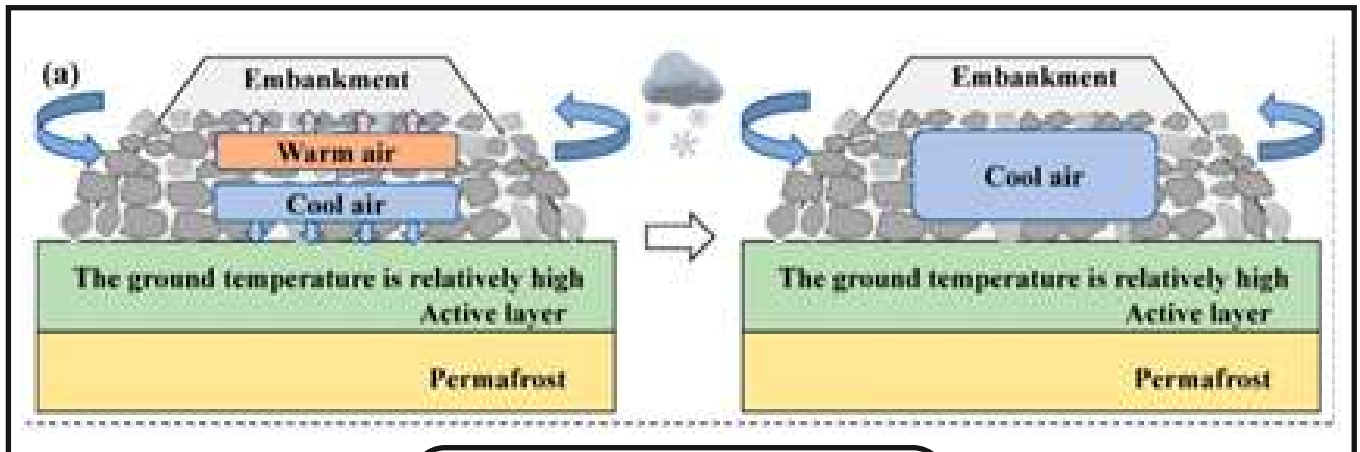
**Insulation with Installation of Foam Board**



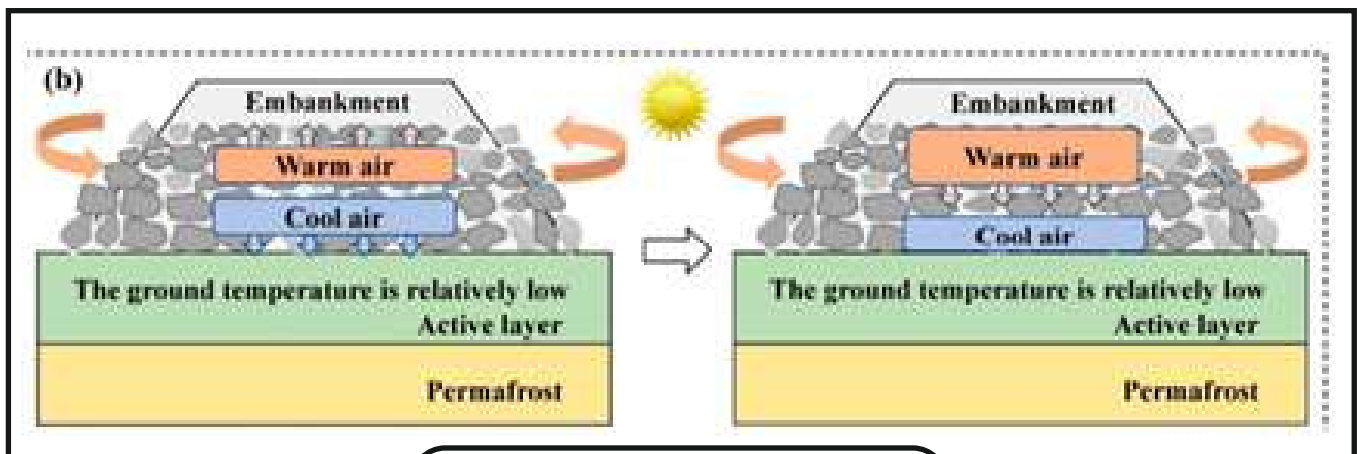
41. **Extruded Poly Styrene (XPS).** The XPS board is a rigid foam sheet having a closed-cell structure and is produced in a fully automated, continuous extrusion process. It is manufactured via an extrusion process where plastic resin and other additives are combined and extruded through a die. The extruded foam then cools and expands into its final shape. High compressive strength, low thermal conductivity, resistance to water vapour diffusion and water absorption, long-term durability under buried conditions, lightweight, easy to handle and non-toxic to the environment makes it an ideal insulating material for pavements.

42. **Thermosiphons.** Thermosiphons are pipes that are installed in the ground that aim to bring down the temperature of the permafrost during the winter so it can better withstand summer warming. In the winter, the air temperature is typically colder than the permafrost. The relatively warm permafrost will vaporize fluid in the pipes (usually ammonia or carbon dioxide) and cause it to rise. This vapor gets colder at the top of the pipe, where it is exposed to cold winter air. That causes it to turn to a cold liquid and drop back down. This process repeats and keeps the permafrost colder than it would otherwise be. Colder permafrost is less likely to thaw when air temperatures increase in the summer.

43. **Air Convecting Embankment (ACE).** Roads or runways built with ACE treatment consist of coarse rock under a thin layer of asphalt and also along the road or runway embankment. The coarse rock allows air between the permafrost and the surface to move around. In the winters, the warmer air around the permafrost rises (just like with thermosiphons), hits the cold asphalt and drops back down. This keeps the permafrost colder than it would be otherwise, which in turn makes it more resilient as temperatures warm in the summer.



(a) Cold Season



(b) Warm Season

**Schematic Diagram of the Working Principle of a Block-Stone Embankment**



## **Information Communication Technology (ICT) as Enabler**

44. Considering the huge volume of data about various construction activities in aspects of planning, execution, budgeting, real-time monitoring being generated, with the requirement of faster dissemination of data for quick decision making, a need is being felt to integrate all the processes and utilize ICT for entire functioning of the organisation for quicker and effective decision making with judicious utilization of resources. Notwithstanding the challenges, the Information Technology (IT) Roadmap of BRO has been in sync with contemporary technologies being used by other government agencies including armed forces and is aligned to the Digital India roadmap. BRO has formalised an IT Roadmap in 2019 incorporating 10 Information Technology projects to be developed during the period 2019-2022. The Roadmap included ongoing and future IT projects and hardware projects leading to effective use of IT in areas such as Works Management, Human Resource Management, Information Security, Training, Stores Management and Office automation. Out of these, the following software have already been completed and are currently in use successfully:-

- (a) Works Management System.
- (b) Digitisation of Road Infrastructure at Border Areas.
- (c) GREF Human Resource Management Suite (GHRMS).
- (d) Recruitment Management System.
- (e) Procurement and Inventory Management System.
- (f) Border Roads Automated Human Resource Management Application (BRAHMA).
- (g) Budget Management System.
- (h) Resource Management System .
- (j) Mail Management System (e-Office).
- (k) Posting Management Software.

In addition following two softwares are under development:-

- (a) Integrated Training Management System (ITMS)
- (b) Smart Performance Appraisal Reporting Recording Online Window (SPPAROW)



- 45 . **Need for Automation.** As on date, BRO does not have its captive communication and data network. It is entirely dependent on MTNL/BSNL and hence, not much of the thrust on automation could be given considering cyber security implications. Now, with a secure link up with the Army communication network, PAN India data connectivity to BRO enables the organisation for rapid automation. Further, the use of Army media will not only be restricted to automation but also be leveraging new-age technologies like Artificial Intelligence, Machine learning, block chains and exploiting its potential. Therefore there is an urgent need to integrate the existing systems and develop new systems. Automated systems and processes in the organisation would align with e-government efforts, optimize utilization of resources, establish transparent systems, modify procedures for faster decision making and enhance responsiveness and accountability.
46. **Objectives.** The role of IT is quintessential in the journey of BRO to shift from traditional methods to SMART methods for achieving the following objectives: -
- (a) **Simple.** Simplification of rules and procedures of BRO making it user friendly.
  - (b) **Maximise** utilization of available resources.
  - (c) **Accountability.** ICT helps to set standards of performance and efficiently measures it.
  - (d) **Responsive.** Efficient service delivery.
  - (e) **Transparent.** The information is available to all stakeholders bringing transparency.

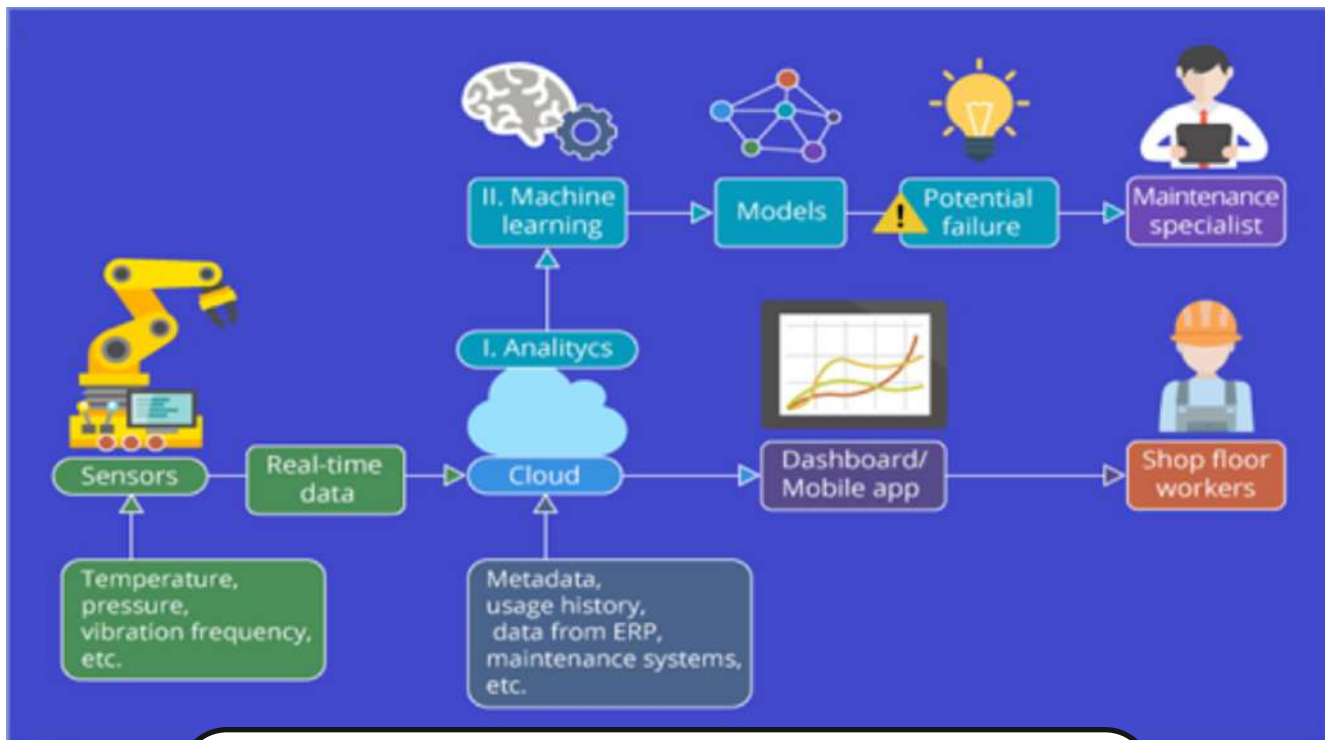
### **Projects in the Pipeline**

25. The Border Roads Organisation has already leaped into new age technologies. The organisation has undertaken steps towards the automation of systems and processes. Projects which the organisation endeavours to implement/has already implemented are as follows:-

- (a) **IoT for Equipment Management.** BRO equipment needs accurate and timely maintenance to ensure serviceability at all times as it impacts the progress of works. IoT based monitoring system with sensors would track various parameters of the vehicle which could be compared with the historical data in the cloud for deviation and an alert can be generated. The Border Road Organisation has already taken the first step toward the incorporation of IoT-based system monitoring. A detailed study is in the process of acquiring software from reputed companies that will be able to

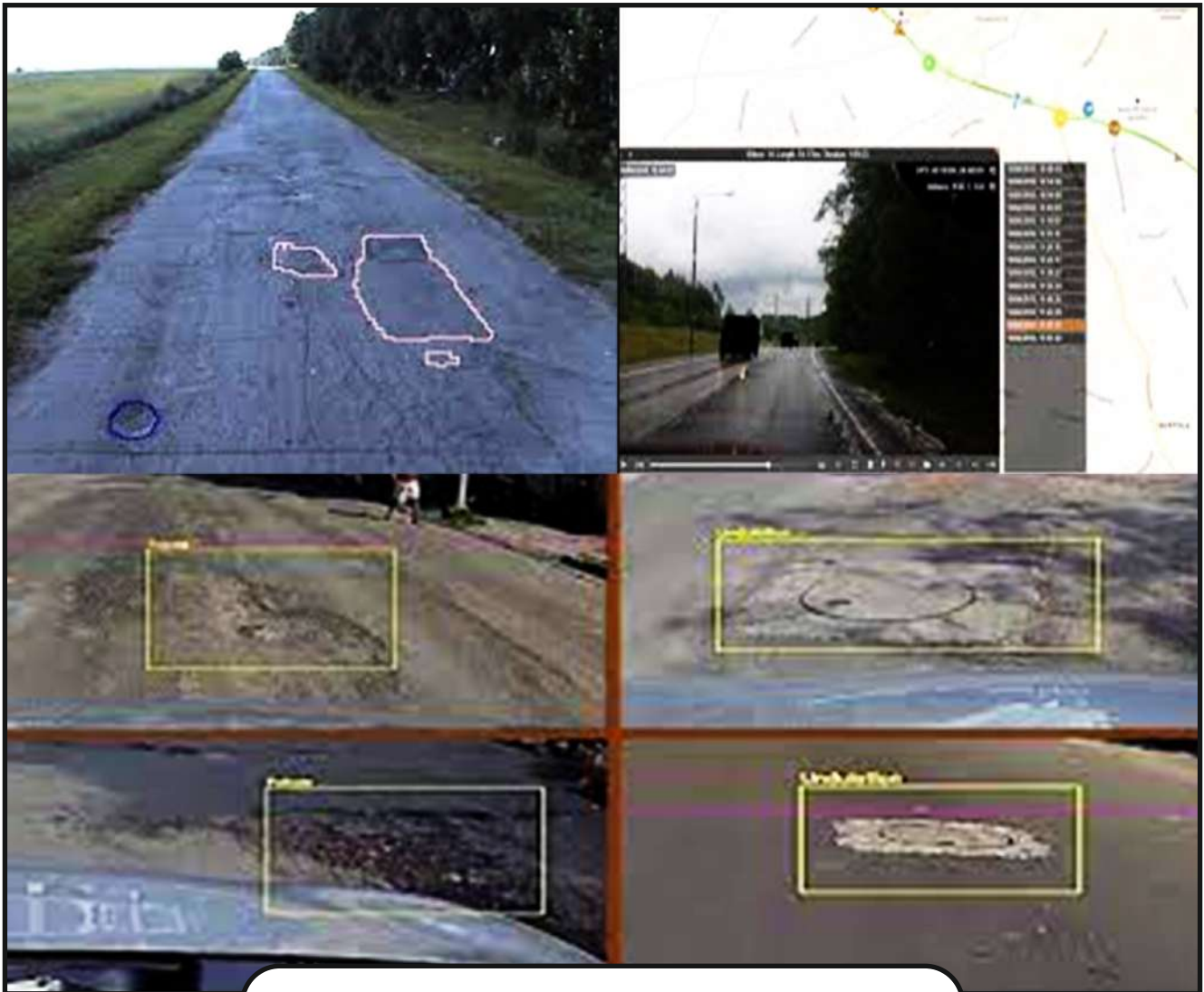


monitor the movement of Vehicles, Dozers, excavators even in a remote location. The introduction of such systems will also have a way for obtaining labelled data sets which will be required for designing Machine Learning models for Border Road Organisation. This will assist in the monitoring of C Vehicles for output and carry out preventive maintenance.



**Real Time Equipment Management System**

(b) **AI Based Road Analysis.** The use of AI-driven models for capturing and analysing road conditions has also been planned. The system combines a user-friendly Artificial Intelligence (AI) technology tool, high-quality video data and reliable methodology to quickly and accurately assess pavement surface conditions up to four times faster and at half the price of a manual road survey. A trial of survey vehicle has also been planned which will collect the road data and will employ very high-grade sensors.



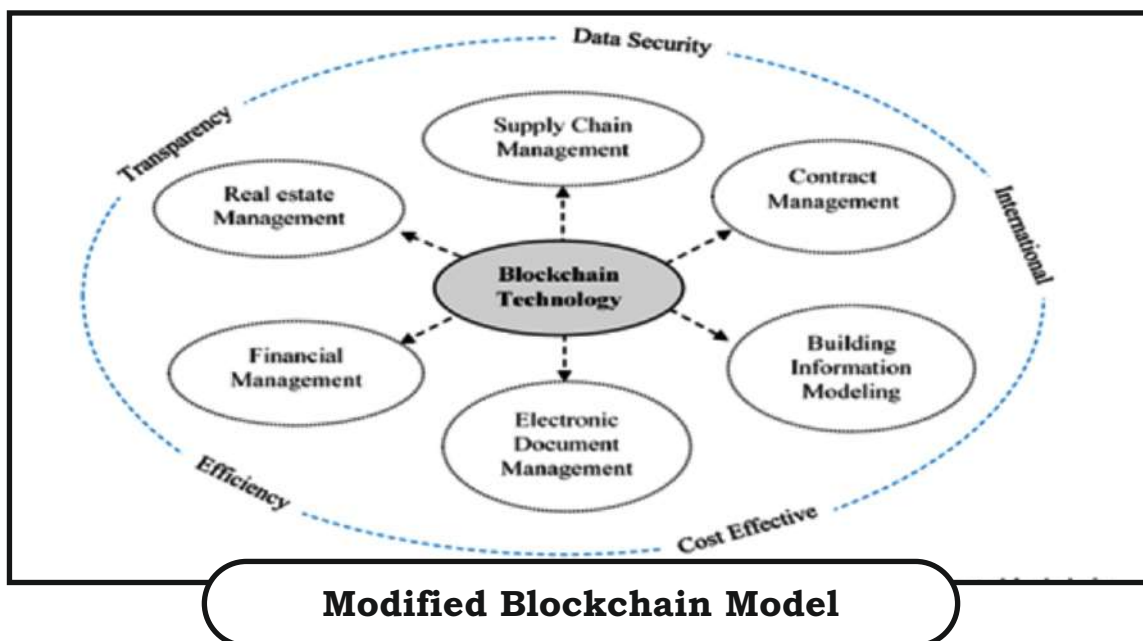
**Identification of Road Defects using AI**

(c) **AI-based Recruitment Management System.** The AI models will be able to do better management of new recruits to the job. Already the system in the BRO has been automated and data will be generated with every recruitment drive. Needless to say, the predictive model can be designed with in-house available data in times to come.

(d) **Facial Recognition System.** Biometric systems are already implemented within the premises. The system has now ensured for accounting of each and every individual and has done away with the system of the traditional headcount. Systems using computer vision and deep learning models are being developed which will be installed at entry locations and it will pick up the faces from a distance resulting in better accountability and monitoring.



- (e) **Resource Optimisation.** AI and ML-driven mechanisms will be incorporated in the future which will be able to find out the quantum of work with each Task Force considering multiple parameters like terrain, climatic conditions, availability of resources and many more. Such models can easily predict the output of task forces and will also suggest transferring of manpower from one sector to another to achieve better speed and efficiency in work.
- (f) **Supply Chain and Convoy Management.** The project is already a subject of research at DRDO and is focussed on Military interests. Such a model will be transposed into the BRO as per the requirement.
- (g) **Block Chain Technology for Construction Management.** Rapid advances in technology are mainly driving transformation in construction and undoubtedly one of the big buzzwords that the technological revolution has birthed is “**Block Chain**”. A block chain system is designed to continuously track updates of digital records and could revolutionize the way that project teams build in the future. Block chain in construction has the potential to be a game-changer.
- (h) **Met Data and Weather Analysis.** BRO envisages collecting and analysing data from multiple sources like SASE, ISRO and NDRF and predicting the weather for the early opening of passes and also to remain responsive and prepared for natural disasters.





### Way Ahead for BRO

48. The Border Road Organisation is already in the process of automating its road and land records. The data which was unlabelled and incomplete is now at an awarded stage of compilation on a GIS platform. The thought process has been aligned toward availability of data for future use. Since the accuracy of AI-based predictive models will depend on the training data i.e., the historical data, hence it becomes imperative that we should plan for data management. The road map of 2047 for BRO has been planned and is as given below:-

Phases	Description	Timeline	Remarks
<b>Phase I</b>	<b>Field Tablet Based System</b> Induction of Field tablet-based system for updating the work progress. The case for development of software has been processed. The executives on ground will be able to update the data even from remote locations.	Jun 2022	The case has already been processed.
	<b>Posting Management System.</b> Deployment of Posting management software for GREF officers, BRAHMA and SPARROW software.	Jun 2022	The work on posting management software is in progress. PI for SPARROW is being expedited from NIC.
	<b>Sensor-Based Monitoring of BRO Resources.</b> Installation of Servers to serve the maps for updating of details from field areas. Deployment of vehicle and equipment monitoring system along with the installation of sensors.	Aug 2022	
<b>Phase II</b>	<b>AI Based Integrated Road Information System</b> The system will employ high-precision sensors including LiDAR technology.	Dec 2022	NCNC trials to be conducted by Dec 2022.
	<b>Internet of Things (IoT) Hub</b> Integrating the equipment with sensors to monitor the progress of various parameters of equipment. The Sensors will be GPS and GPRS enabled. The conceptualization of IoT Hub has commenced.	Jun 2023	The work on details is under progress. Identification of vendors for NCNC trials is under planning.
	<b>Facial Recognition Based Attendance System.</b> Facial recognition based attendance system using computer vision.	Jun 2025	Integration with existing biometric server will be done for centrally monitoring the attendance system. The system will be integrated with the File management system. The system will be implemented up to Project HQ level.



Phases	Description	Timeline	Remarks
	<b>IoT based Maintenance of Specialist Equipment.</b>	Dec 2025	After the conceptualisation of the IoT Hub in Jun 2023, the data repository will be prepared and labelling of data for AI model for maintenance of such equipment will commence along with monitoring of work.
	<b>Machine Learning Model for Optimisation of Workload.</b>	Dec 2025	With the availability of data of WMS, IMS and GIS it will become possible to optimise and transpose resources within various Projects and Task Forces.
	<b>Supply Chain and Convoy Management.</b>	Dec 2025	AI model for specific needs pertaining to BRO will be designed in tandem with convoy management of Army to achieve optimisation of resources.
	<b>Supply Chain and Convoy Management.</b>	Dec 2025	AI model for specific needs pertaining to BRO will be designed in tandem with convoy management of Army to achieve optimisation of resources.
<b>Phase III</b>	<b>Weather Support for Disaster Management.</b> The AI-powered robots will be able to carry out a recce and integrate data pertaining data to ground conditions with servers of ISRO, Mausam online, etc.	Jun 2026	BRO envisages collecting and analysing data from multiple sources like the Meteorological Department, ISRO and NDRF and predicting the weather for the early opening of passes and to be proactive in case of a natural disaster



Phases	Description	Timeline	Remarks
<b>Phase III</b>	<p><b>AI based Budget Allotment and Anomaly Detection.</b></p> <p>The AI-powered robots will be able to carry out a recce and integrate data pertaining data to ground conditions with servers of ISRO, Mausam online, etc.</p>	Jun 2026	The feasibility of establishing such a system is a possibility.
	<p><b>Autonomous Cyber WarfareAI.</b></p> <p>Tools to carry out cyber checks to outperform the black hat hackers.</p>	Jun 2027	The planning for a cyber cell at BRO will be done in near future with a mandated task of cyber security.
	<p><b>AI Powered Specialist Equipment.</b></p> <p>The use of AI-driven vehicles will provide a cutting edge. AI-driven snow ploughs to clear runways have already become a reality.</p>	Dec 2027	AI driven snow cutters and snow ploughs can make an initial way for the deployment of equipment.
<b>Phase IV</b>	<p><b>Construction Management through Block Chain Technology.</b></p> <p>The transparency and accountability will increase many folds with this technology.</p>	Dec 2028	The research in this field is in a rudimentary stage.
<b>Phase V</b>	<p>Incorporation of new Technologies and up-gradation of existing systems as per new IT protocols and World standards.</p>	2030 -2047	IT being a dynamic field, BRO will have to remain alive to the latest developments.





## CHAPTER IV- MODERN VEHICLES/EQUIPMENT AND PLANT

1. Departmental execution of the work is carried out by BRO through its fleet of Vehicles/Equipment/Plant (V/E/P). The organisation holds a variety of V/E/P in large numbers scattered over 18 Projects all along the North-West, North and North-East frontiers of the Country. Inventory of V/E/P makes this organisation self-sustaining and gives an edge over other Government organisations engaged in similar work. Own fleet of V/E/P makes the organisation agile in responding to all contingencies and strategic needs of the country.
2. Modernization of the V/E/P fleet and faster induction of new-age equipment would exponentially enhance the capability of the organisation. The construction industry is experiencing a dynamic era of rapid innovation. As new, creative technologies come on board, manufacturers are improving products and services to ensure better machine uptime, higher machine lifecycle values and unique customer solutions. The important developments in construction equipment technology are given in the following paras.





3. Like drones, operators are controlling equipment from digital cockpits to advance mining projects. Developments in 5G technology bring remote operation of heavy equipment miles down in a mine from a safe above-ground location. This takes humans out of dangerous conditions and helps attract new workers because it's less dangerous.

### **Connected Machines /Telematics**

4. Telematics is one of the key technologies changing the way the construction industry does business. A telematics system can provide machine diagnostics alerts that help prevent downtime, theft, and misuse. The most imminent changes are coming with uptime. Connected machines are sending tons of information that can be used for actionable predictions. For example, knowing a machine will break down enables companies to take them offline for maintenance before a jobsite is unexpectedly thrown to a halt. The big change is that some OEMs are receiving all of this data and filtering it for dealers and customers, sending them only actionable alerts. Manufacturers also send along advanced reporting, created by a team of experts.



**Payload Weighing**

5. Another way that construction equipment continues to advance is through payload weighing, which gives construction agencies the ability to monitor material moved to a worksite. **M/s John Deere** offers an advanced payload scale as well as an embedded payload scale with more limited detail functionality. The payload weighing system measures total bucket loads, trucks loaded, cycle times, and more. Similarly, **M/s Caterpillar** offers onboard weighing systems and real time feedback in the cab. This helps operators hit exact loading targets, see bucket and truck load weights, and track key performance indicators like daily production tonnage, truck load counts, tons/hours, tons/fuel burned, and more. The technology in general can help eliminate trips to the scale, helping to improve productivity and increase operator efficiency, all while driving down costs and creating a safer jobsite.

6. With the aim of improving the pace of construction and automating processes, certain equipment which has been identified is given below, and trials have also been conducted/ planned to be conducted on many of them:-




**(Disclaimer :Images below are purely indicative)**

Ser No	Name of Equipment	Purpose
(a)	<p><b>Heavy Duty Wheel Loader.</b></p> 	<p>Bucket Capacity of <math>\geq 3</math> Cu m. For Site Clearance.</p>



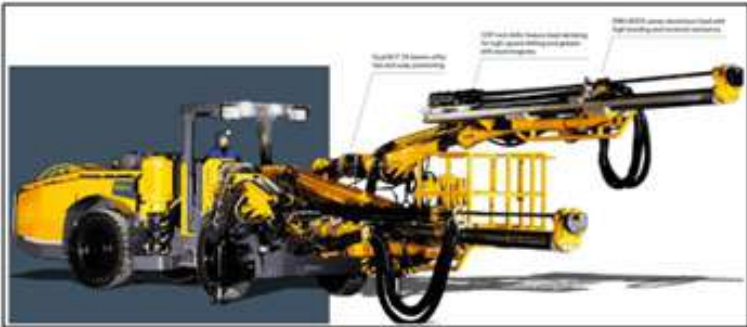


<p>(b)</p>	<p><b>Hydraulic Excavator EX 70/EX 130.</b></p> 	<p>Formation cutting, Site Clearance.</p>
<p>(c)</p>	<p><b>Tele Handler.</b></p> 	<p>Highly manoeuvrable equipment with Telescopic Boom which can be fitted with numerous attachments at its end to enable several operations at extended height or reach with safety and ease.</p>
<p>(d)</p>	<p><b>Self-Loading Concrete Mixer.</b></p> 	<p>Self-Loading Concrete Mixer, with the concrete batch controller, can weigh &amp; load aggregates, cement &amp; water, mix and transport concrete within the site.</p>

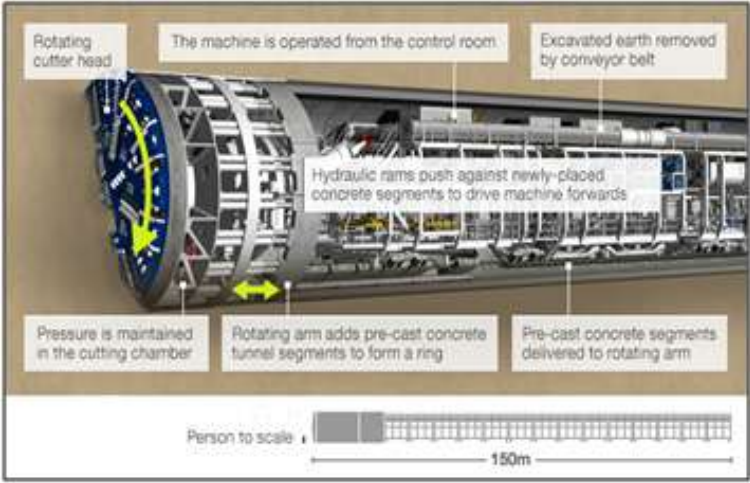




<p>(e) <b>Pothole Repair Machine.</b></p>		<p>Used for swift repairing of cracks, potholes, shoulders, fissures, etc. Automatic, single man operated machine.</p>
<p>(f) <b>Automatic Batching and Mixing Plant.</b></p>		<p>Fully-automatic concrete batching &amp; mixing plant can be used for cold mix and for producing homogenous concrete.</p>
<p>(g) <b>Rock Breaker.</b></p>		<p>In Hard rock regions for breaking large rocks.</p>





<p>(h) <b>Slope Compactors.</b></p>		<p>Compaction of soil on slopes forming embankments in road construction.</p>
<p>(i) <b>Shotcrete Machine.</b></p>		<p>For concreting during Tunnelling and other similar construction.</p>
<p>(j) <b>Boomer Rock Drill.</b></p>		<p>For Tunnel Construction.</p>



<p>(k)</p>	<p><b>Tunnel Boring Machine (TBM).</b></p> 	<p>For tunnel construction.</p>
<p>(l)</p>	<p><b>AI-driven Snow Cutters and Snow Plough.</b></p> 	<p>For snow clearance.</p>
<p>(m)</p>	<p><b>Pavement Preservation Machine.</b></p> 	<p>Mechanical process of applying a protective coating to asphalt-based pavements to provide a layer of protection from the elements i.e. water, oils and UV damage.</p>






<p>(n)</p>	<p><b>Backhoe Loaders.</b></p> 	<p>Equipment provides superior digging, trenching, back-filling and material handling capability.</p>
<p>(o)</p>	<p><b>Road Reclaimers.</b></p> 	<p>Road Reclaimers pulverize the asphalt layer and mix it with the underlying base to stabilize deteriorated roadways. The reclaimers can add asphalt emulsions or other binding agents during pulverization or during a separate mix pass.</p>
<p>(p)</p>	<p><b>Elevating Scrapers.</b></p>	<p>They are self-loading hauling system with the added ability to mix and homogenize material. This equipment also excels in fine finish grading work.</p>






<p>(q)</p>	<p><b>Multi Cut Floor Saw Machine.</b></p> 	<p>For making separating <i>cuts</i> in asphalt and concrete.</p>
<p>(r)</p>	<p><b>Road Marking Vehicle</b></p> 	<p>For road marking as per international standards.</p>
<p>(s)</p>	<p><b>Lidar Drone</b></p> 	<p>For collecting accurate and recent topographic data for highest accuracy topographic information. For providing a transparent view of the site progression throughout the project lifecycle and allows to document and compare the as-built status with the design while tracking resources. For performing volume calculations.</p>





<p>(t)</p>	<p><b>Robotic Total Station</b></p> 	<p>Quick installation processes, accurate, Prism lock, Reflectorless measurement capabilities.</p>
<p>(u)</p>	<p><b>Network Survey Vehicle</b></p> 	<p>For Network surveys for maintenance planning.</p> <p>For Condition surveys on both paved and unpaved roads.</p> <p>For post-construction validation surveys.</p> <p>For asset and inventory surveys</p> <p>For iRAP or other videos based safety inspections.</p> <p>For GIS mapping projects.</p> <p>For Research projects.</p> <p>For Road corridor mobile mapping,</p>
<p>(v)</p>	<p><b>Driller</b></p> 	<p>Useful for Rock Hardness 150 Mps &amp; above, using drill and blast.</p> <p>Recommended hole diameter 51 – 89 mm / 2 – 3.5 inch</p> <p>Excavator requirement : 20 Ton Excavator</p>



<p>(w) <b>Drumcutter</b></p>		<p>Usefull for Soft &amp; Fractured Rock Strata Rock Hardness 20 – 80 Mpa around the site.</p>
<p>(x) <b>Precast Machine</b></p>	 <p>CONCRETE PIPE</p> <p>U DRAIN</p>	<p>Common base machine for all forms Portable Quality Control</p>
<p>(y) <b>Slope Protection- Rock Bolting</b></p>		<p>For Rock Bolting in upto 200 Mpa. Depth of 6 Mtr</p>



<p>(z)</p>	<p><b>Spiral Walking Excavator</b></p> 	<p>Capability to negotiate rugged terrain due to its spider legs.</p> <p>Can negotiate steep slopes 45 degrees to 60 degrees.</p>
<p>(aa)</p>	<p><b>GPS Based Route Guidance System for Snow Clearance</b></p> 	<p>Guides the equipment through the road alignment during snow clearance operations when the alignment of the road is not visible</p>



## CHAPTER V - BRO VIDESH

1. The BRO has been involved in development and maintenance of road network along India's border areas and in friendly foreign countries. The BRO is the only Government Agency in the country which has the inherent capability of undertaking road infrastructure projects through departmental execution which gives it a unique advantage over its competitors. Under the DGBR, the force comprises of officers and personnel of GREF, duly augmented by Army officers and personnel, **thereby giving it a unique character of military resolve and technical acumen.** With all its complement of engineers, administrative, logistical and medical support staff, the BRO is a self-contained, ready to be launched organisation in any theatre or country to further India's interests.

2. BRO, till recently, undertook the entire works departmentally. Since 2016, default mode of execution for projects costing more than Rs. 100 crore (now revised to Rs 150 Crore) has been mandated as EPC mode. This has also resulted in enhanced capacity of BRO to undertake work. At present BRO is undertaking works on roads in LTRoWP and other works entrusted to it by MEA and MoHA. A number of other agencies/ Govt organizations like NHIDCL, NHAI are being assigned works in areas where earlier only BRO used to work. BRO has immense unutilized potential to undertake more works, however budgetary and other considerations for assignment of work limits optimum employment of BRO. This leaves BRO with experienced manpower, resources and equipment to take up the infrastructure works elsewhere in the world.

### **Construction in Friendly Foreign Countries.**

3. Construction works undertaken by BRO in Afghanistan, Myanmar, Bhutan and Tajikistan have endeared the people of these countries and reinforced India as a genuine friend, who believes in mutual respect and prosperity of nations. It is **proposed that BRO be used to extend infrastructure development support to**



**other friendly foreign countries in the Middle East, Central Asia, SE Asia and Africa including through the participation of BRO in the building of trans-national multi-modal economic corridors.**

4. India's aspirations are rising higher with the grand vision of '**SAGAR - Security and Growth for All in the Region**'. BRO intends to play its rightful role and thus effectively bridge the gap between aspirations and the available capability.

#### **UN Missions.**

5. India is a major troop contributing country in various UN missions. Post war or conflict reconstruction is an essential facet of maintaining peace and restoring normalcy. However, the same has remained on a subdued scale as regards deployment in peacekeeping operations is concerned. While Indian Army Engineers have been part of UN missions, their role has been mostly for providing engineering support to peacekeepers. It is in the interest of India to play a more intrinsic role in capacity building infrastructure for post-conflict societies under the UN mandate by undertaking the construction of roads, airfields, helipads, hospitals, schools, water supply schemes and renewable energy projects. It is **proposed that BRO units/sub-units should form part of all UN missions to undertake post-conflict reconstruction and rehabilitation works.**

#### **Pay Offs for Taking up Road and Infrastructure Development Works in Foreign Countries**

6. With its vast expertise and experience, availability of departmental resources, BRO is firmly poised to expand its Area of Interest/ Presence in foreign countries. Participation by BRO in friendly foreign countries will accrue benefits of establishing foot prints overseas/off shore thereby furthering the capability of BRO, enable revenue generation and establishing imprints of 'Atma Nirbhar Bharat' abroad. Further presence of a BRO in friendly foreign countries will further strengthen the diplomatic and strategic ties with India.



7. Some of the advantages of BRO undertaking road infrastructure works in neighbouring friendly foreign countries are summarized as under:-
- (a) Economic. South East and central Asia has a massive and growing need for infrastructure development. There is tremendous potential for cross-border cooperation on connectivity and infrastructure development. BRO's participation in friendly foreign projects will lead to revenue generation and funds inflow in form of foreign currency thereby adding to the economy.
  - (b) Misc. Besides having immense strategic payoffs, by undertaking construction projects in friendly foreign countries, BRO will be able to sharpen its competitive edge by evolving its work methodology incorporating best construction practices. Its personnel deployed in the projects abroad will have an opportunity and exposure to latest construction techniques and equipment thereby improving their technical expertise, knowledge base and supervision skills.

### **DGBR's Visit to Bangladesh**







## CHAPTER VI: OBJECTIVES

1. Border Roads Organisation with a large footprint in the far flung areas is best suited to give shape to the Country's new aspirations by expanding its own expertise and core competencies to support multitude of Government initiatives across various spheres of infrastructure development. It is a Win-Win situation with the amalgamation of the Nation's aspirations and the Organisation's own vision. Above actionable aspects have been quantified in various objectives segregated under proposed umbrella headings.

Type of Project	Objectives
Strategic Infrastructure	<b>Objective 1.</b> Dual Use UG Storage Facilities for Ammunition & Strategic Vehicles/ platforms.
	<b>Objective 2.</b> UG FOL Storage Facilities.
	<b>Objective 3.</b> Execute Operational, Capital and Revenue Works for all three services.
	<b>Objective 4.</b> Capital Work for Strategic Forces.
	<b>Objective 5.</b> Construction of CBRN Infrastructure.
Strengthening Organisation	<b>Objective 6.</b> Strengthening of BRO.
	<b>Objective 7.</b> Enhancement in Financial Capability
	<b>Objective 8.</b> Upgradation of Accommodation
Roads	<b>Objective 9.</b> Road Construction with Upgraded Specifications.
	<b>Objective 10.</b> Road Construction in Hinterland / Coastal Areas



<b>Bridges</b>	<b>Objective 11.</b> Upgradation of Bridges in Border Areas.
<b>Air Infrastructure</b>	<b>Objective 12.</b> Construction of Airfields, ALGs and Helipads with support infrastructure.
	<b>Objective 13.</b> Hardened Aircraft Shelters for Airfields.
<b>Tunnels</b>	<b>Objective 14.</b> Construction of Strategic Tunnels.
<b>Foreign Country Infrastructure Development</b>	<b>Objective 15.</b> BRO Videsh.
	<b>Objective 16.</b> Trans-Border Economic Corridor.
	<b>Objective 17.</b> Participation in UN Missions.
<b>Self-Reliance and Road Safety</b>	<b>Objective 18.</b> Automation.
	<b>Objective 19.</b> Road Safety.
	<b>Objective 20.</b> Self Reliance on Construction.
	<b>Objective 21.</b> Construct 5000 km of Roads using Plastic/Recycled Material.
<b>New Technologies</b>	<b>Objective 22.</b> Induction of New Technologies.
<b>Advanced Equipment</b>	<b>Objective 23.</b> Induction of New Equipment
<b>Facilitating Road Users</b>	<b>Objective 24.</b> BRO Café.

2. **Objective Timelines.** These objectives are proposed to be achieved in three phases with **Short Term** wef 2022- 2030, **Mid Term** wef 2030- 2037 and **Long Term** wef 2037-2047.



## Description of Objectives

### Strategic Infrastructure

3. India has been continually drawing up comprehensive border management plan to keep enemy forces at bay. A well-developed border infrastructure brings in multiple benefits – **economic** and **social well-being** of the local population, as well as **security and military preparedness**. The military preparedness and security benefits are particularly critical in this region given the long-standing border and territorial issues with India's neighbours.

4. In this direction, the organisation is not confining its missions to its present work profile but is going much beyond to include various strategic projects deliverables for strategic forces and sister services too to include **Underground (UG) Storage facilities, Logistics infrastructure, Chemical, Biological, Radiological and Nuclear (CBRN) Infrastructure**.

### Strengthening the Organisation

5. An aspiring organisation needs rock-solid foundation, robust procedures and happy and efficient team. Apropos, it is imperative that the organisation is further galvanised by undertaking innumerable steps as outlined in the objectives below. The entire literature and layers are proposed to be revitalised to strengthen existing ones and further establish strong tentacles to undertake newer tasks. Enhancement of the financial capability is an inescapable objective.

### Roads and Bridges

6. Roads and Bridges are the major components of infrastructure development and has been the strength of the organisation. Since inception, the BRO has made significant progress and technological advancements in this field. Further enhancement and diversification is imperative and an inescapable requirement.



### **Air Infrastructure**

7. Amidst changed behaviour and approach of our adversaries in the border areas in the recent past, it has become essential that the Air Infrastructure is undertaken on a war-footing. BRO has deep connect with the construction of Lines of Communication and proposes to further construct infrastructure for Air Force. Under this initiative, BRO in consultation with Indian Air Force shall undertake construction of Airfields, ALGs and Helipads with support infrastructure and Hardened Aircraft Shelters for Airfields.

### **Tunnels**

8. BRO with its clear vision and defined missions has undertaken innumerable tunnelling projects in view of multitude advantages that Tunnels provide, especially from strategic and defence point of view apart from **allowing rapid and unobstructed transport facilities in border towns and congested cities alike**. Tunnels with inherent nature of saving long term costs are suitable for high population density areas.

### **Foreign Country Infrastructure Development**

9. India's aspirations are rising higher with the grand vision of '**SAGAR - Security and Growth for All in the Region**'. BRO intends to play its rightful role and thus effectively bridge the gap between aspirations and the available capability.

### **Self-Reliance and Road Safety**

10. In keeping with the Government's initiatives for '**Make in India**' and 'Road Safety', the organisation has taken a lead towards '**Atma Nirbharta**' and endeavours to construct roads with zero fatalities.



### **New Technologies**

11. With higher thrust on infrastructure development over the last couple of years, new and emerging technologies are reshaping the dynamics of road construction. BRO has always been in forefront of absorbing new technologies. Despite the remote and inaccessible areas where the BRO is deployed, we have been successful in implementing some of the new technologies across various projects and plan to introduce more advance and indigenous technologies in phases over the next 25 years so as to move further ahead on our path of sustainable development and Atma Nirbharta.

### **Advanced Equipment**

12. Multifold and exponential growth in road infrastructure development in recent years has become possible due to eclectic fusion of latest and innovative equipments. The BRO has taken large number of initiatives to assimilate these new advancements by conducting various NCNC trials in the remotest of areas having difficult terrain and inclement weather conditions. The organisation is constantly making endeavours to adopt and incorporate these new equipments so as to achieve maximum efficiency, output and precision.

### **Facilitating Road Users**

13. A set of major reforms have been undertaken to enhance quality of life with better facilities for living and livelihood that includes physical, social, institutional and economic infrastructure. In this light, concept of BRO Cafés is being proposed by BRO. Such cafes shall not only facilitate local economy & employment but will also help commuters on the roads constructed by BRO. These cafes shall provide Solar Baking, Vehicle Charging Systems and Communication Connectivity Systems. BRO proposes to take few of these initiatives such as Gati Shakti Project to the Border Areas.





## CHAPTER VII- SHORT TERM OBJECTIVES ( 2022-2030)

### Objectives with Timeline Benchmarks

#### Strategic Infrastructure

Quantified objectives are given in following paras.

(a) **Objective 1: Dual Use UG Storage Facilities for Ammunition & Strategic Vehicles/ Platforms.**

(i) **Deliverables by 2030.**

(aa) Prepare a 25 year road map in consultation with all three services of Armed Forces for requirement of underground facilities in forward areas for storage of critical WWR Ammunition.

(ab) Create dual use tunnel / UG infrastructure for protection to strategic platforms in forward areas.

(ac) Commence works on the approved road map starting with highest priority be completed in Phase 1.

(ad) Ammunition Storage Facilities upto Command Level to be completed.

(b) **Objective 2: UG FOL Storage Facilities.**

(i) **Deliverables by 2030.**

(aa) Prepare a road map with all three services and CAPFs in forward areas for creating facilities for storage of FOL (WWR).

(ab) Begin phased construction of these assets.

(c) **Objective 3: Execute Operational, Capital and Revenue Works for All Three Services.**

(i) **Deliverables by 2030.**

(aa) All operational works in forward areas and coastal areas to be executed by BRO for all three services.

(ab) Road works in all forward military stations/ military assets to be undertaken by BRO, where possible.



- (d) **Objective 4: Capital Work for Strategic Forces.**
- (i) **Deliverables by 2030.** Construction of Nuclear Command and Control Centres for Strategic Forces in forward areas by BRO.
- (e) **Objective 5: Construction of CBRN Infrastructure.**
- (i) **Deliverables by 2030.**
- (aa) Prepare road map till 2047 for construction of CBRN facilities for housing and protection of Armed Forces as well as Civilian Population in remote and sensitive forward areas.
- (ab) Make essential CBRN facilities in sensitive forward areas for Armed Forces and assets in a phased manner.

### **Strengthening the Organisation**

- (a) **Objective 6: Strengthening of BRO.**
- (i) **Deliverables by 2030.** Undertake Structured Reorganisation of BRO to undertake an expanded role in infrastructure development to include: -
- (aa) Review role and charter of BRO.
- (ab) Strengthening of Higher BRO Organisation at MoD (BR) & HQ DGBR with coordinating representatives in MHA, MEA and MoRTH.
- (ac) Review Organisation of Projects and Task Forces based on state wise affiliation and work load.
- (ad) Restructure Road Construction Companies for UN Mission.
- (ae) Organise Integrated Task Forces for Foreign Country works.
- (af) Raise HQ for Design & Consultancy, R&D and coordinate technologies & techniques.
- (ag) Upgrade GREF Centre as a Centre of Excellence and construct an Institute for Roads, Bridges, Airfields and Tunnel Construction.
- (ah) Update BR Regulations.
- (b) **Objective 7: Enhancement in Financial Capability.**
- (i) **Deliverables by 2030.** Annual Target Rs 20000 Crs.



(c) **Objective 8: Upgradation of Accommodation.**

(i) **Deliverables by 2030.**

- (aa) Construction of carbon neutral, energy efficient and comfortable accommodation for the BRO Karmyogis.
- (ab) Semi-Permanent accommodation as per authorized plinth area upto Platoon level.
- (ac) Create associated infrastructure to support the single and married accommodation.

**Roads and Bridges**

(a) **Objective 9: Road Construction with Upgraded Specifications.**

(i) **Deliverables by 2030.**

- (aa) All Tehsils in Border States to be connected with NHSL.
- (ab) All District HQ to be connected with NHDL.

(b) **Objective 10: Road Construction in Hinterland / Coastal Areas.**

(i) **Deliverables by 2030.**

- (aa) Road Construction by BRO in the Hinterland to include LWE affected areas.
- (ab) Roads for Seema Suraksha Bal and Paramilitary Forces.
- (ac) Construction of all roads where road differential is present in consultation with Armed Forces.

(c) **Objective 11: Upgradation of Bridges in Border Areas.**

(i) **Deliverables by 2030.**

- (aa) Undertake 100% review of all existing bridges and classify them as either '**Fit for Use**' or '**To be Repaired**' or '**To be Reconstructed**'.
- (ab) Undertake reconstruction / rehabilitation as per the above study.
- (ac) All existing Bailey Bridges to be converted into Permanent Bridges of Cl 70 specifications.
- (ad) All temporary bridges to be Cl 70 Double Lane Modular Bridges.



## **Air Infrastructure**

### **(a) Objective 12: Construction of Airfields, ALGs and Helipads with Ancillaries & Support Infrastructure.**

#### **(i) Deliverables by 2030.**

(aa) Prepare a 25 year road map for speedy and secure deployment of our air assets against any external aggression in consultation with Air Force and Army.

(ab) Plan to include supporting UG/OG infrastructure to support forward operations.

(ac) ALGs should be there at maximum three hours from forward deployed battalion (Helipads in areas where ALGs not possible at maximum one hour distance from forward most posts).

### **(b) Objective 13: Hardened Aircraft Shelters for Airfields.**

#### **(i) Deliverables by 2030.**

(aa) In consultation with Air Force, prepare a plan for construction of aircraft shelters.

(ab) Construct hardened aircraft shelters in all forward airfields within 500kms from the borders.

## **Tunnels**

### **(a) Objective 14: Construction of Strategic Tunnels.**

#### **(i) Deliverables by 2030.**

(aa) Make a 25 year plan for construction of tunnels to enhance connectivity in remote and high altitude mountainous areas.

(ab) Complete Sela Tunnel, Nechipu Tunnel, Brahmaputra Underground Tunnel and Shinkula Tunnel.



## Foreign Country Infrastructure Development

(a) **Objective 15: BRO Videsh.**

(i) **Deliverables by 2030.** Three Projects to be deployed in friendly foreign countries for development of road infrastructure.

(b) **Objective 16: Trans-Border Economic Corridor. BRO intends to be a great facilitator to the diplomatic initiative** designed to promote economic, strategic and cultural relations with the vast Asia-Pacific region at different levels. India's Act East Policy, though initially an economic strategy to boost India's trade and investment relations with the Southeast Asian region has not only expanded its geographical reach to include more countries but has also assumed significant strategic, political dimensions and salience.

(i) **Deliverables by 2030.**

(aa) Prepare a road map in consultation with MEA, MHA and MoD for making an economic corridor that interlinks Myanmar-India-Nepal-Bhutan-Bangladesh.

(ab) Prepare a financial outlay, funding and construction organisation plan for execution of the project.

(c) **Objective 17: UN Missions.** In the past decade, India's presence in UN mission has increased. However the footprint of BRO in these missions is lacking. This means, that in a way, the country is not capitalising on the available resource in the form of BRO to leverage and facilitate all-inclusive diplomacy.

(i) **Deliverables by 2030.** Three Road Construction Companies to be deployed in UN Missions.



### **Self-Reliance and Road Safety**

(a) **Objective 18: Automation.** BRO shall completely automate the existing systems and procedures so as to ensure higher roads construction rates, increased productivity, more efficient use of materials, better product quality, improved road safety and better HR management.

(i) **Deliverables by 2030.**

- (aa) Automation of Work Procedures.
- (ab) Software development & installation for automatic generation of reports & returns.
- (ac) BRO units upto Platoons to be connected by WAN.
  - (i) Paperless office working.
  - (ii) Posting Management.
  - (iii) Inventory Management.
  - (iv) Works Management.
  - (v) Budget Management.
  - (vi) EMB.
- (ad) Automation of BRO Records for Pay & Allowances.
- (ae) Satellite Based Voice & Data Connectivity till Road Construction Company level.
- (af) Induction of Field Tablet based System for work monitoring.
- (ag) Sensor based monitoring of BRO resources.
- (ah) Robust Cyber Network to avoid data pilferages.

(b) **Objective 19: Road Safety.** In light of the fact that the Nation's road casualties are the highest in the world, the importance of Road Safety cannot be undermined. Apropos, the BRO aims to introduce **systematic and formal process for checking road safety aspects** of existing roads and carefully planning new schemes with an objective to minimise road accident occurrence. This initiative shall not only reduce the levels of risks to road users and construction workers but also reduce life cycle cost of design for the impending construction.



(i) **Deliverables by 2030.**

(aa) Dedicated Directorate to look after Road Safety and Quality Assurance.

(ab) Carrying out Road Safety Audit of 100% roads and implement recommendations in a phased manner.

(ac) Complete 25% of roads as Zero Fatality Corridors.

(ad) Convert the existing Centre of Excellence into **Institute of National Repute on Road Safety and Awareness.**

(c) **Objective 20: Self Reliance on Construction Equipment.** At present to keep snow laden roads open throughout the year and undertake tunnelling activities, BRO is dependent on imported machinery. BRO, in this regard, shall reduce this dependence and fully rely on '**Make in India' equipment.** While doing so, it shall maintain an **active interface with the capital goods /auto industry and share operational and technical requirements** with the Indian private industry.

(i) **Deliverables by 2030.** Import of construction equipment to be cut short by 50% of the current procurement.

(d) **Objective 21: Construct 5000 Kms of Roads using Plastic/ Recycled Materials.** Roads constructed from waste plastic facilitate active absorption & utilisation of waste plastic. Apropos, as a responsible road construction agency, BRO shall undertake construction of Plastic-Bitumen Composite roads. These roads shall have better wear resistance than standard asphalt concrete roads. They will be impermeable and have better flexibility resulting in less rutting and less need for repairs. The benefits would be two fold; utilisation of waste plastic and reduced maintenance costs in the long run. This will not only save Capital and Revenue budget, but also result in optimal use of waste plastic which otherwise damages the environment.



(i) **Deliverables by 2030.**

- (aa) Prepare a Road Map of constructing roads using waste material / plastic.
- (ab) Prepare a plan of constructing 2500 kms of such roads in border areas.
- (ac) Construct 500 kms of roads using new technology of recycling.

**New Technologies**

(a) **Objective 22: Induction of New Technology.** In line with its own vision, BRO aspires to upgrade to the latest trends and strives to induct newest technologies. BRO shall endeavour to implement various modelling and monitoring systems in addition to optimal use of satellite data and AI tools.

(i) **Deliverables by 2030.**

- (aa) Implementation of Building Information Modelling for design, execution and operation/ maintenance of roads, bridges and tunnels.
- (ab) Implementation of Field Table based Integrated System for Works Monitoring upto Project Level.
- (ac) Implementation of Microsurfacing in place of traditional resurfacing layer as renewal course.
- (ad) Introduction of concept of Perpetual Pavement in BRO and trial construction of one road.
- (ae) Start of study and preparation of frame work for road construction in permafrost areas.
- (af) Prepare a roadmap for undertaking construction of SMA and Porous pavements in BRO.
- (ag) Construct Avalanche Protection Structures on vulnerable locations on roads above 1400 ft. destabilized locations on important roads.
- (ah) Construct Cut and Fill tunnels/ slope stabilisation measures at destabilized locations on important roads.
- (ai) BRO to start using modified bitumen so as to increase the strength and durability of the pavement.

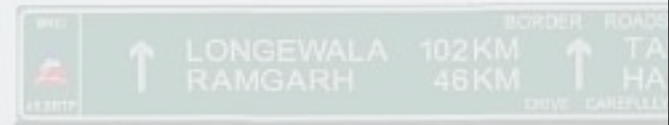


### Advanced Equipment

- (a) **Objective 23: Induction of New Equipment.** In line with its own vision, BRO aspires to upgrade to the latest equipments which could increase the output and provide safety to the men in adverse conditions.
- (i) **Deliverables by 2030.**
- (aa) Modernisation of ageing fleet of equipments so as to reduce the downtime and increase the output.
  - (ab) Induct machineries like heavy duty wheel loaders, Tele Handlers, Self Loading concrete mixers etc. for accelerating the pace of works.
  - (ac) Concept of Intelligent compaction Measurement Values (ICMV) to be introduced in BRO roads.
  - (ad) Introduction of departmental Tunnel Boring Machine.
  - (ae) Introduction of Spider Leg Excavator.
  - (af) Introduction of GPS based Route Guidance System for snow clearance operations.

### Facilitating Road Users

- (a) **Objective 24: BRO Cafés.**
- (i) **Deliverables by 2030.** Construction of 75 BRO Cafés in forward areas to be completed in Phase 1 with development of State-of-the-Art facilities like Solar Baking, Vehicle Charging Systems, Communication Connectivity etc.





## CHAPTER VIII - MID TERM OBJECTIVES ( 2030-2037)

### Objectives with Timeline Benchmarks

#### Strategic Infrastructure

(a) **Objective 1: Dual Use UG Storage Facilities for Ammunition & Strategic Vehicles/ Platforms.**

(i) **Deliverables by 2037.**

(aa) Construct dual use infrastructure in forward areas as per the road map.

(ab) All Ammunition Storage Facilities till the Corps level to be completed.

(b) **Objective 2: UG FOL Storage Facilities.**

(i) **Deliverables by 2037.** Continue execution and construction of storage facilities for all three services CAPFs in forward area.

(c) **Objective 3: Execute Operational, Capital and Revenue Works for All Three Services.**

(i) **Deliverables by 2037.** All works to include construction of infrastructure in border areas where MES cover is either not present or not effective, BRO to take over all works in these forward areas & to be executed by their Projects.

(d) **Objective 4: Capital Work for Strategic Forces.**

(i) **Deliverables by 2037.** To graduate from Road infrastructure to hospitals, major buildings and ancillary structures for Strategic Forces in forward areas by BRO.

(e) **Objective 5: Construction of CBRN Infrastructure.**

(i) **Deliverables by 2037.** Undertake phased construction of CBRN facilities all along the Northern Border sensitive areas and also along the Western Borders.



### **Strengthening the Organisation.**

- (a) **Objective 6: Strengthening of BRO.**
  - (i) **Deliverables by 2037.**
    - (aa) Undertake tasks as per reformed charter.
    - (ab) Continue with incorporating changes in organisation to meet environment requirements and greater role.
- (b) **Objective 7: Enhancement in Financial Capability.**
  - (i) **Deliverables by 2037.** Annual Target Rs 50000 Crs.
- (c) **Objective 8: Upgradation of Accommodation.**
  - (i) **Deliverables by 2037.**
    - (aa) Permanent accommodation for all officers & personnel upto Task Force level as per authorized scales of accommodation.
    - (ab) Portable Sewage Treatment Plants for all detachments of BRO.

### **Roads and Bridges**

- (a) **Objective 9: Road Construction with Upgraded Specifications.**
  - (i) **Deliverables by 2037**
    - (aa) All forward locations to be connected with NHSL.
    - (ab) All Tehsil Roads to have NHDL.
- (b) **Objective 10: Road Construction in Hinterland / Coastal Areas.**
  - (i) **Deliverables by 2037**
    - (aa) Construction of Coastal Highways.
    - (ab) Construction of approach roads for Railways, Inland waterways, Airports and Ports by BRO under Project Gati Shakti.
- (c) **Objective 11: Upgradation of Bridges in Border Areas.**
  - (i) **Deliverables by 2037.** Next phase of temporary bridges to be converted in CI 70 Modular Bridges.



## Air Infrastructure

### (a) **Objective 12: Construction of Airfields, ALGs and Helipads with Ancillaries & Support Infrastructure.**

#### (ii) **Deliverables by 2037.**

(aa) Continue to create these assets and reinforce the air infrastructure in forward areas.

(ab) Make state-of-the-art, all weather airfields to connect remote areas.

(ac) Construct black top helipads to support operations and Cubby Hole Bunkers (CHB) with roof for Heli-protection and support infrastructure.

### (b) **Objective 13: Hardened Aircraft Shelters for Airfields.**

(i) **Deliverables by 2037.** Construct hardened aircraft shelters for airfields within 300 kms from the borders.

## Tunnels

### (a) **Objective 14: Construction of Strategic Tunnels**

(i) **Deliverables by 2037.** All Passes above 12000 feet and in slide prone areas to have an alternate connectivity by tunnels.

## Foreign Country Infrastructure Development

### (a) **Objective 15: BRO Videsh.**

(i) **Deliverables by 2037.** Undertake airfield infrastructure projects in friendly foreign countries.

### (b) **Objective 16: Trans-Border Economic Corridor.**

#### (i) **Deliverables by 2037.**

(aa) Four Projects of BRO to be reassigned for raising Joint Task Forces to coordinate works, share expertise and execute the projects in their respective areas using each other's resources and technical expertise.

(ab) Complete phased execution of the projects.



(c) **Objective 17: UN Missions.**

- (i) **Deliverables by 2037.** Five Road Construction Companies to be deployed in UN Missions.

**Technology, Self-Reliance and Road Safety**

(a) **Objective 18: Automation.**

(i) **Deliverables by 2037.**

(aa) Completion and execution of Road Assets Management System.

(ab) Map all the roads including Road geometry, planning post construction maintenance management, visualisation of road conditions and forecasting works requirement.

(b) **Objective 19: Road Safety.**

(i) **Deliverables by 2037.**

(aa) Undertake consultancy contracts for Road Safety and audit of roads other than that of BRO.

(ab) Completed execution of Road Safety Works as part of Zero Fatality Corridors.

(c) **Objective 20: Self Reliance on Construction Equipment.**

(i) **Deliverables by 2037.**

(aa) 100% reliance on 'Make in India' equipment.

(ab) No construction equipment to be imported.

(d) **Objective 21: Construct 5000 Kms of Roads using Plastic/ Recycled Materials.**

- (i) **Deliverables by 2037.** Construct 2000 kms of plastic roads.

**New Technologies**

(a) **Objective 22: Induction of New Technology.**

(i) **Deliverables by 2047.**

(aa) Implementation of Microsurfacing in 50 % of the roads in place of traditional resurfacing layer as renewal course.

(ab) Construction of 500 Km Perpetual Pavement in BRO and trial construction of one road.

(ac) Construction of 5 roads in permafrost areas.



- (ad) BRO to be an expert in SMA and Porous pavements.
- (ae) Construct Avalanche Protection Structures on vulnerable locations on roads above 10000 feet.
- (af) Construct Cut and Fill tunnels/ slope stabilisation measures at destabilized locations on 70% of the roads.
- (ag) Introduce the concept of Self Healing Asphalt in BRO.
- (ah) Warm Mix Asphalt technology to be used at vulnerable locations in place of traditional Hot Mix Technology.
- (aj) Modified bitumen to be fully incorporated in BRO.

### **Advanced Equipment**

(a) **Objective 23: Induction of New Equipment.** In line with its own vision, BRO aspires to upgrade to the latest equipments which could increase the output and provide safety to the men in adverse conditions.

(i) **Deliverables by 2037.**

- (aa) BRO to be an expert in construction of tunnels with Tunnel Boring Machines/NATM Method.
- (ab) Procurement of Spider Leg Excavators for Greenfield formation cutting.
- (ac) GPS based Route Guidance System to be installed on all the equipments involved in snow clearance operations.
- (ad) Concept of Intelligent compaction Measurement Values (ICMV) to be implemented in 50 % of BRO roads.

### **Facilitating Road Users**

(a) **Objective 24: BRO Cafés.**

- (i) **Deliverables by 2037.** Additional 75 BRO cafes to come up in Border areas.





## CHAPTER IX- LONG TERM OBJECTIVES ( 2037-2047)

### Objectives with Timeline Benchmarks

#### Strategic Infrastructure

(a) **Objective 1: Dual Use UG Storage Facilities for Ammunition & Strategic Vehicles/ Platforms.**

(i) **Deliverables by 2047.** Completion of all strategic underground infrastructures for strategic platforms and storage of critical ammunition in forward areas.

(b) **Objective 2: UG FOL Storage Facilities.**

(i) **Deliverables by 2047.** Complete construction of all WWR FOL Storage facilities for all three services & CAPFs in forward areas.

(c) **Objective 3: Execute Operational, Capital and Revenue Works for All Three Services.**

(i) **Deliverables by 2047.** Optimisation of work to be undertaken by giving adequate responsibility to MES and BRO for executing works in Border States.

(d) **Objective 4: Capital Work for Strategic Forces.**

(i) **Deliverables by 2047.** Construction of underground tunnels connecting the various nerve centres of Strategic Forces in forward areas.

(e) **Objective 5: Construction of CBRN Infrastructure.**

(i) **Deliverables by 2047.** Construction of underground CBRN tunnels connecting the various nerve centres of Strategic Forces in forward areas.



### **Strengthening Organisation**

- (a) **Objective 6: Strengthening of BRO.**
  - (i) **Deliverables by 2047.** BRO to be the premier infrastructure construction organisation within the country with active participation in execution of projects in Foreign Countries.
- (b) **Objective 7: Enhancement in Financial Capability.**
  - (i) **Deliverables by 2047.** Annual Target Rs 100000 Crs
- (c) **Objective 8: Upgradation of Accommodation.**
  - (i) **Deliverables by 2047.** Availability of accommodation for all families with development of associated infrastructure to provide high quality of life for all with families.

### **Roads and Bridges**

- (a) **Objective 9: Road Construction with Upgraded Specifications.**
  - (i) **Deliverables by 2047.** All forward posts should be connected with NHDL.
- (b) **Objective 10: Road Construction in Hinterland / Coastal Areas.**
  - (i) **Deliverables by 2047.** Construction of NHs/ SHs by BRO in Border States and in the hinterland in under-developed areas.
- (c) **Objective 11: Upgradation of Bridges in Border Areas.**
  - (i) **Deliverables by 2047.** All strategic and border areas bridges which are required for speedy mobilisation will be converted to Cl 70 permanent bridges.

### **Air Infrastructure**

- (a) **Objective 12: Construction of Airfields, ALGs and Helipads with Ancillaries & Support Infrastructure.**
  - (i) **Deliverables by 2047.** Complete the construction of strategic infrastructure to support air operations against Northern and Western adversary.
- (b) **Objective 13: Hardened Aircraft Shelters for Airfields.**
  - (i) **Deliverables by 2047.** All airfields to be employed for active operations and are also strategic in nature to have hardened aircraft shelters.



## Tunnels

(a) **Objective 14: Construction of Strategic Tunnels.**

- (i) **Deliverables by 2047.** All snow bound areas above 9000 feet to have tunnel connectivity.

## Foreign Country Infrastructure Development

(a) **Objective 15: BRO Videsh.**

- (i) **Deliverables by 2047.** Undertake marine engineering projects in friendly foreign countries.

(b) **Objective 16: Trans-Border Economic Corridor.**

(i) **Deliverables by 2047.**

(aa) Completion of Myanmar-India-Nepal-Bhutan-Bangladesh Economic Corridor.

(ab) Ensure mechanisms to facilitate free movement and trade on the Corridor.

(c) **Objective 17: UN Missions.**

- (i) **Deliverables by 2047.** Two TFs to be deployed in UN Missions.

## Technology, Self-Reliance and Road Safety

(a) **Objective 18: Automation.** BRO shall completely automate the existing systems and procedures so as to ensure higher roads construction rates, increased productivity, more efficient use of materials, better product quality, improved road safety and better HR management.

(i) **Deliverables by 2047.**

(aa) Satellite Based Voice & Data Connectivity till detachment level.

(ab) Networked connectivity of resources of all Projects for dynamic allocation and transfer of resources.

(ac) AI based Integrated Road Information System.

(ad) Facial Recognition based Attendance and Auto Payment System



for CPLs.

- (ae) Internet of Things (IoT) based monitoring of specialist vehicles.
  - (af) Machine Learning (ML) model for optimisation of work load.
  - (ag) Internet of Things (IoT) based Supply Chain and Convoy Management.
  - (ah) Satellite based Survey of Roads and prediction of Road Health.
  - (aj) AI based warning sign for dangerous driving on BRO roads.
- (b) **Objective 19: Road Safety.**
- (i) **Deliverables by 2047.**
    - (aa) BRO to be a lead agency in Policies and Guidelines on Road Safety and Awareness.
    - (ab) Institutional Research Centre in coordination with leading World Road Safety Organisations.
- (c) **Objective 20: Self Reliance on Construction Equipment.**
- (i) **Deliverables by 2047.** All equipment used in Road Construction will be indigenous and 'Made in India'.
- (d) **Objective 21: Construct 5000 Kms of Roads using Plastic/ Recycled Materials.**
- (i) **Deliverables by 2047.** Complete construction of 5000 kms of plastic roads or roads made with recycled waste.

### **New Technologies**

- (a) **Objective 22: Induction of New Technology.**
- (i) **Deliverables by 2047.**
    - (aa) Implementation of Microsurfacing in 50 % of the roads in place of traditional resurfacing layer as renewal course.
    - (ab) Construction of 1000 Km Perpetual Pavement in BRO and trial construction of one road.
    - (ac) BRO to be an expert and the nodal department for road construction in permafrost areas.
    - (ad) Construct Avalanche Protection Structures at all the roads of BRO, wherever applicable.



- (ae) Construct Cut and Fill tunnels/ slope stabilisation measures at destabilized locations on 100% of the roads, wherever applicable.
- (af) Concept of Self Healing Asphalt to be fully incorporated in working culture of BRO.

### **Advanced Equipment**

(a) **Objective 23: Induction of New Equipments.** In line with its own vision, BRO aspires to upgrade to the latest equipments which could increase the output and provide safety to the men in adverse conditions.

(i) **Deliverables by 2047.**

- (aa) Introduction and incorporation of Remotely controlled and Operated machines in the BRO.
- (ab) Introduction of the Telematics/ connected machines in BRO.
- (ac) Equipments with the technology of Pay Load weighing to be introduced in the BRO.
- (ad) Procurement of equipments for controlled and precise monitoring of concreting works in high altitude areas.
- (ae) Concept of Intelligent compaction Measurement Values (ICMV) to be implemented in 100 % of BRO roads.

### **Facilitating Road Users**

(a) **Objective 24: BRO Cafés.**

- (i) **Deliverables by 2047.** Construct **100 BRO Cafe's in border areas.**



## CONCLUSION

1. The advent of India on the Global Stage through a rapid metamorphosis has resulted in setting of National Goals to hitherto unknown levels and necessitates the coming together of all agencies and organisations for fructification of Vision 2047. For the Nation to achieve its enunciated Vision, Aims, Mission, Intent and Objectives, it is but imperative for a collective National Resolve to work towards achievement of focussed outcome. The Border Roads Organisation, by virtue of its contribution to Nation Building thus far and the inherent expertise in infrastructure development acquired over the preceding six decades, is aptly poised to support the Nation in its futuristic endeavour.
2. The BRO has acquired immense expertise over the years in construction of roads, bridges, tunnels and airfields in remote and far-flung areas of the country. The quality and pace of work demonstrated by the organisation in achieving and in many cases exceeding laid down targets makes it suitable to expand its area of expertise into new domains to assist in the modernisation drive of the country. The BRO Vision 2047 document is a step in that direction, taking a holistic overview of the Strengths, Challenges, Opportunities and Threats and articulating ways, ends and means to maximise, overcome, exploit and negate respectively the tenets of the SCOT Analysis.
3. Infusion of technology in administrative and technical domains has been identified as a key force multiplier, necessary to propel the organisation into the magnificent realms of accelerated and AI induced development. A review of the role and charter of BRO based on envisaged employment, a practical and need based organisational transformation dovetailed with a focussed resolution of HR challenges are the foundations on which the Vision 2047 document is premised. A deliberate and diligent analysis of future infrastructure requirements and the socio-economic impact desired has been undertaken to ensure that the new infrastructure domains being proposed for employment of BRO are realistic and need based. A synergised integration of strategic advantage with socio-economic growth has been identified as a prerequisite to augmenting the Nation's Comprehensive National Power with Soft Power Projection capability having been dovetailed into the proposed expansion of BRO Videsh to execute projects overseas. Deployment of BRO units as part of UN Missions to undertake reconstruction and rehabilitation related infrastructure development in conflict affected regions of the World has been proposed to further augment India's



credentials as a responsible Global Power and World Leader.

4. Involvement of the BRO in undertaking Humanitarian Assistance and Disaster Relief Operations is aimed at exploiting the organisation's existing connect with the masses. The inherent expertise to establish grass root linkages with the population is proposed to be exploited by providing the BRO a pan-India platform to undertake comprehensive Nation Building activities. The BRO Vision 2047 document proposes to be a game changing and path breaking roadmap intended at not just catapulting the BRO to greater accomplishments and technical proficiency but also projecting the country to its envisaged global leadership role. The organisation guided by its visionary leadership and spurred by its motto '**Shramen Sarvam Sadhyam**' remains committed to **Either Finding a Way or Making One** and the Vision 2047 document sets course for this noble and illustrious journey.

