7, August, 2021
iGrip Webinar

Key issues for developing GRS structures for Indian railway

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東京大学
THE UNIVERSITY OF TOKYO

RRR
スリーアール工法協会

iGrip, June, 2020

iGrip Initiative for Geotechnical Research & Innovative Practices — IIT Gandhinagar

iGrip webinar series on GEOSTRUCTURES

Development of Geosynthetics Reinforced-soil Structure for Japanese high-speed bullet train "Shinkansen"

Monday, June 08, 2020 @ 10:00AM (India)

Prof. Kenji Watanabe
University of Tokyo

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Prof. Kenji Watanabe
University of Tokyo.

Dr. Kenji Watanabe graduated in Civil Engineering from the University of Tokyo in 1998. He obtained a Ph.D. at the University of Tokyo in 2007. From 2000, he worked for RTRI (Railway Technical Research Institute, Japan), specializing in design and construction of railway earth structures and Geosynthetic reinforced soil (GRS) structures. He was engaged in the development of a new GRS structures such as GRS bridge abutment and GRS integral bridge, those of which require higher performance compared to GRS retaining walls. He was in charge of railway design standard on earth structure and retaining structure which was revised according to performance-based design method in 2012. From 2014 to 2015 he worked at IFSTTAR (The French Institute of Science and Technology for Transport, Development and Networks) as a visiting researcher in Geotechnical engineering through the IFSTTAR-RTRI collaborative research on reinforced-soil structures. He has been Associate Professor of Civil Engineering at the University of Tokyo since 2018.

Abstract

Geosynthetic-Reinforced Soil Retaining Wall (GRS RW) with full-height rigid facing has been constructed for a total length more than 180 km at more than 1,100 sites mainly for railways in Japan. A very high cost-effectiveness with low life-cycle costs and a high stability against heavy rains and severe earthquakes have been validated for the last 30 years. The history of the application of GRS structures will be first briefly introduced and the three main elements of the structure (soil, rigid facing and geosynthetics) are overviewed in the presentation.

Based on several experiments and field observation, the design procedure of these GRS structures together with conventional RW and bridge abutment were established and published as "Design Standards for Railway Structures and Commentary (Earth Retaining Structure)" which follows the concept of performance-based design. Finally, the recent research activities applying geosynthetics for the railway structure will be introduced.

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IIIS

IGrip-IIT Gandhinagar Hosts A Webinar On Geosynthetics Technologies Of Japanese High-Speed Bullet Train "Shinkansen"

by India Education Diary ... On Jun 8, 2020

Share

Gandhinagar: Initiative for Geotechnical Research and Innovative Practice (IGrip) at the Indian Institute of Technology Gandhinagar (IITGN) organiscd a webinar on Development of Geosynthetics Reinforced soil Structure for Japanese high-speed bullet train "Shinkansen". It was the fifth webinar in the iGrip Webinar series with global experts on Geostructures.

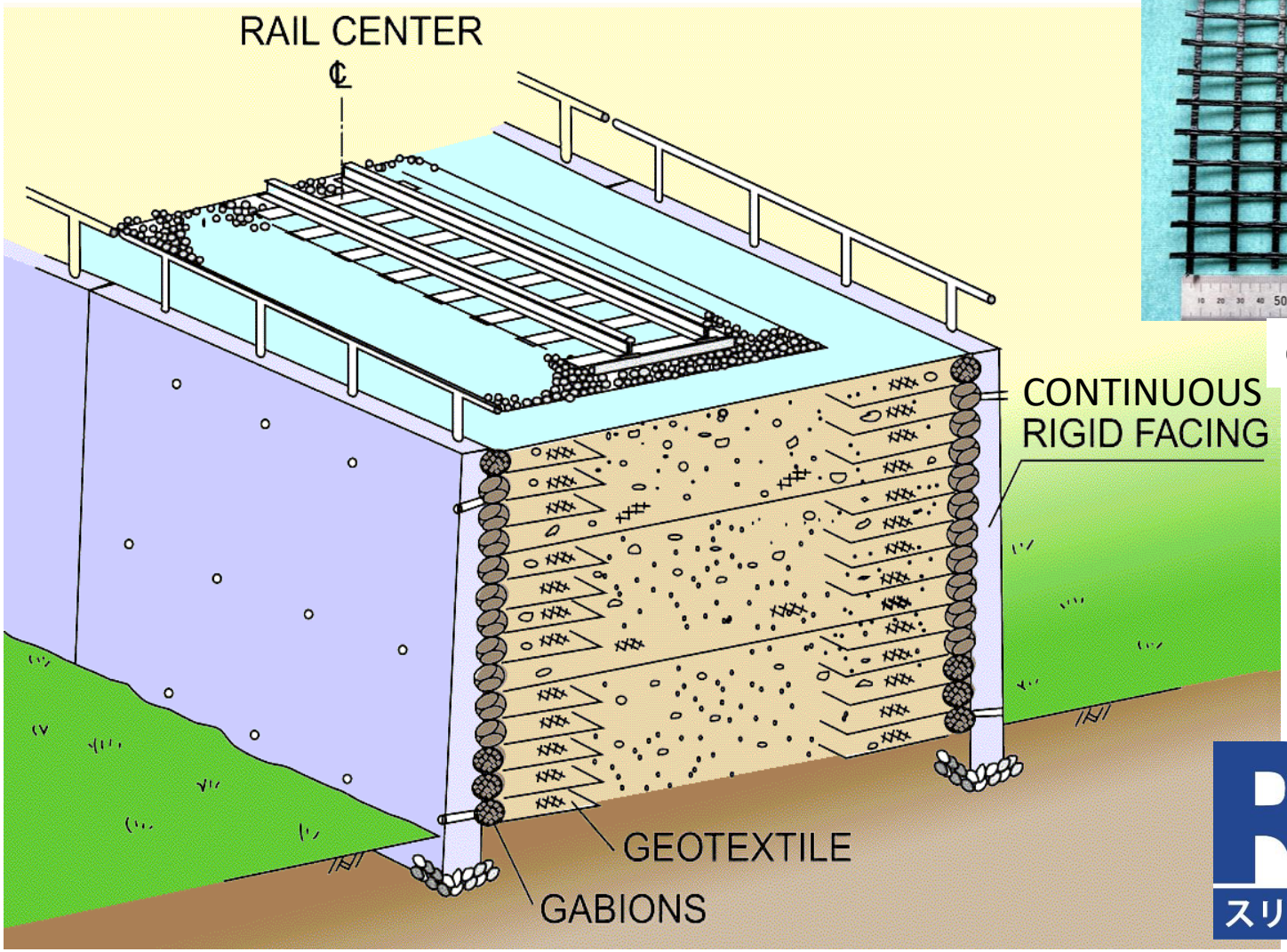
Today's lecture was delivered by Dr Kenji Watanabe, Associate Professor of Civil Engineering at the University of Tokyo. Dr Watanabe specialises in design and construction of railway earth structures and Geosynthetic Reinforced soil (GRS) structures and has worked with Railway Technical Research Institute (RTRI), Japan, and The French Institute of Science and Technology for Transport, Development and Networks (IFSTTAR).

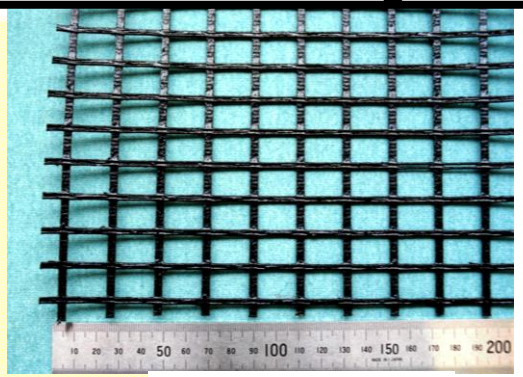
At the beginning of the webinar, Dr Watanabe briefly introduced the history of the application of GRS structures and then elaborated on the three main elements of the structure (soil, rigid facing and geosynthetics). Explaining

Download presentation slides

https://igrip.iitgn.ac.in/wp-content/uploads/2020/07/iGripWebinar-5-Presentation-Watanabe.pdf

GRS retaining wall in Japan Railway





Geotextile

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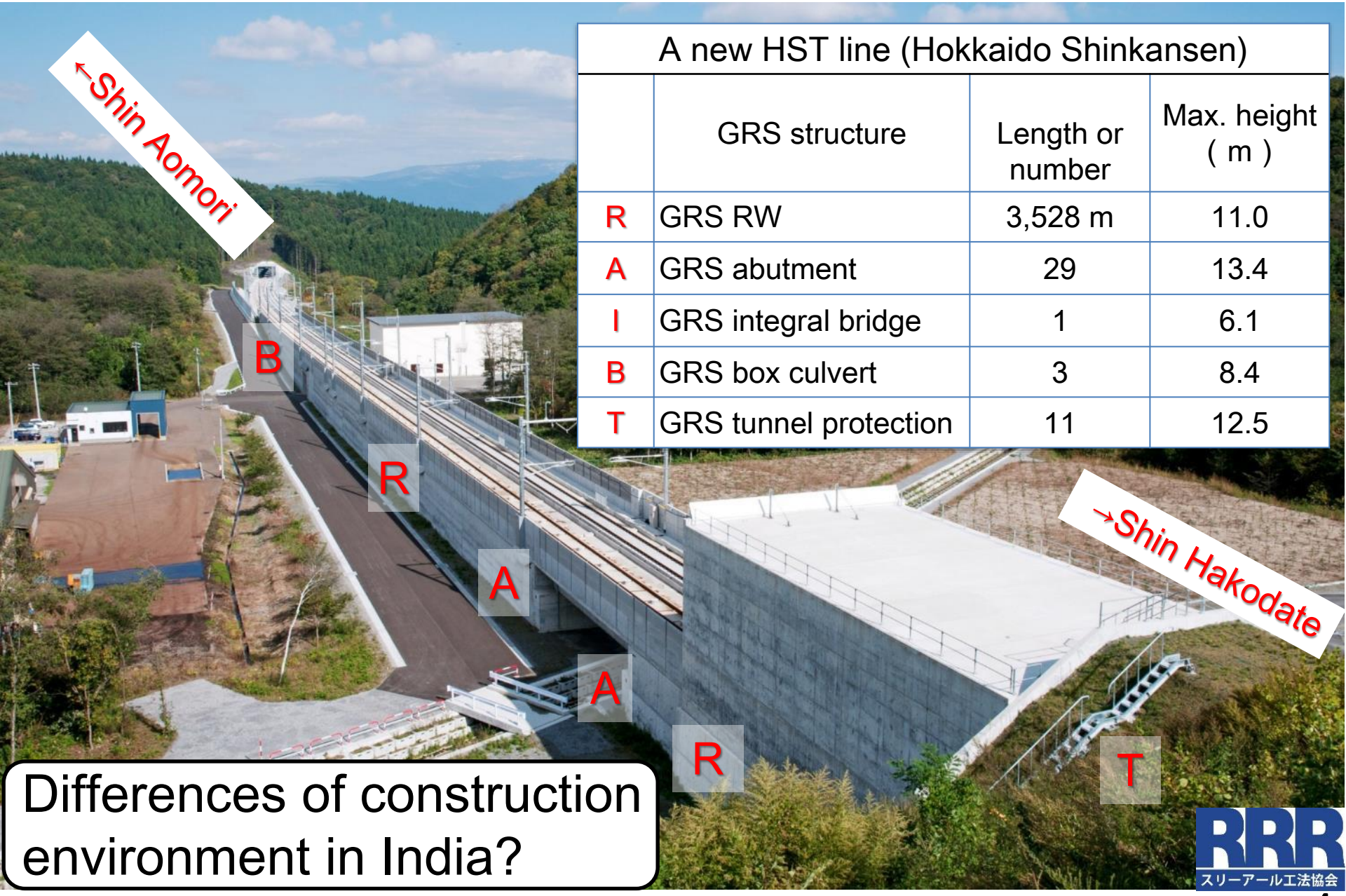
Reinforced Railroad with Rigid Facing-Method

RRR Association: http://www.rrr-sys.gr.jp/en/

Various GRS structures for Japanese high-speed rail (2013)



A new HST line (Hokkaido Shinkansen)			
	GRS structure	Length or number	Max. height (m)
R	GRS RW	3,528 m	11.0
A	GRS abutment	29	13.4
I	GRS integral bridge	1	6.1
B	GRS box culvert	3	8.4
T	GRS tunnel protection	11	12.5

Differences of construction environment in India?

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Differences between India and Japan

- **Material for earthwork**

  High-grade material (SQ3, F_c<12%) is not easy to obtain due to the geological reason

- **Ground conditions**

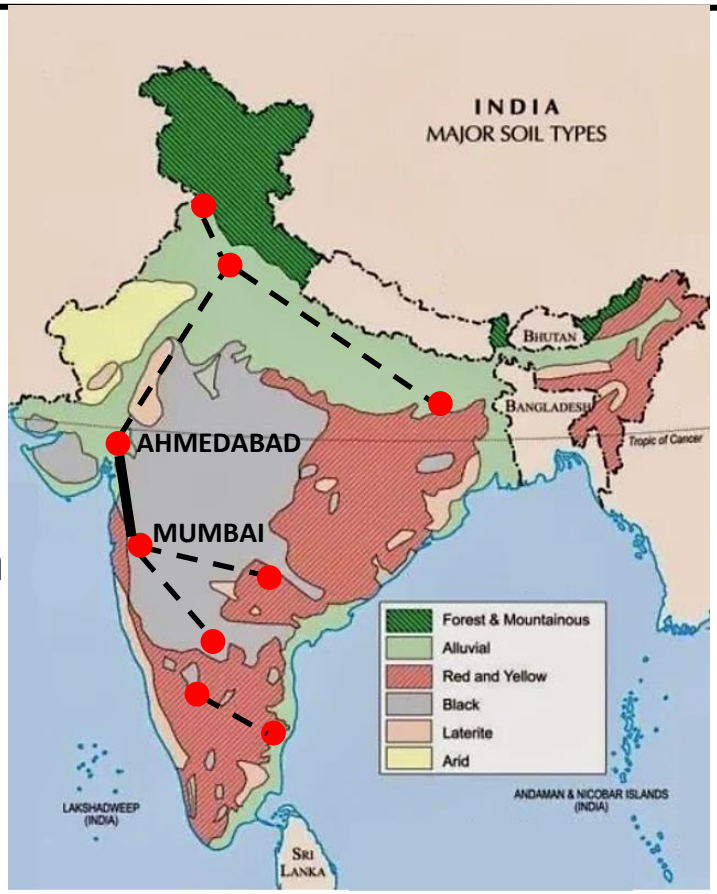
  Problematic soil (BCS) is widely spread

- **Rainfall**

  It rains more than in Japan during rainy season

- **Heavy axle load**

  It is heavier than Japan, such as DFC



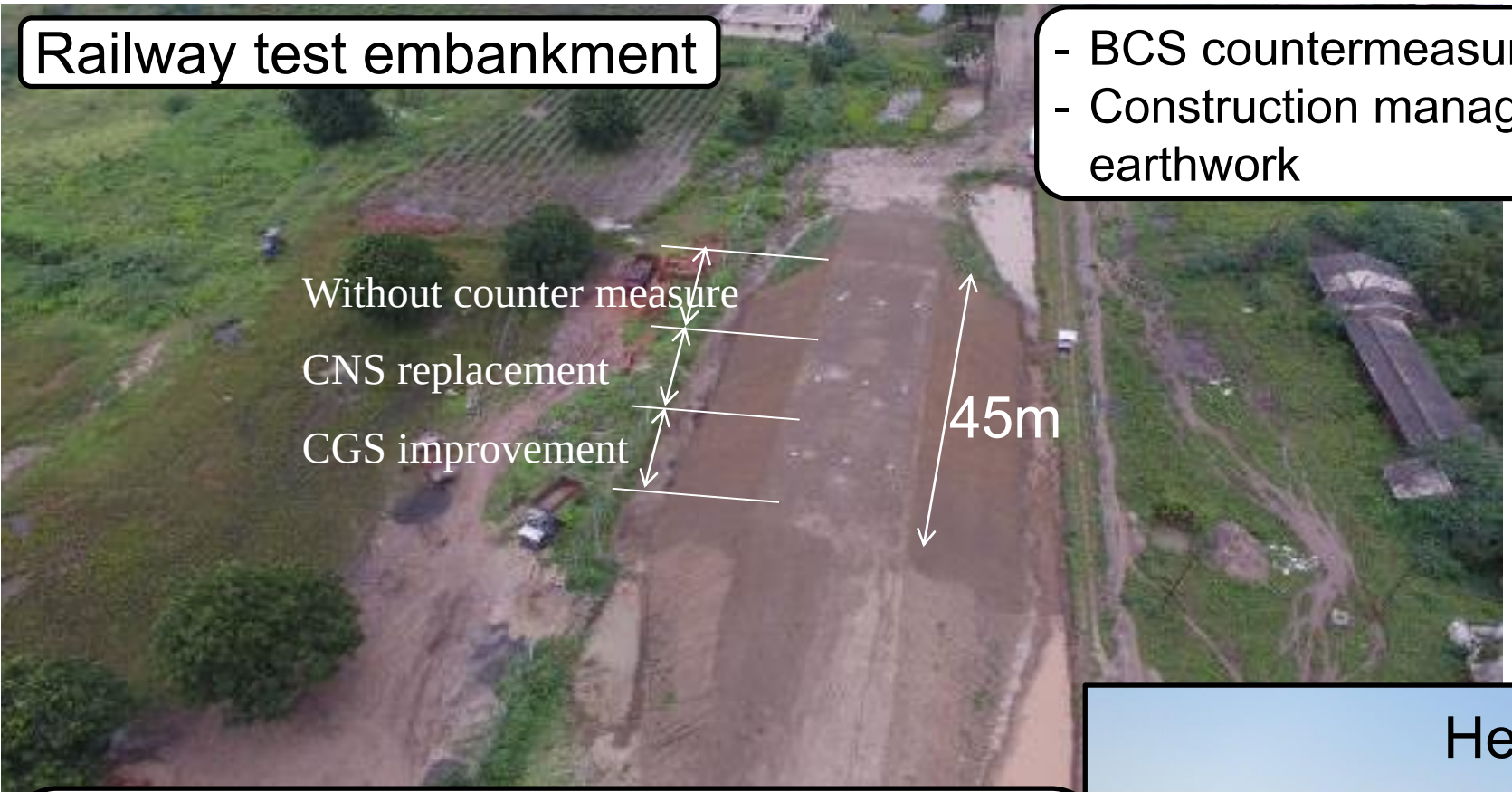
Severe construction condition! (except for EQ)

-The basic principle of RRR (GRS structure) is applicable in India.
- It could be the most cost-effective construction method.
- However, it is better to customize the structural detail to meet the Indian environment.

Previous Project: Construction of test embankment on Black Cotton soil (Vadodara,2016-2017)

Railway test embankment

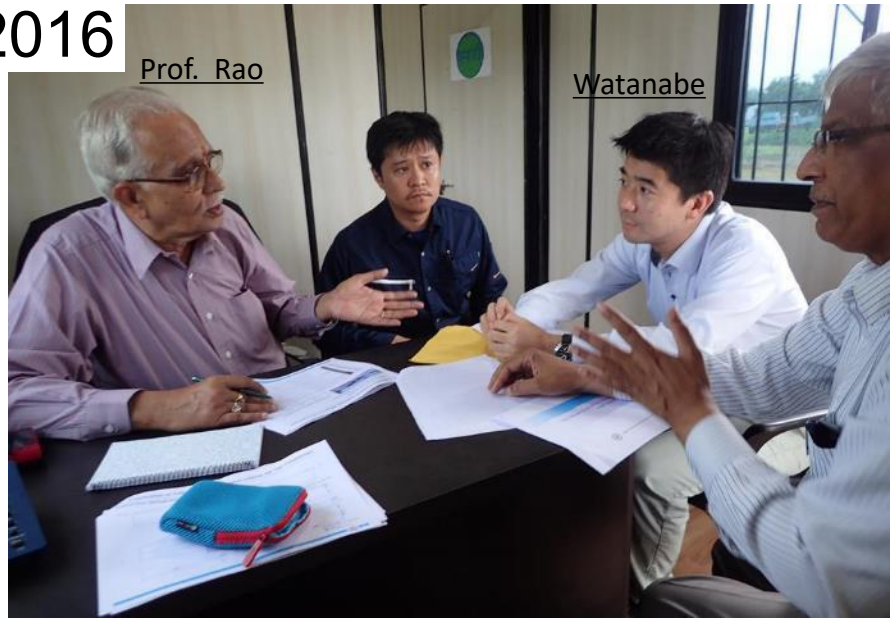
- BCS countermeasure
- Construction management of earthwork



- SQ3 material was difficult to obtain (70km far from the site)
- Black cotton soil cause many problems without appropriate countermeasure

Test embankment on Black Cotton soil (Vadodara)

12/7/2016



Technical meeting
@ IIT Gandhinagar

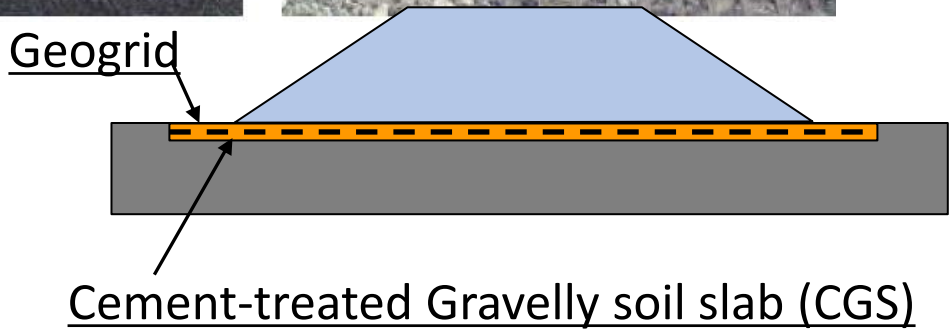
13/7/2016

11/10/2017

Geogrid for BCS countermeasure

Biaxial geogrid (PVA: Polyvinyl Alcohol)

Settlement of embankment was effectively reduced by CGS layer with geogrid

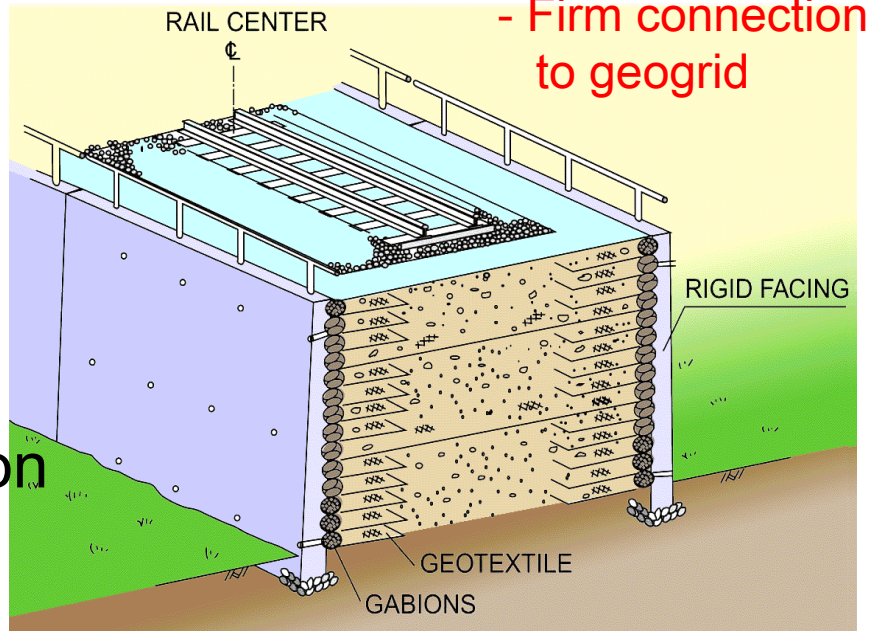


Watanabe, K., Nakajima, S., Fujiwara, T. Yoshii, K. and G. Venkatappa Rao: Construction and field measurement of high-speed railway test embankment built on Indian expansive soil "Black Cotton Soil", *Soils and Foundations*, Vol. 61, No. 1, pp.218-238, 2021, https://doi.org/10.1016/j.sandf.2020.08.008

Key issues for developing Indian GRS

Three main elements for GRS structure
= Soil, Geosynthetics, and Facing

- Rigid
- Firm connection to geogrid



- Soil

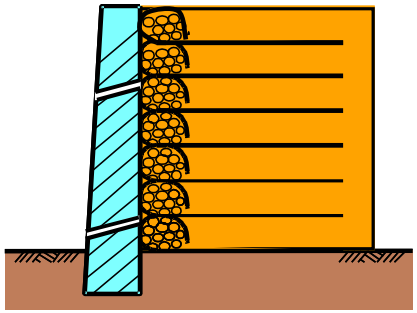
Effective compaction control?
How to utilize 2nd graded soil?

- Geosynthetics

Most reliable material, less variation

- High quality
(strength, creep, alkali resistance)

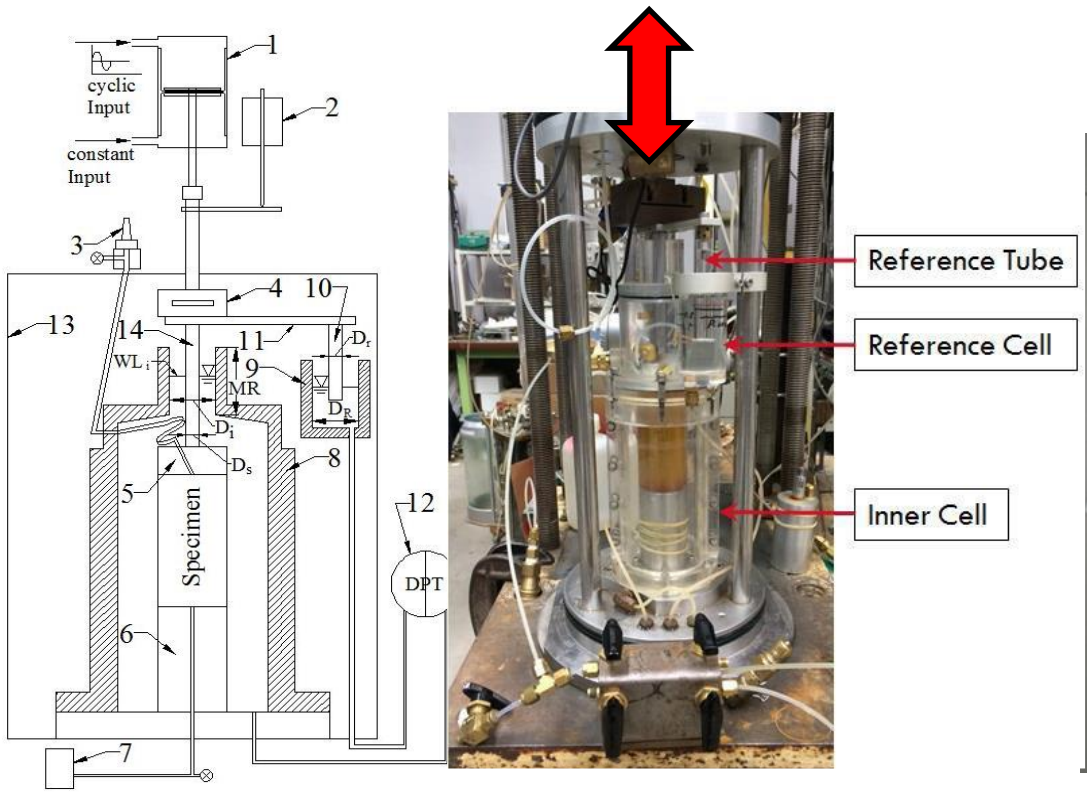
- Interaction with
"well- compacted 2nd graded soil"



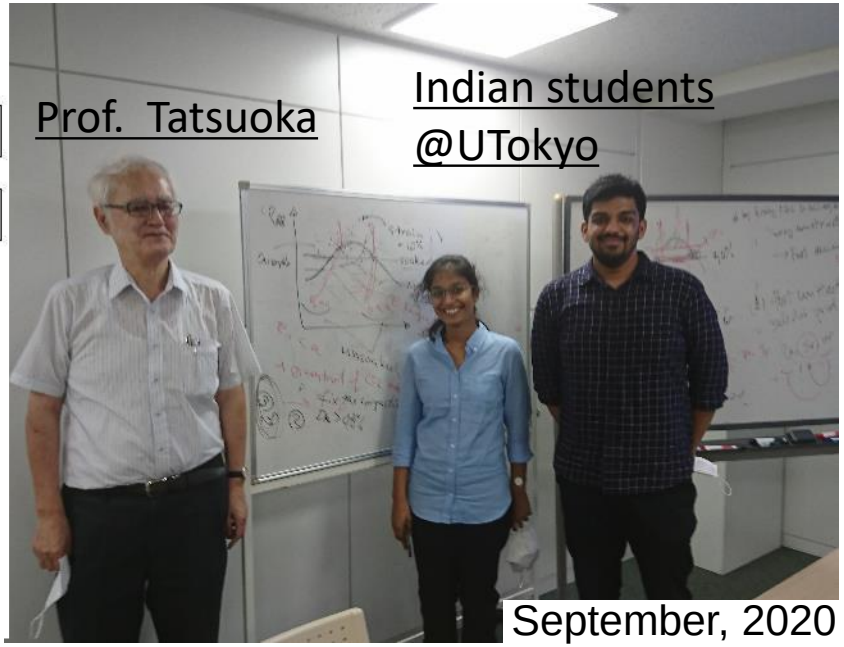
Current study at University of Tokyo

- Effective compaction method for utilizing 2nd graded banking material for railway embankment (SQ2)

Keywords: Compaction ratio, Sr, unsaturated soil, suction
Cyclic loading(=traffic load)



Special triaxial apparatus for unsaturated soil



Discussion on “Compaction”

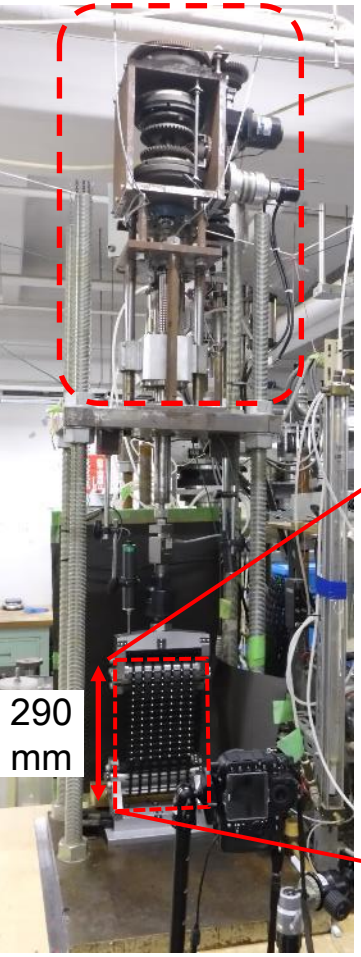
Current study at University of Tokyo

GRS wall with various types of soil and geogrid

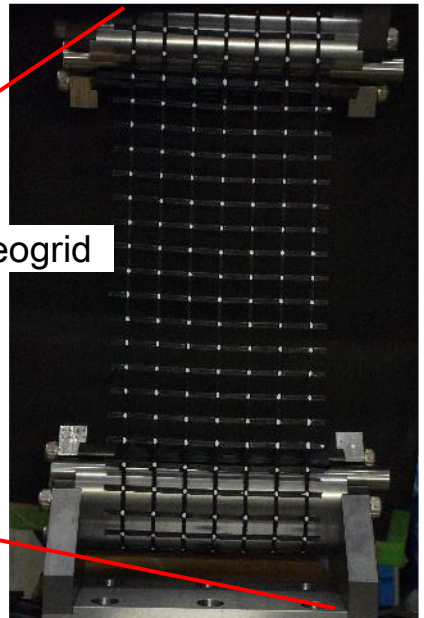
Keywords: Deformation characteristic of geogrid, Interaction, best arrangement of geogrid

<In-isolation tensile test> Indian student

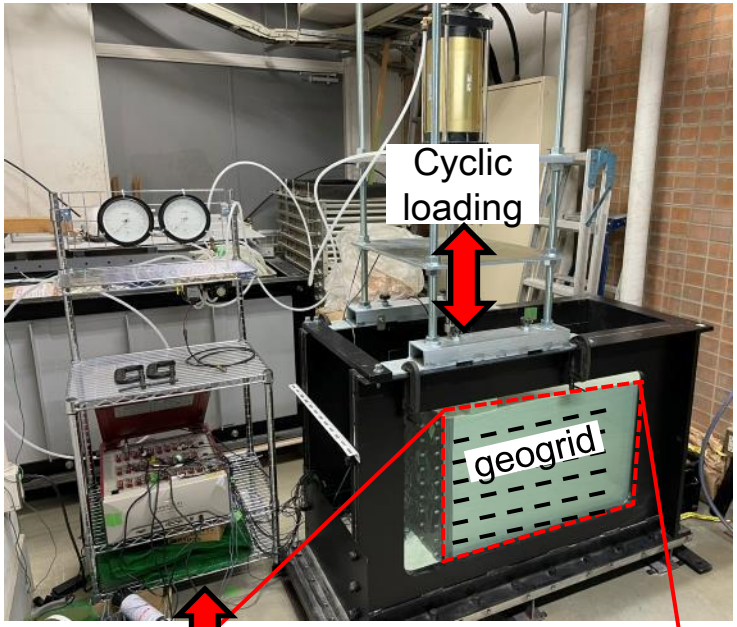
Special loading device

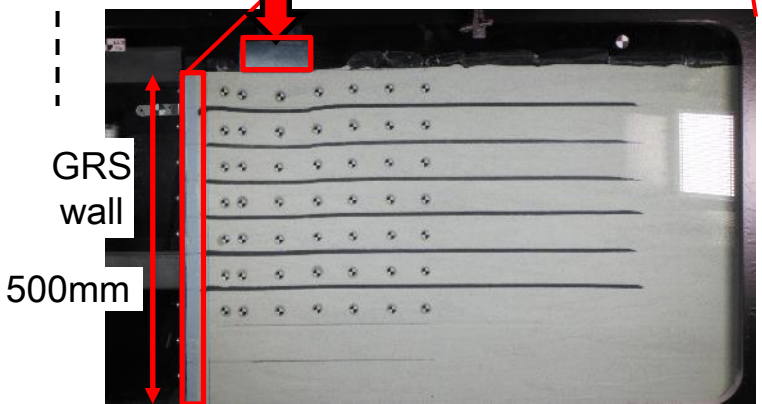


- Displacement control
- Various strain rate
  (1000 times change of loading speed)
- Creep, relaxation, cyclic load



<Model test on GRS wall>





Summary

- GRS structure is the most cost-effective construction method (from walls to bridges).
- Full-height rigid facing which is contacted strongly to geosynthetics is the key aspect of this technique.
- We need to customize/modify the current technique to meet the Indian environment.
  (banking material, ground condition, rainfall, heavy axle load)
- Fundamental research on "Effective compaction", "Interaction between soil and geosynthetics" are needed

Thank you for your attention!

- RRR Association
  http://www.rrr-sys.gr.jp/en/

- Related English papers (pdf files)
  http://www.rrr-sys.gr.jp/en/related-papers/

- Technical guideline
  (Manual for the design and construction of RRR Geosynthetic-Reinforced Soil structures)
  https://drive.google.com/file/d/1XplkIP4CD7YtQjcLHMDe9jvb2iIftvbK/view?usp=sharing