Protecting and Investing in Natural Capital
in Asia and the Pacific

Developing Bio-engineering Capacity for the
Local Government Engineering Department Operations
in the Chattogram Hill Tracts, Bangladesh

Bio-engineering Nature-based Solutions for Linear Infrastructure Slope Stabilisation and Protection

TRAINING REPORT

OCTOBER 2022

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INTRODUCTION

Project Background

The initiative "Bangladesh: Climate Resilient Livelihood Improvement and Watershed Management in Chattogram Hill Tracts Sector Project" of the Asian Development Bank (ADB) aims to improve livelihoods and sustainable use of natural resources in the Chattogram Hill Tracts (CHT), Bangladesh. The project is focusing on the lagging development in CHT by addressing selected deficiencies in the following five forms of capital that are considered necessary to sustain livelihoods and improve overall human well-being: physical, human, financial, social, and natural capital. The interventions in improving these capitals will be delivered under five outputs: (i) rural roads rehabilitated; (ii) community infrastructure developed; (iii) watershed management strengthened; (iv) agriculture production, processing and marketing improved; and (v) rural non-farm skills related to agriculture value chains improved. The intervention and succeeding outputs are expected to deliver the outcome of enhanced sustainable livelihood opportunities and access to basic services for the CHT rural population which includes women and vulnerable groups.

An ADB Transaction Technical Assistance (TRTA) "Bangladesh: Preparing the Climate Resilient Livelihood Improvement and Watershed Management in Chattogram Hill Tracts Sector Project" is supporting the required readiness conditions for project implementation. The TRTA consultant team is assisting the government to prepare the proposed project and undertake necessary due diligence. The assistance includes preparation of feasibility studies, bid documents, and bid evaluation of goods, works and services packages.

To support this initiative, ADB's technical assistance "Regional: Protecting and Investing in Natural Capital in Asia and the Pacific" (TA-9461), administered by the Environment Thematic Group (ETG) engaged nature-based solutions (NbS) bio-engineering experts to co-develop, with the project team, national policy recommendations and government buy-in to NbS pertaining to infrastructure projects, specifically those for road construction and rehabilitation. The intervention was expected to develop guidelines, rate analysis norms and standard specifications of bio-engineering works, and to assess the training needs for the planning and implementation of bio-engineering works. These activities are to help in mainstreaming roadside bio-engineering as a practical NbS in government policies to inform and complement overall project design and implementation with associated engineering options.

Technical Assistance Activities

The guidelines, rate analysis norms and standard specification of bio-engineering works have been duly prepared. Training needs assessments (TNA) were conducted for policy and managerial level senior staff, as well as for field level engineers of Local Government Engineering Department (LGED) of Bangladesh (see Training Needs Assessment Report on the Appendix). A three-day bio-engineering training course was developed. In the training course, the first day was designed for both the managers and field engineers, while the other two days were designed only for the field engineers. The topics of each day were divided into several modules, which in turn were then divided into numerous sessions. Topics of the training course are listed below with the training schedule.

The Asian Development Bank (ADB) Environmental Thematic Group (ETG) then organised the implementation of the training course, which was entitled: "Bio-engineering Nature-based Solutions for Linear Infrastructure Slope Stabilisation and Protection". This took place on 1, 2 and 4 August 2022 via Zoom Cloud Meeting with staff of the LGED.

TRAINING COURSE

The objective of the training course was to equip the participating LGED engineers with the knowledge and skills they require for conducting site appraisal, and then for designing, implementing and managing bio-engineering works for slope protection and erosion control works. The following was the scope of expected knowledge outputs and key take-aways for achieving the overall training objective:

- Slope instability, types, causes and mechanisms of failure
- Introduction to bio-engineering principles and design
- Nursery design, construction, and plant production
- Bio-engineering site implementation, management, and maintenance
- Rate analysis norms and standard specification for bio-engineering works

COURSE PARTICIPANTS

The training course was attended by Additional Chief Engineers (ACE), Superintending Engineers (SE), Executive Engineers (EE), Upazila Engineers (UE), Senior Assistant Engineers (SAE), Assistant Engineers (AE) and Sub-assistant Engineers (SuAE) of LGED.

A total of 83 LGED officials attended the training course. Among the manager level staff were: two Additional Chief Engineers from CHT and the Climate Resilient Local Infrastructure Center (CReLIC); five Superintending Engineers from CHT, Integrated Water Resources Management (IWRM), Roads and Building Design Unit and Bridge Design Unit; thirteen Executive Engineers from CHT, Climate Resilient Infrastructure Mainstreaming Project (CRIMP), IWRM, Roads and Building Design Unit, Bridge Design Unit, Gopalganj and Cumilla; one Project Director and two Deputy Project Directors from Rural Connectivity Improvement Project (RCIP); two Deputy Secretaries from the Ministry of Chittagong Hill Tracts Affairs; and one retired Additional Chief Engineer of LGED.

The field engineer level staff consisted of: twenty-four Upazila Engineers, one Senior Assistant Engineer, two Assistant Engineers and three Sub-assistant Engineers from CHT, four Senior Assistant Engineers from CRIMP, two Senior Assistant Engineers, one Assistant Engineer from Planning and Design Unit, two Senior Assistant Engineers, two Assistant Engineers from RCIP, four Senior Assistant Engineers and three Assistant Engineers from Roads and building Design Unit, two Senior Assistant Engineers from Bridge Design Unit and one Assistant Engineer from Human Resource Development, Environment & Gender Unit.

The list of participants is attached as Appendix A.

HIGHLIGHTS AND SALIENT POINTS

Opening of the Bio-engineering Training

Isao Endo, Environment Specialist of ADB, kicked off the event by gladly welcoming participants and expressing gratitude to LGED for jointly organizing the bio-engineering webinar training series. Nature-based solutions (NbS) such as bio-engineering are becoming viable investment options for achieving a prosperous and inclusive economy while preserving precious ecosystems that is our main source of wealth. Roads and railways are necessary for modern economies. However, these are also main drivers of ecosystem degradation and biodiversity loss which negatively affects economic growth in the long run. Therefore, sustainable linear infrastructure is vital for sustainable development, and even more so for climate mitigation and adaptation. ADB is actively promoting NbS to assist ADB's Developing Member Countries to own quality infrastructures that are sustainable and inclusive. ADB leverage NbS by integrating green and gray designs through bio-engineering which is a promising and practical investment solution for achieving resiliency while providing a nature positive future. In Bangladesh, there are ADB projects that mainstream NbS bio-engineering such as the ongoing Rural Connectivity Improvement Project and proposed Climate Resilient Livelihood Improvement and Watershed Management in Chattogram Hill Tracts Sector Project. It is hoped that this training will contribute to such projects and other initiatives led by the Government of Bangladesh.

Gopal Krishna Debnath of LGED and CReLIC provided opening remarks and highlighted that NbS bio-engineering is an emerging technology world-wide. Integrating NbS for climate change adaptation and disaster risk management is very important because we need to find nature solutions for our ecosystems and biodiversity to survive as we achieve sustainable development. Applying bio-engineering at the field level will be economical and contribute to greenhouse gas reduction while highly benefitting the country and the people of Bangladesh. LGED engineers were encouraged to participate attentively and actively contribute on the field.

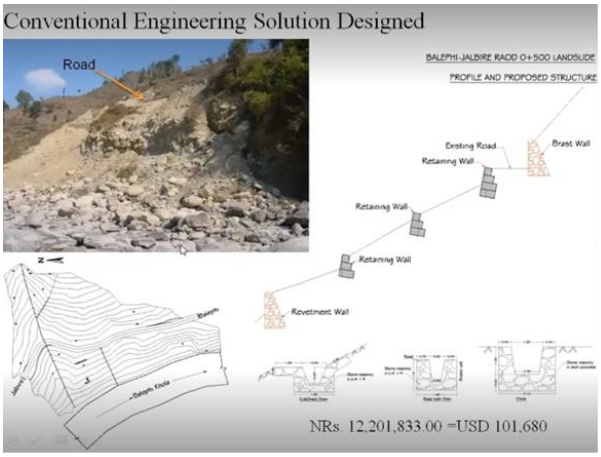
Mohammad Shariful Islam served as the facilitator and moderator for the webinar training series. Having extensive experience and knowledge on bio-engineering (particularly on application of vetiver grass), he also provided valuable discussion points for the participants and bio-engineering experts. In addition, he provided local knowledge and supplemented on-site contexts where bio-engineering could be applied effectively as well as identifying limitations on the ground for adaptation and replication. Equally valuable was his aptitude in gathering important information during discussions for localizing bio-engineering standards and norms to the context of Bangladesh.

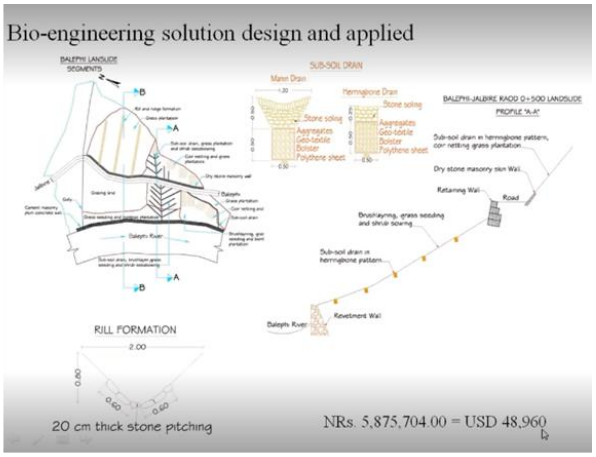
Training proper and key discussion points

Shankar Rai led the training over the course of three days. Composed of seven modules, the design follows the Bio-engineering Training Manuals for Managers and Field Engineers that was developed through the TNA. Thus, the training and its modules are custom-made for LGED mangers and field engineers. The training is also a two-way process where participants could share their knowledge and experiences. This knowledge sharing was very helpful to put the bio-engineering concepts and examples in the local context of Bangladesh, especially for the Chattogram Hill Tracts. The following sections are key discussions points.

Beyond road slope stabilization and protection. In Bangladesh, there are also rainwater harvesting structures and canals that needs slope stabilization and protection. These sites are important for fish cultivation and a source of economy, livelihood and food security.

Cost effectiveness of bio-engineering compared to conventional engineering solutions is also of great interest to the participants. A practical example was provided showing the cost estimate and actual cost of applying bio-engineering design (See below). Aside from the cost difference, bio-engineering structures also tend to have longer lifespan as the vegetation regenerates.





Availability of plants materials is also a concern for bio-engineering works that should be addressed. This include identifying suitable species as well as species that are resilient to inundations. During the discussions, participants provided information on potential areas for nurseries as well as potential plant species for bio-engineering in Bangladesh.

Most common challenges and local conditions when applying bio-engineering in Bangladesh where also shared by the participants. For example, protecting and stabilizing *embankments on sandy and soft soils* are common concerns. *Rotational failures* are also most common in the area partly caused by hill cuttings without proper design nor permission (e.g., for houses). Large *teak wood gardens* in Chattogram Hill Tracts areas also contribute to erosion. The broad leaves accumulate raindrops and release larger drips causing surface erosions. This is why a mixed of plant species is always recommended for minimizing such problems.

Research topics that could benefit application of bio-engineering in Bangladesh were also discussed. For example, research to compare performance of coir and jute materials can help determine the most suitable application. Research on applying mixed plant species is also necessary to determine optimal combination for the sites. These could also be piloted in different areas of Bangladesh. There are also ongoing research on application of jute bags for nursery operations as alternative to polypots in the country.

LGED engineers would like to apply **bio-engineering at the grass root level** and invited the bio-engineering experts to Bangladesh to provide suggestions and advice to field activities. In addition, there are already requests for ADB and LGED to produce fit for purpose **bio-engineering guidelines, booklets and training manuals that would benefit the engineers.** At this point, **Shuva Sharma** shared that such materials are already being prepared and reviewed to fit the local context of Bangladesh. He further elaborated that bio-engineering is not a panacea. In the case of a road in Rangamati for example, deep seated structural problems would require geotechnical engineering measures in combination with bio-engineering solutions. **Syed Abdur Rahim** also added the importance of piloting slope stabilization and protection schemes and even setting up of nurseries. It was proposed to conduct piloting in LGED's projects including those that are ADB financed.

Concluding Session

Towards the end of the bio-engineering training, Gopal Krishna Debnath of LGED expressed interest in arranging field visits with ADB and the bio-engineering experts to help conduct on-site assessments, determine potential bio-engineering solutions and conduct practical experience-based learning for LGED engineers. In closing, Isao Endo provided the remarks by thanking LGED and the participants for successfully completing the bio-engineering training. It is also hoped that the cooperation will continue and explore future collaboration beyond the current initiative. In addition, any opportunity will be explored including further dialogues at the policy level which is related to the country partnership strategy between ADB and the Government of Bangladesh.

TRAINING SCHEDULE

Day/Time (Bangladesh time)	Modules	Technical Content
1 August 2022	**DAY 1: Introduction to bio-engineering training course**	
10:00 a.m.-10:05 a.m.	Opening of Bio-engineering Training Course: Asian Development Bank (ADB) and Local Government Engineering Department (LGED)	
10:05 a.m.-12:00 p.m.	**MODULE 1:** Slope instability, failure, and protection measures	Introduction to the training course
		Type of slope instability and components of an unstable slope
		Causes and mechanisms of slope failure
		Slope protection practice and bio-engineering
12:00 p.m.-1:00 p.m.	**MODULE 2:** Introduction to bio-engineering and designing structures with nature	Engineering design and functions in bio-engineering systems
		Bio-engineering structures and their design
		Site assessment and selection of bio-engineering techniques
		Selection of plant species for bio-engineering
1:00 p.m.-2:00 p.m.	**Health Break**	
2:00 p.m.-2:50 p.m.	**MODULE 3:** Programming bio-engineering works, rate analysis norms, and standard specifications	Bio-engineering works for slope protection
		Bio-engineering maintenance task and seasonal work programming of bio-engineering works
		Rate analysis norms and standard specifications for bio-engineering works

Day/Time (Bangladesh time)	Modules	Technical Content
2 August 2022	**DAY 2: Bio-engineering nursery construction and collection of materials**	
10:00 a.m.-10:05 a.m.	**Recap of Day 1 Training Session**	
10:05 a.m.-12:00 p.m.	**MODULE 4:** Bio-engineering nursery site selection, design, and construction	Siting bio-engineering nursery
		Nursery components and size
		Nursery layout, design, and nursery bed construction
12:00 p.m.-1:00 p.m.	**MODULE 5:** Collection of seed and vegetative plant materials	Seed collection and storage
		Collection of vegetative plant materials
1:00 p.m.-2:00 p.m.	**Health Break**	
2:00 p.m.-3:00 p.m.	**Open Discussion and Announcements**	
4 August 2022	**DAY 3: Bio-engineering nursery operations and bio-engineering works**	
10:00a.m.-10:05 a.m.	**Recap of Day 2 Training Session**	
10:05a.m.–12:00 p.m.	**MODULE 6:** Bio-engineering nursery operations	Compost production and filling polypots
		Seed sowing and planting cuttings in nursery
		Care of young plant in nursery
		Hardening, lifting, and transporting to site
		Scheduling nursery work and record keeping
12:00 p.m.-1:00 p.m.	**MODULE 7:** Site preparations and bio-engineering works	Site preparation and spoil disposal
		Construction of vegetative structures
		Practical application of bio-engineering works
		Application of rate analysis norms and standard specification for bio-engineering works
1:00 p.m.-2:00 p.m.	**Health Break**	
2:00 p.m.-2:50 p.m.	**Open Discussion and Training Course Evaluation**	
2:50 p.m.-3:00 p.m.	**CLOSING SESSION: ADB**	

TRAINING EVALUATION

In order to evaluate the knowledge acquisition of participants, pre- and post-course self-assessment was conducted to evaluate the bio-engineering knowledge and skills before training (see Appendix B: Training Needs Assessment) and right after the training. The same form was used for both assessments. In the questionnaire, a list of bio-engineering elements was included, and knowledge and skills were rated on a scale of Novice to Expert level. The summary results of the pre- and post-course self-assessment of participants are presented in the tables below.

Pre- and Post-course Self-assessment of Managers

The table below shows overall pre- and post-course self-assessment responses of Managers in percentage (%) terms for knowledge in different areas of bio-engineering and their competency levels in bio-engineering.

Bio-engineering elements	Self-assessment before training					Self-assessment after training				
	Level of competence and knowledge					Level of competence and knowledge				
	Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert
1. Slope instability and types	17%	-	50%	17%	16%	-	-	22%	67%	11%
2. Landslide / slope instability assessment procedure	-	17%	50%	17%	16%	-	-	22%	56%	22%
3. Bio-engineering principle and design aspects	50%	33%	-	17%	-	-	-	33%	56%	22%
4. Bio-engineering design	33%	17%	50%	-	-	-	-	44%	45%	11%
5. Bio-engineering plants	67%	-	33%	-	-	-	-	11%	78%	11%
6. Bio-engineering nursery design and construction, and plant production	83%	-	17%	-	-	-	-	33%	67%	
7. Bio-engineering site implementation	33%	33%	17%	17%	-	-	-	33%	56%	11%
8. Bio-engineering management	33%	33%	17%	17%	-	-	-	33%	34%	33%
9. Bio-engineering site maintenance	50%	33%	-	17%	-	-	-	22%	45%	33%

Pre- and Post-course Self-assessment of Field Engineers

The table below shows the overall pre- and post-course self-assessment responses of Field Engineers in percentage (%) terms for knowledge and skills in different areas of bio-engineering, and their competency levels in bio-engineering.

Bio-engineering elements	Self-assessment before training										Self-assessment after training									
	Level of competence										Level of competence									
	Knowledge					Skill to design and implementation					Knowledge					Skill to design and implementation				
	Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert
1. Slope instability and types	8%	44%	28%	16%	4%	48%	28%	4%	16%	4%	-	21%	47%	27%	5%	-	32%	37%	26%	5%
2. Landslide/slope instability assessment procedure	12%	40%	36%	8%	4%	56%	28%	4%	8%	4%	-	5%	58%	32%	5%	-	37%	37%	21%	5%
3. Bio-engineering principle and design aspects	52%	28%	20%	-	-	76%	16%	8%	-	-	-	15%	32%	53%		-	37%	47%	16%	-
4. Bio-engineering design	64%	32%	4%	-	-	80%	16%	4%	-	-	-	16%	42%	37%	5%	-	37%	42%	21%	-
5. Bio-engineering plants	32%	48%	4%	16%	-	68%	16%	4%	12%	-	-	26%	37%	26%	11%	-	37%	37%	26%	-

Bio-engineering elements	Self-assessment before training										Self-assessment after training									
	Level of competence										Level of competence									
	Knowledge					Skill to design and implementation					Knowledge					Skill to design and implementation				
	Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert
6. Bio-engineering nursery design and construction, and plant production	52%	32%	8%	4%	4%	72%	16%	-	12%	-	-	32%	37%	21%	10%	-	53%	21%	26%	-
7. Bio-engineering site implementation	56%	12%	28%	4%	-	72%	12%	8%	8%	-	-	21%	42%	26%	11%	-	32%	42%	21%	5%
8. Bio-engineering management	52%	20%	28%	-	-	76%	8%	12%	4%	-	-	32%	26%	26%	16%	-	47%	32%	11%	10%
9. Bio-engineering site maintenance	56%	16%	28%	-	-	72%	12%	12%	4%	-	-	26%	37%	32%	5%	-	37%	42%	21%	-

Training Content

Right after the training course, the participants were provided with a set of questionnaires to evaluate the training course. Each individual was given an opportunity to rank activities and sessions. The participants expressed their views on the training content as follows.

Module	Technical Content	Relevance to work in bio-engineering				Level of interest of topic area				Time allocation		
		Very relevant	Relevant	Not very relevant	Not at all relevant	Very interesting	Interesting	Not very interesting	Not at all interesting	Too much	About right	Too little
MODULE 1: Slope instability, failure, and protection measures	Type of slope instability and components of an unstable slope	79%	21%	-	-	54%	43%	3%	-	14%	61%	25%
	Causes and mechanisms of slope failure	68%	32%	-	-	50%	47%	3%	-	18%	54%	28%
	Slope protection practice and bio-engineering	72%	28%	-	-	64%	33%	3%	-	11%	68%	21%
MODULE 2: Introduction to bio-engineering and designing structures with nature	Engineering design and functions in bio-engineering systems	61%	39%	-	-	50%	47%	3%	-	11%	64%	25%
	Bio-engineering structures and their design	61%	39%	-	-	54%	43%	3%	-	7%	64%	29%
	Site assessment and selection of bio-engineering techniques	61%	39%	-	-	58%	39%	3%	-	14%	61%	25%
	Selection of plant species for bio-engineering	75%	25%	-	-	61%	36%	3%	-	14%	61%	25%

Module	Technical Content	Relevance to work in bio-engineering				Level of interest of topic area				Time allocation		
		Very relevant	Relevant	Not very relevant	Not at all relevant	Very interesting	Interesting	Not very interesting	Not at all interesting	Too much	About right	Too little
MODULE 3: Programming bio-engineering works, rate analysis norms, and standard specifications	Bio-engineering works for slope protection	75%	25%	-	-	50%	47%	3%	-	14%	75%	11%
	Bio-engineering maintenance task and seasonal work programming of bio-engineering works	54%	39%	7%	-	29%	61%	10%	-	11%	79%	10%
	Rate analysis norms and standard specifications for bio-engineering works	43%	54%	3%	-	39%	50%	11%	-	28%	65%	7%
MODULE 4: Bio-engineering nursery site selection, design, and construction	Siting bio-engineering nursery	32%	68%	-	-	42%	53%		5%	16%	79%	5%
	Nursery components and size	37%	63%	-	-	26%	58%	16%	-	16%	79%	5%
	Nursery layout, design, and nursery bed construction	47%	53%	-	-	42%	48%	10%	-	16%	84%	-
MODULE 5: Collection of seed and vegetative plant materials	Seed collection and storage	53%	47%	-	-	53%	37%	10%	-	15%	80%	5%
	Collection of vegetative plant materials	48%	47%	5%	-	42%	53%	5%	-	21%	74%	5%
	Compost production and filling polypots	42%	48%	10%	-	32%	58%	10%	-	10%	90%	-

Module	Technical Content	Relevance to work in bio-engineering				Level of interest of topic area				Time allocation		
		Very relevant	Relevant	Not very relevant	Not at all relevant	Very interesting	Interesting	Not very interesting	Not at all interesting	Too much	About right	Too little
MODULE 6: Bio-engineering nursery operations	Seed sowing and planting cuttings in nursery	47%	48%	5%	-	32%	63%	5%	-	26%	69%	5%
	Care of young plant in nursery	37%	58%	5%	-	37%	58%	5%	-	31%	69%	-
	Hardening, lifting, and transporting to site	53%	47%		-	47%	42%	11%	-	26%	63%	11%
	Scheduling nursery work and record keeping	37%	58%	5%	-	37%	58%	5%	-	26%	69%	5%
MODULE 7: Site preparations and bio-engineering works	Site preparation and spoil disposal	58%	42%	-	-	58%	37%	5%	-	5%	79%	16%
	Construction of vegetative structures	53%	47%	-	-	37%	53%	10%	-	10%	74%	16%
	Practical application of bio-engineering works	63%	37%	-	-	53%	42%	5%	-	16%	74%	10%
	Application of rate analysis norms and standard specification for bio-engineering works	42%	48%	10%	-	37%	53%	10%	-	21%	79%	-

The Trainers

The participants were provided with a set of questionnaires to give their feedback on the trainers/mentors. Each individual was given an opportunity to rank the trainers/mentors. The participants expressed their view on trainers/mentors as follow;

	Agree strongly	Agree	Disagree	Disagree strongly
I found the trainers friendly	75%	25%	-	-
I could understand the trainers	32%	65%	3%	-
The trainers were well organised	40%	57%	3%	-

Training Course Materials

The participants expressed their view on training course materials as follows;

	Very good	Good	Poor	Very poor
Training course materials	47%	36%	17%	-

Suggestions from the Participants on the Training

The overall suggestions and feedback on the training course from the participants are as follows.

- The training course was very much relevant for slope protection and erosion control works and more training is required.
- Physical / face to face training session would be more interactive and effective.
- The training course was interactive and enhanced our knowledge on slope protection and erosion control works by using bio-engineering techniques. If this training course was face to face with field practice it would have been more effective and efficient for knowledge transfer.
- Providing the course materials beforehand would have made the training course more fruitful.
- Classroom sessions and site visit with field practical sessions is required for better understanding.
- The training course was very relevant for LGED Engineers, and more Sub-assistant Engineers should have been involved.
- This training course was very important for Engineers, who are working in the hilly region of Bangladesh. If this training course was face to face with field practice it would be more fruitful. Special thanks to ADB and LGED high officials who initiated and developed this very interesting and fruitful training course.

Results show that the training remained effective and improved capacity of participants even when delivered virtually due to COVID-19 restrictions. For example, the tables show an obvious shift from novice to higher basic to expert levels of competencies. In addition, majority of participants find that content of the training is very relevant to their work.

APPENDIX A: LIST OF PARTICIPANTS

List of participants at Manager Level

S.No.	Name	Designation/Office
1	Engr. Md. Enamul Haque	Additional Chief Engineer, Chattogram Division
2	Mr. Gopal Krishna Debnath	Additional Chief Engineer, CReLIC
3	Engr. Md. Adbur Rashid Khan	Superintending Engineer, Rangamati CHT Region
4	Engr. Md. Abdus Salam Molla	Superintending Engineer, Roads and Building Design Unit, Dhaka
5	Engr. Md. Shah Alamgir	Superintending Engineer, Bridge Design Unit, Dhaka
6	Sheikh Mohd. Nurul Islam	Superintending Engineer, (P&D), IWRM Unit, LGED HQ, Dhaka
7	S.M. Abdus Salam	Superintending Engineer, (O&M), IWRM Unit, LGED HQ, Dhaka
8	Engr. Nazmus Sadat Md. Zillur Rahman	Executive Engineer, Bandarban, CHT Region
9	Engr. A. H. M. Ahmed Shafi	Executive Engineer, Rangamat, CHT Region
10	Engr. Rafiqul Islam	Executive Engineer, Khagrachari, CHT Region
11	Engr. Md. Abdur Razzaque	Executive Engineer, Roads and Building Design Unit, Dhaka.
12	Engr. Md. Ibrahim Khalil	Executive Engineer, Roads and Building Design Unit, Dhaka.
13	Engr. Vaskar Kanti Chowdhury	Executive Engineer, Bridge Design Unit, Dhaka.
14	Engr. Tarun Banerjee	Executive Engineer, Bridge Design Unit, Dhaka.
15	Engr. Taposh Chowdhury	Executive Engineer, Bridge Design Unit, Dhaka.
16	Mohammad Nazmul Hasan Chowdhury	Executive Engineer, CRIMP, LGED HQ, Dhaka
17	Md. Mahbub Alam	Executive Engineer, (O&M), IWRM Unit, LGED HQ, Dhaka
18	Md. Safiqul Islam	Executive Engineer, CRIMP, LGED HQ, Dhaka
19	Mr. Md. Kamrul Islam	Project Director, RCIP, Dhaka
20	Mr. Md. Ehsanul Hoque	Executive Engineer, Gopalganj
21	Mr. Mirza Md Iftekhar Ali	Executive Engineer, Cumilla
22	Mr. Md Mansur Ali	Deputy Project Director, RCIP, Dhaka
23	Mr. Md. Manjur Rashid	Deputy Project Director, RCIP, Dhaka
24	Kazi Moklesur Rahman	Deputy Secretary, Ministry of Chittagong Hill Tracts Affairs, CHT Region
25	Ashish Kumar Shaha	Deputy Secretary, Ministry of Chittagong Hill Tracts Affairs, CHT Region
26	Md. Lutfor Rahman	Retired ACE, LGED

List of participants of Field Engineers

S.No.	Name	Designation/Office
1	Engr. Md. Asif Mahmud	Upazila Engineer, Alikadam, Bandarban, CHT Region
2	Engr. Md. Mahfuz Hoque	Upazila Engineer, Thanchi, Bandarban, CHT Region
3	Engr. Md. Nazrul Islam	Upazila Engineer, Naikhyongchari, Bandarban, CHT Region
4	Engr. Md. Mahfuzul Hoque	Upazila Engineer, Lama, Bandarban, CHT Region
5	Engr. Md. Jamal Uddin	Upazila Engineer, Ruma, Bandarban, CHT Region
6	Engr. Md. Moniruzaman	Upazilla Engineer, Baghaichari, Rangamati, CHT Region
7	Engr. Md. Monirul Islam Chowdhury	Upazila Engineer, Kaptai, Rangamati, CHT Region
8	Engr. Md. Nazim Uddin	Upazila Engineer, Kaukhali, Rangamati, CHT Region
9	Engr. Pronob Roy Chowdhury	Upazila Engineer, Rangamati Sadar, Rangamati, CHT Region
10	Dr. Ziaul Islam Mazumder	Upazila Engineer, Langadu, Rangamati, CHT Region
11	Engr. Mohammad Irfanul Kabir	Upazila Engineer, Rangamati, CHT Region
12	Ayube Ali	Upazila Engineer, Nanniarchar, Rangamati, CHT Region
13	Engr. Mutiur Rahman	Upazila Engineer, Juraichari, Rangamati, CHT Region
14	*Name not provided*	Upazila Engineer, Rowangchori, Rangamati, CHT Region
15	Engr. Md. Raju Ahmed	Upazila Engineer, Dighinala, Khagrachari, CHT Region
16	Engr. Ashiqur Rahman	Upazila Engineer, Mahalchari, Khagrachari, CHT Region
17	Engr. Md. Shakhawat Hossain	Upazila Engineer, Khagrachari Sadar, Khagrachari, CHT Region
18	Engr. Md. Belal Hasan	Upazila Engineer, Khagrachari Sadar, Khagrachari, CHT Region
19	Engr. Naimul Islam	Upazila Engineer, Ramgarh, Khagrachari, CHT Region
20	Engr. Md. Sajjad Mahmood Khan	Upazila Engineer , Matiranga, Khagrachari, CHT Region
21	Engr. Shishir Chandra Das	Upazila Engineer, Laxmichari, Khagrachari, CHT Region
22	Engr. Abdul Khaleque	Upazila Engineer, Manikchari, Khagrachari, CHT Region
23	Engr. Aurun Kumar Das	Upazila Engineer, Panchari, Khagrachari, CHT Region
24	Engr. Abdul Mannan	Upazila Engineer, Guimara, Khagrachari, CHT Region
25	Sadia Sharmin	Senior Assistant Engineer, CRIMP, Dhaka
26	Ripon Hore	Senior Assistant Engineer, CRIMP, Dhaka
27	Fatema Ismat Ara	Senior Assistant Engineer, CRIMP, Dhaka
28	Saddam Hossain	Senior Assistant Engineer, CRIMP, Dhaka

S.No.	Name	Designation/Office
29	Ms. Rahena Banu	Senior Assistant Engineer, RCIP
30	Mohammad Fazlul Karim	Senior Assistant Engineer, RCIP
31	Engr. Jugal Krishna Mandal	Senior Assistant Engineer, Rangamati, CHT Region
32	A.K.M. Mostafa Morshed	Senior Assistant Engineer, Planning & Design Unit, Dhaka
33	Sharmin Jebin	Senior Assistant Engineer, Design Unit, Dhaka
34	Engr. Md. Enamul Hoque	Senior Assistant Engineer, Roads and Building Design Unit, Dhaka
35	Engr. Md. Shahidul Islam	Senior Assistant Engineer, Roads and Building Design Unit, Dhaka
36	Engr. Md. Shaiduzzaman	Senior Assistant Engineer, Roads and Building Design Unit, Dhaka
37	Engr. Sharmin Jebin	Senior Assistant Engineer, Roads and Building Design Unit, Dhaka
38	Engr. Mohammad Ali	Senior Assistant Engineer, Bridge Design Unit, Dhaka
39	Engr. Md. Mahadi Islam Sikder	Senior Assistant Engineer, Bridge Design Unit, Dhaka
40	Farjana Binte Huq	Assistant Engineer, Planning & Design Unit, Dhaka
41	Md. Omar Faruk	Assistant Engineer, Human Resource Development, Environment & Gender Unit, Dhaka
42	Chowdhury Roosub	Assistant Engineer, RCIP
43	Altaf Hossain	RCIP
44	Zarin Tasnim Chowdhury	Assistant Engineer, Dhaka
45	Safina Mustary Shams	Assistant Engineer, Bagura XEN Office
46	Engr. Abu Bakar Md. Siddique	Assistant Engineer, Roads and Building Design Unit, Dhaka
47	Engr. Md. Mahmudur Rahman	Assistant Engineer, Roads and Building Design Unit, Dhaka
48	Engr. Md. Shamim Hasan	Assistant Engineer, Roads and Building Design Unit, Dhaka
49	Engr. Kaji Md. Mujibur Rahman	Sub Assistant Engineer
50	Engr. Rabi Chakma	Sub Assistant Engineer, Guimara, Khagrachari, CHT Region
51	Engr. Asif Ahnaf Chowdhury	-
52	Arpita Mozumder	LGED HQ
53	Jobayda Akhter	LGED HQ
54	Md Faruque Biswas	-
55	Shishir Chandra Das	UE, Khagrachari
56	Muhammad Rizqi Arya Pradana	-
57	Mohammad Rezaul Karim	-

APPENDIX B: TRAINING NEEDS ASSESSMENT REPORT

BIO-ENGINEERING TRAINING NEEDS ASSESSMENT REPORT

16 MARCH 2022

ABBREVIATIONS

ACE	:	Additional Chief Engineer
ADB	:	Asian Development Bank
AE	:	Assistant Engineer
CHT	:	Chattogram Hill Tracts
EE	:	Executive Engineer
LGED	:	Local Government Engineering Department
NbS	:	Nature-based Solution
SAE	:	Senior Assistant Engineer
SE	:	Superintending Engineer
SuAE	:	Sub-assistant Engineer
TNA	:	Training Needs Assessment
TRTA	:	Transaction Technical Assistant
UAE	:	Upazila Assistant Engineer
UE	:	Upazila Engineer

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1. INTRODUCTION

1.1. SUMMARY

This report presents the result of the Bio-engineering Training Needs Assessment (TNA) of Local Government Engineering Division (LGED) Chattogram Hill (CHT) Region of Bangladesh. The objective of the TNA is to identify knowledge and skills required for the delivery of training and capacity building initiatives to key stakeholders involved in implementation of bio-engineering for roadside slope stabilization and watershed management works.

The TNA process started with identifying the target groups within LGED and accordingly two levels of target groups were identified and listed as the respondents for Bio-engineering TNA namely Policy and Managerial Level and Implementation Level. The Policy and Managerial levels of professionals include Additional Chief Engineers (ACE), Superintending Engineers (SE) and Executive Engineers (EE) while the implementation levels of professionals are field level Engineers namely Upazila Engineers (UE), Senior Assistant Engineers, Assistant Engineers, and Sub-assistant Engineers.

After identifying the target groups, TNA data was gathered by using specially designed questionnaires for the bio-engineering training needs for Engineers. The relevant questionnaire was shared electronically with the identified respondents while open ended discussion meetings were carried out with the Additional Chief Engineer, Superintending Engineers, Executive Engineers Upazila Engineers, and Transaction Technical Assistant (TRTA) team. Meetings with respondents and the TRTA team included discussions on key issues and challenges of roadside slope protection work they are facing while performing their job. This helped to set the content and level of bio-engineering skills that would be practical for different level of the LGED authorities.

Additional Chief Engineer (ACE), Superintending Engineer (SE), 4 Executive Engineers (EE), 16 Upazila Engineers (UE), 3 Senior Assistant Engineers (SAE), 4 Assistant engineers and 2 Sub-assistant Engineers responded to the TNA survey. The respondents demonstrated high level of enthusiasm in participating in the survey and offered valuable input on bio-engineering training contents for Nature-based Solution (NbS) of roadside slope protection and erosion control work of Bangladesh under the LGED CHT Region.

The questionnaires were formulated in four sections as follows:

- The first part included a role analysis to understand the responsibilities of the respondent,
- This was followed by identification of gaps on the knowledge and skills relating to bio-engineering for roadside slope protection and erosion control work,
- The third part consisted of identifying the training requirement and prioritizing which elements should be focused on training,
- The final part focused on the expected nature and approach to learning.

The tables below summarize the responses on the bio-engineering training identifying areas where the most focus is required. There are a total of four tables, one focusing on the

Awareness, one on the Exposure, one on the Knowledge and the final one on Skills. This heat map clearly identifies areas where the LGED Engineers believe they are competent.

1.2. COMPETENCY LEVEL OF POLICY AND MANAGERIAL LEVEL AUTHORITIES IN DIFFERENT AREAS OF BIO-ENGINEERING

Additional Chief Engineers, Superintending Engineers, and Executive Engineers							
Bio-engineering elements	**Awareness**	**Exposure**	**Current level of (perceived) competency in Bio-engineering**				
			Novice	Basic	Moderate	Competent	Expert
1. Slope instability and types	67%	17%	17%		50%	17%	16%
2. Landslide/ slope instability assessment procedure	67%	33%	-	17%	50%	17%	16%
3. Bio-engineering principle and design aspects	67%	-	50%	33%		17%	-
4. Bio-engineering design	33%	-	33%	17%	50%	-	-
5. Bio-engineering plants	67%		67%	-	33%	-	-
6. Bio-engineering nursery design and construction, and plant production	17%	-	83%	-	17%	-	-
7. Bio-engineering site implementation	50%	33%	33%	33%	17%	17%	-
8. Bio-engineering management	33%	17%	33%	33%	17%	17%	-
9. Bio-engineering site maintenance	17%	-	50%	33%	-	17%	-

1.3. COMPETENCY LEVEL OF FIELD ENGINEERS IN DIFFERENT AREAS OF BIO-ENGINEERING

Upazila Engineers, Senior Assistant Engineers, Assistant Engineers, and Sub-assistant Engineers												
Bio-engineering elements	Awareness	Exposure	Level of competent									
			Knowledge					Skill to design and implementation				
			Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert
1. Slope instability and types	52%	24%	8%	44%	28%	16%	4%	48%	28%	4%	16%	4%
2. Landslide /slope instability assessment procedure	52%	20%	12%	40%	36%	8%	4%	56%	28%	4%	8%	4%
3. Bio-engineering principle and design aspects	44%	12%	52%	28%	20%	-	-	76%	16%	8%	-	-
4. Bio-engineering design	44%	8%	64%	32%	4%	-	-	80%	16%	4%	-	-
5. Bio-engineering plants	52%	20%	32%	48%	4%	16%	-	68%	16%	4%	12%	-
6. Bio-engineering nursery design and construction, and plant production	52%	12%	52%	32%	8%	4%	4%	72%	16%	-	12%	-
7. Bio-engineering site implementation	44%	8%	56%	12%	28%	4%	-	72%	12%	8%	8%	-
8. Bio-engineering management	40%	8%	52%	20%	28%	-	-	76%	8%	12%	4%	-
9. Bio-engineering site maintenance	40%	8%	56%	16%	28%	-	-	72%	12%	12%	4%	-

2. TRAINING NEEDS ASSESSMENT (TNA) ON BIO-ENGINEERING

The target groups within LGED were explored and two levels of target groups were identified for bio-engineering training needs assessment, namely Policy and Managerial Level and Implementation Level. The Policy and Managerial levels of professionals include Additional Chief Engineers (ACE), Superintending Engineers (SE) and Executive Engineers (EE), while implementation levels professionals include field Engineers namely, Upazila Engineers (UE), Senior Assistant Engineers (SAE), Assistant Engineers and Sub-assistant Engineers. After identifying the targeted groups, two sets of TNA questionnaires were developed (One set of questionnaires for Policy and Managerial Level and another set of questionnaires for Implementation Level. Sample questionnaires (attached as Annex A) were shared to respondents for TNA survey.

The purpose of the training needs assessment survey was to identify existing knowledge and skill of target groups, analysis of gaps in knowledge and skills on key needs in relation to bio-engineering in order to provide a basis for designing training programmes. The process of training needs assessment was the following objectives;

- to identify the current Knowledge and Skills gaps of target groups in bio-engineering and provide detailed information on the training needs for further development of capacity at policy and managerial and field level,
- to recommend the bio-engineering training outline for addressing bio-engineering training needs for the target groups,
- to provide curricula content and map out the scope of bio-engineering training for target groups.

The Bio-engineering TNA questionnaire required officers to assess themselves on their competency level in various elements of bio-engineering as shown below:

Bio-engineering elements	Awareness	Exposure	Level of competent									
			Knowledge					Skill to design and implementation				
			Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert
1. Slope instability and types												
2. Landslide /slope instability assessment procedure												
3. Bio-engineering principle and design aspects												
4. Bio-engineering design												
5. Bio-engineering plants												

Bio-engineering elements	Awareness	Exposure	Level of competent									
			Knowledge					Skill to design and implementation				
			Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert
6. Bio-engineering nursery design and construction, and plant production												
7. Bio-engineering site implementation												
8. Bio-engineering management												
9. Bio-engineering site maintenance												

One of the accepted forms of assessment of the level of competency of an individual is self-assessment, given that an individual generally knows where their strengths and weaknesses lie though this may come with some level of bias. Over the course of the assessment of training needs, the level of competency in some of the key areas has been self-assessed by the officers of LGED. The levels of competency as given in the self-assessment form were redefined as follows in order to provide for a better understanding of competencies of the respondents:

- **Awareness** - Have generally heard about the subject
- **Exposure** - Have an acceptable level of exposure on the subject matter to have a broad understanding of the principles and practices
- **Knowledge** - The knowledge on the subject has been acquired through education and training but has not been put to practical use
- **Skill/Ability to work** - Have the ability to work in a specified area giving satisfactory results.

3. FINDINGS OF BIO-ENGINEERING TRAINING NEEDS ASSESSMENT

3.1. POLICY AND MANAGERIAL LEVEL

At the Policy and Managerial Level, six respondents were identified in the CHT Region of LGED. The respondents were Additional Chief Engineer, Superintending Engineer and four Executive Engineers who participated in the TNA survey (respondents list is attached as Annex B). All respondents have responded to the TNA survey

The collected survey data was analyzed to assess existing level of competency in different areas of bio-engineering.

The table below shows overall responses in percentage (%) terms for awareness, exposure, and knowledge in different areas of bio-engineering and current competency level of Policy and Managerial Level of LGED CHT Region.

Additional Chief Engineers, Superintending Engineers and Executive Engineers							
Bio-engineering elements	**Awareness**	**Exposure**	**Level of competency in knowledge**				
			Novice	Basic	Moderate	Competent	Expert
10. Slope instability and types	67%	17%	17%		50%	17%	16%
11. Landslide /slope instability assessment procedure	67%	33%	-	17%	50%	17%	16%
12. Bio-engineering principle and design aspects	67%	-	50%	33%		17%	-
13. Bio-engineering design	33%	-	33%	17%	50%	-	-
14. Bio-engineering plants	67%		67%	-	33%	-	-
15. Bio-engineering nursery design and construction, and plant production	17%	-	83%	-	17%	-	-
16. Bio-engineering site implementation	50%	33%	33%	33%	17%	17%	-
17. Bio-engineering management	33%	17%	33%	33%	17%	17%	-
18. Bio-engineering site maintenance	17%	-	50%	33%	-	17%	-

General Observations

Awareness

- 46% of the respondents are aware of bio-engineering.

Exposure

- 11% of the respondents have exposure in bio-engineering.

Knowledge

- 11% of the respondents have expressed their competency level of knowledge in bio-engineering at competent level, 26% at moderate level, 18% at basic level and 41% at novice or inexperienced.

Work Experience

- Work experience of the respondents in the road sector varied from 16 to 33 years.

Work Experience in Bio-engineering

- 67% of the respondents indicated that they have bio-engineering work experience. Work experience of respondents varied from one and half years to twenty years.

Currently Working in Bio-engineering

- 67% of the respondents reported that they are currently working in bio-engineering.

Training

- 33% of the respondents reported that they have attended bio-engineering training.

Gender and Age Group

- All respondents are male and 40 plus in age.

Training Approach

- During the meetings and field visit the respondents strongly mentioned the need of in person (face-to-face) training sessions.

The information above indicates that the Policy and Managerial Level of Officers consider themselves not adequately exposed in different areas of bio-engineering and consider themselves novice. This is despite the fact that 67% (i.e., 4 out of 6 respondents) have been working in bio-engineering sector. This demonstrates their keen interest in having training in bio-engineering works.

3.2. FIELD LEVEL ENGINEERS

A total of 31 potential respondents from field level Engineers were identified in CHT Region of LGED to participate in the survey process. These comprised 22 Upazila Engineers, 3 Senior Assistant Engineers, 4 Assistant Engineers and 2 Sub-assistant Engineers. Completed TNA survey form was received from 23 respondents as follows: 16 Upazila engineers, 3 Senior Assistant Engineers, 4 Assistant Engineers and 2 Sub-assistant Engineers (respondents list is attached as Annex B). The collected survey data was analyzed for the competency level of knowledge and skill in different areas of bio-engineering of the survey participants.

The table below shows overall responses in percentage (%) for awareness, exposure, knowledge, and skill in different areas of bio-engineering and current competency level among field Engineers of LGED CHT Region.

Upazila Engineers, Senior Assistant Engineers, Assistant Engineers, and Sub-assistant Engineers												
Bio-engineering elements	**Awareness**	**Exposure**	**Level of competent**									
			Knowledge					**Skill to design and implementation**				
			Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert
10. Slope instability and types	52%	24%	8%	44%	28%	16%	4%	48%	28%	4%	16%	4%
11. Landslide/slope instability assessment procedure	52%	20%	12%	40%	36%	8%	4%	56%	28%	4%	8%	4%
12. Bio-engineering principle and design aspects	44%	12%	52%	28%	20%	-	-	76%	16%	8%	-	-
13. Bio-engineering design	44%	8%	64%	32%	4%	-	-	80%	16%	4%	-	-
14. Bio-engineering plants	52%	20%	32%	48%	4%	16%	-	68%	16%	4%	12%	-
15. Bio-engineering nursery design and construction, and plant production	52%	12%	52%	32%	8%	4%	4%	72%	16%	-	12%	-
16. Bio-engineering site implementation	44%	8%	56%	12%	28%	4%	-	72%	12%	8%	8%	-
17. Bio-engineering management	40%	8%	52%	20%	28%	-	-	76%	8%	12%	4%	-
18. Bio-engineering site maintenance	40%	8%	56%	16%	28%	-	-	72%	12%	12%	4%	-

General Observations

Awareness

- 47% of the respondents indicated that they are aware of bio-engineering.

Exposure

- 13% of the respondents indicated that they have exposure in bio-engineering.

Knowledge

- 5% of the respondents have expressed their competency level of knowledge in bio-engineering at competent level, 20% of the respondents have expressed their knowledge in bio-engineering at moderate level, 31% of the respondents have expressed their knowledge in bio-engineering at basic level and 43% of the respondents have expressed their competency level of knowledge in bio-engineering at novice or inexperienced.

Skill

- 7% of the respondents have expressed their competency level of skill in bio-engineering at competent level, 6% of the respondents have expressed their skill in bio-engineering at moderate level, 17% of the respondents have expressed their skill in bio-engineering at basic level and 69% of the respondents have expressed their competency level of skill in bio-engineering at novice or inexperienced.

Work Experience

- Work experience of the respondents in the road sector varied from 1 month to 31 years.

Work Experience in Bio-engineering

- 20% of the respondents indicated that they have bio-engineering work experience. Work experience of respondents varied from 6 months to 2 years.

Currently Working in Bio-engineering

- 24% of the respondents reported that they are currently working in bio-engineering.

Training

- 8% of the respondents reported that they have attended bio-engineering training.

Gender and Age Group

- 92% of the respondents are male and 8% respondents are female,
- 56% of respondents are below 40 years and 44% respondents are plus 40.

Training Approach

- During the meetings and field visit the respondents strongly mentioned the need of in person (face-to-face) training sessions.

The data given above shows that the Field Level Engineers have less exposure in different areas of bio-engineering and majority of them consider themselves novice with little skills or exposure in bio-engineering. This indicates that Field Level Engineers would significantly benefit from training in bio-engineering.

4. TRAINING REQUIREMENTS

The respondents self-assessed their competency level of knowledge and skill in different areas of bio-engineering. The self-assessment of respondents shows that bio-engineering knowledge and skill are highly desired by LGED Engineers of CHT Region. This is consistent across both field level as well as senior management and policy level Engineers. Hence two levels of bio-engineering training is recommended for LGED Engineers of CHT Region. Bio-engineering orientation training for Policy and Managerial Levels will largely contribute to develop awareness and motivate the potential policy makers in use of bio-engineering for roadside slope stabilization and watershed management works. On the other hand, training on bio-engineering skills will help to impart skills among Field Level Engineers. Accordingly, bio-engineering training recommendation is as follows:

Training Level	Training Input	Participants
Training for Policy and Managerial Level (Level-I).	Orientation Training	• Additional Chief Engineer • Superintending Engineer • Executive Engineers
Training for Field Level Engineers (Level-II)	Training to impart skills at user level for hands-on experience in bio-engineering	• Upazila Engineers • Senior Assist. Engineers • Assist. Engineers • Sub-assistant Engineers

4.1. BIO-ENGINEERING TRAINING FOR POLICY AND MANAGERIAL LEVEL

Bio-engineering orientation training is essential for Policy and Managerial Levels to make the decision makers more aware and informed of the potential of bio-engineering measures for roadside slope stabilization and watershed management works. This will further contribute to initiative positive behavioural changes and increase motivation among decision makers, and designers to promote and adopt Nature-based Solution for roadside slope stabilization and watershed management work.

4.2. TRAINING CONTENT AND TOPIC FOR POLICY AND MANAGERIAL LEVEL

- Introduction to the training course
- Slope instability and types
- Causes and mechanisms of slope failure
- Components of an unstable slope
- Roadside slope protection practices
- Introduction to bio-engineering
- Design aspects of civil engineering structures

- Engineering functions of bio-engineering system
- Vegetative structures and design aspects of vegetative structures
- Interaction between plants and civil engineering structures
- Landslide/slope instability assessment procedure
- Selection of bio-engineering techniques
- Selection of plant species for bio-engineering
- Bio-engineering nursery
- Construction of vegetative structures
- Bio-engineering work in Nepal and Timor-Leste (Regional knowledge exchange on bio-engineering best practices of Nepal and Timor-Leste)
- Bio-engineering maintenance tasks
- Bio-engineering work programming and scheduling
- Guidelines on Bio-engineering Practices for Road and Watershed Management Works
- Training evaluation

4.3. TRAINING DURATION AND APPROACH

The training for the Policy and Managerial Level shall be designed as a 1-day orientation training event. Due to the travel restrictions imposed due to COVID 19 restrictions, training will be carried out using online virtual media.

4.4. TRAINING CONTENT AND TOPIC, AIM AND OBJECTIVES

CONTENT AND TOPIC	AIM	OBJECTIVES
1. Introduction to the training course	• To introduce the participants to the Course, the Trainers and each other so that they will clearly appreciate the nature of the Course and will get to know the other people with whom they are working.	The participants will be able to: - describe the approaches to training which will be used - discuss the objectives of the Course - establish working relationships with the other members of the Course
2. Slope instability and types	• To teach the participants slope instability types and its impact. Participants will use this information as an instability assessment, and as a basis for specifying appropriate remedial measures.	Participants will be able to: - understand and describe type of slope instability and impacts of slope instability.
3. Causes and mechanisms of slope failure	• To teach the participants geomorphological processes underlying and leading to slope failure. Participants will use this information as an instability assessment, and as a basis for specifying appropriate remedial measures.	Participants will be able to: - name the causes of, and conditions leading to, slope failure - name the mechanisms by which strength in a slope is lost, and by which failure occurs - state the relationship between these two sets of principles
4. Components of an unstable slope	• To teach the participants general characteristics of an unstable slope and relate these to mechanisms of failure. Participants will use this information as part of the process of the assessment of instability.	The participants will be able to: - describe the four zones of a landslide - describe the four principal material types and their association with the mechanisms of failure

CONTENT AND TOPIC	AIM	OBJECTIVES
		- describe the significance of the slope affected to the assessment
5. Roadside slope protection practices	• To show the participants conventional and bio-engineering methods of slope protection work so that they can understand the differences between conventional and bio-engineering methods of slope protection work.	The participants will be able to: - describe and compare the advantage and disadvantage of conventional and bio-engineering method of slope protection work.
6. Introduction to bio-engineering	• To introduce the meaning of bio-engineering and establish its importance so that the participants understand the idea of bio-engineering and are motivated to learn about it and apply it in their work	The participants will be able to: - define the term 'bio-engineering' - justify the general use of bio-engineering in road construction and maintenance
7. Design aspects of civil engineering structures	• To revise engineering structures, with their functions, construction and uses, so that the participants are able to plan the integration of civil and vegetative structures.	The participants will be able to: - identify suitable structures for given sites - justify their choices - design their construction
8. Engineering functions of bio-engineering system	• To teach the participants the mechanical and hydrological engineering functions of plants so that they will be able to use this information in designing bio-engineering measures.	The participants will be able to: - describe the six engineering functions which may be performed by plants - describe the hydrological functions of plants - explain the adverse and beneficial effects of plants

CONTENT AND TOPIC	AIM	OBJECTIVES
9. Vegetative structures and design aspects of vegetative structures	• To teach the range of vegetative engineering systems and their design principles so that the participants can analyse the different systems and correctly apply them.	The participants will be able to: - describe the main vegetative engineering systems - explain each system's functions and operations - select suitable systems for different site conditions - describe their limitations.
10. Interaction between plants and civil engineering structures	• To teach the participants the changes in the relative strength of civil engineering and vegetative engineering structures over time and the relationship between the two types of structure so that they are able to use this information in planning fully integrated bio-engineering works.	The participants will be able to: - describe the changes in the relative strength of civil engineering and bio-engineering structures - explain how civil engineering and vegetative engineering structures may be integrated to increase their effectiveness - explain how an engineering function may be handed over from one type of structure to another type and the need for the two structures to be compatible.
11. Landslide/slope instability assessment procedure	• To teach the participants assessment procedure of landslide and slope instability assessment so that they are able to describe appropriate remedial measures for slope protection work.	The participants will be able to: - describe how to assess a site for the application of bio-engineering measures.

CONTENT AND TOPIC	AIM	OBJECTIVES
12. Selection of bio-engineering techniques	• To teach the participants how to select the optimum technique for slope stabilisation using bio-engineering measures so that they are able to choose appropriate techniques for stabilising sites.	The participants will be able to: - describe how to assess a site for the application of bio-engineering measures - explain the critical factors affecting the selection of techniques - apply the guidelines for applying bio-engineering
13. Selection of plant species for bio-engineering	• To teach the participants to select suitable plant species for meeting the requirements of specific sites so that they can apply this knowledge in planning bio-engineering implementation.	The participants will be able to: - identify the physical site characteristics which may influence the choice of species - describe the process of selecting appropriate plant species for specific situations - identify suitable species for a range of situations and justify their choices
14. Bio-engineering nursery	• To teach the participants importance of bio-engineering nursery and how to select suitable nursery sites through assessment of the characteristics of land position, natural qualities, and location with respect to the road so that they can efficiently produce plants for bio-engineering work.	The participants will be able to: - state the site characteristics and resources which are needed for a good nursery - state the criteria for spacing out nurseries along a road line - identify suitable sites and evaluate proposed sites. - describe the components of a nursery

CONTENT AND TOPIC	AIM	OBJECTIVES
15. Construction of vegetative structures	• To teach the participants the methods of establishing of vegetative engineering structures so that they are able to supervise the implementation of these works.	The participants will be able to: - describe the procedures for implementing the vegetative engineering systems - identify the key points related to safety and effectiveness in these procedures - explain the importance of adopting a stepwise procedure in implementing these systems
16. Bio-engineering work in Nepal and Timor-Leste (Regional knowledge exchange on bio-engineering best practices of Nepal and Timor-Leste)	• To show the participants bio-engineering practice of Nepal and Timor-Leste.	The participants will be able to: - describe potential of bio-engineering works for roadside slope stabilization and erosion control works.
17. Bio-engineering maintenance task	• To teach the participants the importance of bio-engineering maintenance, the tasks which are required and the frequency with which these tasks have to be carried out so that they can use this information as a basis for programming bio-engineering maintenance.	The participants will be able to: - explain the importance of maintaining bio-engineering works - identify the main tasks performed in bio-engineering maintenance - explain the frequency with which maintenance tasks must be carried out - outline the recommended procedures for thinning and pruning trees.
18. Bio-engineering work programming	• To teach the participants to programme bio-engineering works in relation to the biological calendar and how this	The participants will be able to:

CONTENT AND TOPIC	AIM	OBJECTIVES
	programme can be accomplished within the framework of the financial systems so that they are able to manage the programming of bio-engineering work within their regions.	- explain the importance of careful programming from the biological point of view - prepare a bio-engineering calendar - explain how bio-engineering programmes may be achieved within the framework of the Fiscal Year.
19. Guidelines on Bio-engineering Practices for Road and Watershed Management Works	• To introduce the Guidelines on Bio-engineering Practices for Road Works and Slope Stabilization and Watershed Management Works prepared by ADB TA-9461 REG: Protecting and Investing in Natural Capital in Asia and the Pacific for LGED Bangladesh.	The participants will be able to: - explain the importance of the bio-engineering guideline for roadside slope stabilization and watershed management work, - apply the bio-engineering guidelines in the design of roadside slope stabilization and watershed management works of LGED, - check whether the bio-engineering guidelines have been applied in the execution of a contract of roadside slope stabilization and watershed management works.
20. Training evaluation	• To obtain the participants' evaluation of the training so that this information can be used in the improvement of future trainings.	The participants will be able to: - express their individual views on the training - discuss the effectiveness of the training - present recommendations for improvements to the training.

4.5. BIO-ENGINEERING TRAINING FOR FIELD ENGINEERS

This training course is designed to impart skills at a user level for field level applications by the engineering officers responsible for planning, design, execution, and supervision of work. The skill imparted through the training course will be provide to Upazila Engineers, Senior Assistant Engineers, Assistant Engineers, and Sub-assistant Engineers of LGED CHT Region.

4.6. TRAINING CONTENT/TOPIC FOR FIELD ENGINEERS

- Introduction to the training course
- Slope Instability and types
- Causes and mechanisms of slope failure
- Components of an unstable slope
- Roadside slope protection practices
- Introduction to bio-engineering
- Design aspects of civil engineering structures
- Engineering function of bio-engineering system
- Vegetative structures and design aspects of vegetative structures
- Interaction between civil and vegetative structures
- General plant types
- Landslide/slope instability assessment procedure
- Selection of bio-engineering techniques
- Selection of plant species for bio-engineering
- Siting of bio-engineering nursery
- Nursery components and size
- Nursery layout, design, and nursery bed construction
- Seed collection and storage
- Collection of vegetative plant material
- Compost production and filling polypots
- Seed sowing and planting cuttings in nursery
- Care of young plant in nursery
- Hardening, lifting, and transporting to site
- Scheduling nursery work and record keeping
- Site safety and traffic control
- Site preparation and spoil disposal
- Construction of vegetative structures

- Bio-engineering work in Nepal and Timor-Leste slide presentation (Regional knowledge exchange on bio-engineering best practices of Nepal and Timor-Leste)
- Bio-engineering maintenance task
- Yearly and seasonal work programming of bio-engineering work
- Guidelines on Bio-engineering Practices for Road and Watershed Management Works.
- Training course evaluation

4.7. TRAINING DURATION AND APPROACH

The training course for the Field Engineers is designed as a for 3 to 4 day long training event. This would be highly effective when carried out in-person. However, owing to COVID limitations, the training will be carried out through online virtual media.

4.8. TRAINING CONTENT/TOPIC, AIM AND OBJECTIVES

CONTENT/TOPIC	AIM	OBJECTIVES
1. Introduction to the training course	• To introduce the participants to the Course, the Trainers and each other so that they will clearly appreciate the nature of the Course and will get to know the other people with whom they are working.	The participants will be able to: - describe the approaches to training which will be used - discuss the objectives of the Course - establish working relationships with the other members of the Course
2. Slope instability and types	• To teach the participants slope instability and impacts of slope instability. Participants will use this information as part of the process of the assessment of slope instability.	The participants will be able to: - understand and describe slope instability and its impacts on road. - describe type of slope instability.
3. Causes and mechanisms of slope failure	• To teach the participants geomorphological processes underlying and leading to slope failure. Participants will use this information as a slope instability assessment, and as a basis for specifying appropriate remedial measures.	Participants will be able to: - name the causes of, and conditions leading to, slope failure - name the mechanisms by which strength in a slope is lost, and by which failure occurs - state the relationship between these two sets of principles
4. Components of an unstable slope	• To teach the participants general characteristics of an unstable slope and relate these to mechanisms of failure. Participants will use this information as part of the process of the assessment of instability.	The participants will be able to: - describe the four zones of a landslide - describe the four principal material types and their association with the mechanisms of failure

CONTENT/TOPIC	AIM	OBJECTIVES
		- describe the significance of the slope affected to the assessment of instability
5. Roadside slope protection practices	• To show the participants conventional and bio-engineering methods of slope protection work so that they can understand the differences between conventional and bio-engineering method of slope protection work.	The participants will be able to: - describe and compare the advantage and disadvantage of conventional and bio-engineering method of slope protection work.
6. Introduction to bio-engineering	• To introduce the meaning of bio-engineering and establish its importance so that the participants understand the idea of bio-engineering and are motivated to learn about it and apply it in their work	The participants will be able to: - define the term 'bio-engineering' - justify the general use of bio-engineering in road construction and maintenance
7. Design aspects of civil engineering structures	• To revise engineering structures, with their functions, construction and uses, so that the participants are able to plan the integration of civil and vegetative structures.	The participants will be able to: - identify suitable structures for given sites - justify their choices - design their construction
8. Engineering function of bio-engineering system	• To teach the participants the mechanical and hydrological engineering functions of plants so that they will be able to use this information in designing bio-engineering measures.	The participants will be able to: - describe the six engineering functions which may be performed by plants - describe the hydrological functions of plants - explain the adverse and beneficial effects of plants

CONTENT/TOPIC	AIM	OBJECTIVES
9. Vegetative structures and design aspects of vegetative structures	• To teach the range of vegetative engineering systems and their design principles so that the participants can analyse the different systems and correctly apply them.	The participants will be able to: - describe the main vegetative engineering systems - explain each system's functions and operations - select suitable systems for different site conditions - describe their limitations.
10. Interaction between civil and vegetative structures	• To teach the participants the changes in the relative strength of civil engineering and vegetative engineering structures over time and the relationship between the two types of structure so that they are able to use this information in planning fully integrated bio-engineering works.	The participants will be able to: - describe the changes in the relative strength of civil engineering and bio-engineering structures - explain how civil engineering and vegetative engineering structures may be integrated to increase their effectiveness - explain how an engineering function may be handed over from one type of structure to another type and the need for the two structures to be compatible.
11. General plant types	• To teach the different plant groupings that are relevant to bio-engineering and the value of different types of plants for performing bio-engineering functions so that the participants are able to use this knowledge as a background to select plants for bio-engineering.	The participants will be able to: - describe the broad grouping of species used in bio-engineering - define the term 'improvement plant' - describe the value of different groups of plants for meeting various bio-engineering functions.

CONTENT/TOPIC	AIM	OBJECTIVES
12. Landslide/slope instability assessment procedure	• To teach the participants assessment procedure of landslide and slope instability assessment so that they are able to describe appropriate remedial measures for slope protection work.	The participants will be able to: - describe how to assess a site for the application of bio-engineering measures.
13. Selection of bio-engineering techniques	• To teach the participants how to select the optimum technique for slope stabilisation using bio-engineering measures so that they are able to choose appropriate techniques for stabilising sites.	The participants will be able to: - describe how to assess a site for the application of bio-engineering measures - explain the critical factors affecting the selection of techniques - apply the guidelines for applying bio-engineering
14. Selection of plant species for bio-engineering	• To teach the participants to select suitable plant species for meeting the requirements of specific sites so that they can apply this knowledge in planning bio-engineering implementation.	The participants will be able to: - describe the process of selecting appropriate plant species for specific situations - identify suitable species for a range of situations and justify their choices
15. Siting of bio-engineering nursery	• To teach the participants how to select suitable nursery sites through assessment of the characteristics of land position, natural qualities, and location with respect to the road so that they can efficiently produce plants for bio-engineering work.	The participants will be able to: - state the site characteristics and resources which are needed for a good nursery - state the criteria for spacing out nurseries along a road line

CONTENT/TOPIC	AIM	OBJECTIVES
		- identify suitable sites and evaluate proposed sites
16. Nursery components and size	• To teach the participants the components of a nursery and the equipment and materials required, and the space required in a nursery so that they are able to use this information in nursery design.	The participants will be able to: - describe the components of a nursery - list the equipment and materials required in a nursery - calculate the area required for a nursery to produce a defined quantity of stock
17. Nursery layout, design, and nursery bed construction	• To teach the basic design criteria for the layout of a nursery and for the individual components so that the participants are able to use this knowledge in the design, construction and setting up of nurseries in their place.	The participants will be able to: - plan the layout for a nursery for a given site - describe the essential design requirements of each nursery component - give reasons for these design requirements - describe the design requirements of nursery beds - describe the procedure for building a nursery bed
18. Seed collection and storage	• To teach the principles of the collection of different types of seeds and their storage so the participants are able to manage the efficient collection and storage of seed for use in nurseries.	The participants will be able to: - select appropriate locations and plants for seed collection - prepare seed collection calendars for the main bio-engineering species

CONTENT/TOPIC	AIM	OBJECTIVES
		- describe the methods of processing and storage
19. Collection of vegetative plant material	• To teach the participants how to recognise suitable plant material from which to take cuttings so that they are able to propagate plants successfully by this method.	The participants will be able to: - identify the parts of plants which can be used for vegetative propagation - identify individual plants as suitable sources of material - state the reasons why those plants are selected - organise the collection of propagation material
20. Compost production and filling polypots	• To teach the participants the procedures for preparing compost and for filling polypots so that they are able to effectively supervise staff carrying out these tasks.	The participants will be able to: - describe how compost is made - explain the advantages of using polypots in a nursery - describe how a polypot is filled
21. Seed sowing and planting cuttings in nursery	• To teach the participants how to prepare and sow different types of seeds, main methods of preparing and planting cuttings so that they are able to instruct staff and check that correct techniques are being followed in nurseries.	The participants will be able to: - describe the treatments required by different types of seeds - state the correct method of preparing and sowing seeds - prepare and sow different types of seeds - describe how a cutting is taken and prepared

CONTENT/TOPIC	AIM	OBJECTIVES
		- describe how the cutting is stored ready for transport and planting - describe how the cutting is planted
22. Care of young plant in nursery	• To teach the procedures that are required for nurturing young plants, and the hazards which threaten them so that the participants are able to manage the production of plants in a nursery.	The participants will be able to: - explain the requirements for successfully rearing plants in a nursery - describe the techniques used to keep young plants growing well - describe the safety precautions which should be taken when chemicals are used
23. Hardening, lifting, and transporting to site	• To teach the reasons for hardening off plants and how this is done, and the procedures for lifting and processing plants prior to transport so that the participants can manage the transfer of plants from the nursery to planting sites.	The participants will be able to: - explain the reasons for hardening plants off - describe the procedures for hardening plants off - describe the procedures involved in lifting different kinds of plants - describe the preparation of plants for transport and their care on site
24. Scheduling nursery work and recording	• To teach the participants how to schedule the activities carried out in a nursery, to arrange them so that they are carried out at the right time and in the proper sequence, and to teach them to complete records in a timely and efficient manner	The participants will be able to: - state the main activities required in running a nursery - prepare a schedule of the activities in a nursery

CONTENT/TOPIC	AIM	OBJECTIVES
	so that they are able to apply this information to the effective management of work in their nursery.	- complete nursery registers - state sources for the procurement of tools and materials used in a nursery
25. Site safety and traffic control	• To teach the participants the issues related to the safety of workers and road users during site works in mountainous areas so that they are able to ensure that these works are carried out safely.	The participants will be able to: - explain the main hazards of working on steep slopes - describe the safety precautions which should be taken to avoid accident and injury - describe the basics of signing and traffic control at roadworks
26. Site preparation and spoil disposal	• To teach the participants the principles of preparing a site for bio-engineering works so that they are able to effectively plan and manage these works.	The participants will be able to: - state the procedure for site preparation for bio-engineering works - check that the trimming has been done correctly - state the basics rules of safe spoil disposal
27. Construction of vegetative structures	• To teach the participants the methods of establishing types of vegetative engineering structures so that they are able to supervise the implementation of these works.	The participants will be able to: - describe the procedures for implementing the main vegetative engineering systems - identify the key points related to safety and effectiveness in these procedures

CONTENT/TOPIC	AIM	OBJECTIVES
		- explain the importance of adopting a stepwise procedure in implementing these systems
28. Bio-engineering work in Nepal and Timor-Leste slide presentation (Regional knowledge exchange on bio-engineering best practices of Nepal and Timor-Leste)	• To show the participants best practice of bio-engineering in Nepal and Timor-Leste.	The participants will be able to: - describe potential of bio-engineering work for roadside slope stabilization and watershed management work.
29. Bio-engineering maintenance task	• To teach the participants the importance of bio-engineering maintenance, the tasks which are required and the frequency with which these tasks have to be carried out so that they can use this information as a basis for programming bio-engineering maintenance.	The participants will be able to: - explain the importance of maintaining bio-engineering works - identify the main tasks performed in bio-engineering maintenance - explain the frequency with which maintenance tasks must be carried out - outline the recommended procedures for thinning and pruning trees
30. Yearly and seasonal work programming of bio-engineering work	• To teach the participants to programme bio-engineering works in relation to the biological calendar and how this programme can be accomplished within the framework of the financial systems of the Government's so that they are able to manage the programming of bio-engineering work within their divisions,	The participants will be able to: - explain the importance of careful programming from the biological point of view - prepare a bio-engineering calendar - explain how bio-engineering programmes may be achieved within the framework of the Government's Fiscal Year

CONTENT/TOPIC	AIM	OBJECTIVES
31. Guidelines on Bio-engineering Practices for Road and Watershed Management Works.	• To introduce the participants the Bio-engineering Guidelines for Roadside Slope Protection and Watershed Management Works, prepared by ADB TA-9461 REG: Protecting and Investing in Natural Capital in Asia and the Pacific for LGED Bangladesh.	The participants will be able to: - explain the importance of the bio-engineering guideline for roadside slope protection and watershed management work, - apply the bio-engineering guidelines in the design of roadside slope protection and watershed management works of LGED, - apply and explain the importance of the rate analysis norms for bio-engineering works - apply the bio-engineering standard specifications in the preparation of contracts - check whether the specifications have been applied in the execution of a contract.
32. Training course evaluation	• To obtain the participants' evaluation of the training course so that this information can be used in the improvement of future training courses.	The participants will be able to: - express their individual views on the Course - discuss the effectiveness of the Course - present recommendations for improvements to the Course

5. ANNEX A: BIO-ENGINEERING TRAINING NEEDS ASSESSMENT QUESTIONNAIRE

TA-9461 REG: Protecting and Investing in Natural Capital in Asia and the Pacific

Climate Resilient Livelihood Improvement and Watershed Management in Chittagong Hill Tracts Sector Project

Bio-engineering Training Needs Assessment (TNA) for Policy and Managerial Level

1. Full name : .....

2. Gender : Male Female

3. Contact No. : ..... Email address : .....

4 Current position : .....

5 Department/Unit : .....

6 Age group : 20-25 26-30 31-40 40+

7 How many years of work experience do you have in road sector?

.....years .....months

8 What is your current role and responsibilities in the organization?

.....
.....
.....

9 Do you have bio-engineering work experience?

Yes No

If Yes, ... years ..... months

10 Are you currently working in bio-engineering?

Yes No

11 Have you attended the bio-engineering training or workshop?

Yes No

If Yes, a) Training .....days b) Workshop ..... days

12 What do you understand by the term bio-engineering?

.....
.....
.....

13 Competency level in various elements of bio-engineering. Please give your level of competency by ticking (√) the boxes in the table below;

Bio-engineering elements	Awareness	Exposure	Level of competent				
			Knowledge				
			Novice	Basic	Moderate	Competent	Expert
1. Slope instability and types							
2. Landslide /slope instability assessment procedure							
3. Bio-engineering							
4. Bio-engineering principle and design aspects							
5. Bio-engineering design							
6. Bio-engineering plants							
7. Bio-engineering nursery design and construction, and plant production							
8. Bio-engineering site implementation							
9. Bio-engineering management							
10. Bio-engineering site maintenance							

14 Suggestions

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TA-9461 REG: Protecting and Investing in Natural Capital in Asia and the Pacific

Climate Resilient Livelihood Improvement and Watershed Management in Chittagong Hill Tracts Sector Project

Bio-engineering Training Needs Assessment (TNA) for Field Engineers

1. Full name : .....

2. Gender : Male Female

3. Contact No. : ..... Email address : .....

4 Current position : .....

5 Department/Unit : .....

6 Age group : 20-25 26-30 31-40 40+

7 How many years of work experience do you have in road sector?

.....years .....months

8 What is your current role and responsibilities in the organization?

.....
.....
.....

9 Do you have bio-engineering work experience?

Yes No

If Yes, ... years ..... months

10 Are you currently working in bio-engineering?

Yes No

11 Have you attended the bio-engineering training or workshop?

Yes No

If Yes, a) Training .....days b) Workshop ..... days

12 What do you understand by the term bio-engineering?

.....
.....
.....

13 Competency level in various elements of bio-engineering. Please give your level of competency by ticking (√) the boxes in the table below;

Bio-engineering elements	Awareness	Exposure	Level of competent									
			Knowledge					Skill to design and implementation				
			Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert
1. Slope instability and types												
2. Landslide /slope instability assessment procedure												
3. Bio-engineering												
4. Bio-engineering principle and design aspects												
5. Bio-engineering design												
6. Bio-engineering plants												
7. Bio-engineering nursery design and construction, and plant production												
8. Bio-engineering site implementation												
9. Bio-engineering management												
10.Bio-engineering site maintenance												

14 Suggestions

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6. ANNEX B: LIST OF RESPONDENTS

List of Respondents from LGED CHT Region

Region	Name of Offices	Name of Responsible Engineers	Designation of Responsible Engineers	Survey Response
Chattogram Division	Additional Chief Engineer's Office	Engr. Md. Enamul Haque	Additional Chief Engineer	In-Person
		Engr. Md. Mahbubur Rahman	Executive Engineer	In-Person
Rangamati	Superintending Engineer's Office	Engr. Md. Adbur Rashid Khan	Superintending Engineer	In-person
Bandarban	XEN Office	Engr. Nazmus Sadat Md. Zillur Rahman	Executive Engineer	Email and in-person
		Engr. Md. Jamal Uddin	Senior Assistant Engineer	Email and in-person
	Rowangchori	Engr. Dibakar Roy	Upazila Engineer	Email
	Bandarban Sadar	Engr. Robiul hossain	Upazila Engineer	Email
	Naikhyongchari	Engr. Md. Abul Kalam Azad	Upazila Engineer	Email
	Lama	Engr. Md. Mahfuzul Hoque	Upazila Engineer	Email

Region	Name of Offices	Name of Responsible Engineers	Designation of Responsible Engineers	Survey Response
Rangamati	XEN Office	Engr. A. H.M. Ahmed Shafi	Executive Engineer	In-person
		Engr. Jugal Krishna Mandal	Senior Assistant Engineer	In-person
	Baghaichari	Engr. Md. Moniruzaman	Upazilla Engineer	Email
	Kaptai	Engr. Md. Monirul Islam Chowdhury	Upazila Engineer	Email
	Kaukhali	Engr. Md. Nazim Uddin	Upazila Engineer	Email
	Rangamati Sadar	Engr. Rony Saha	Upazila Engineer	Email
	Rajosthali	Engr. Hasibul Hasan Dew	Upazila Engineer	Email
Khagrachar	XEN Office	Engr. Rafiqul Islam	Executive Engineer	Email
		Engr. Md. Belal Hasan	Senior Assistant Engineer	Google Form
		Engr. Supan Chakma	Assistant Engineer	Email
		Engr. Asif Ahnat Chowdhury	Assistant Engineer	Google Form
	Dighinala	Engr. Md. Raju Ahmed	Upazila Engineer	Email
	Mahalchari	Engr. Ashiqur Rahman	Upazila Engineer	Google Form

Region	Name of Offices	Name of Responsible Engineers	Designation of Responsible Engineers	Survey Response
	Ramgarh	Engr. Naimul Islam	Upazila Engineer	Google Form
		Engr. Kaji Md. Mujibur Rahman	Sub Assistant Engineer	Google Form
	Laxmichari	Engr. Shishir Chandra Das	Upazila Engineer	Email
	Manikchari	Engr. Abdul Khaleque	Upazila Engineer	Email
	Panchari	Engr. Aurun Kumar Das	Upazila Engineer	Email
		Engr. Rabi Chakma	Sub Assistant Engineer	Google Form and
		Engr. Asif Mohmud	Upazila Engineer	Google Form
Dhaka Division	LGED HQ	Zarin Tasnim Chowdhury	Assistant Engineer	Email
	Bagura XEN office	Safina Mustary Shams	Assistant Engineer	Email

7. ANNEX C: COMPETENCY LEVEL OF OFFICERS TNA FINDINGS

COMPETENCY LEVEL OF POLICY AND MANAGERIAL LEVEL OF OFFICERS IN DIFFERENT AREAS OF BIO-ENGINEERING

Additional Chief Engineers, Superintending Engineers and Executive Engineers									
Bio-engineering elements	**Awareness**	**Exposure**	**Level of competent**					**Experience in bio-engineering**	**Currently working in bio-engineering**
			Knowledge						
			Novice	Basic	Moderate	Competent	Expert		
1. Slope instability and types	67%	17%	17%		50%	17%	16%	67%	67%
2. Landslide /slope instability assessment procedure	67%	33%	-	17%	50%	17%	16%		
3. Bio-engineering principle and design aspects	67%	-	50%	33%		17%	-		
4. Bio-engineering design	33%	-	33%	17%	50%	-	-		
5. Bio-engineering plants	67%		67%	-	33%	-	-		
6. Bio-engineering nursery design and construction, and plant production	17%	-	83%	-	17%	-	-		
7. Bio-engineering site implementation	50%	33%	33%	33%	17%	17%	-		
8. Bio-engineering management	33%	17%	33%	33%	17%	17%	-		
9. Bio-engineering site maintenance	17%	-	50%	33%	-	17%	-		

COMPETENCY LEVEL OF UPAZILA ENGINEERS IN DIFFERENT AREAS OF BIO-ENGINEERING

Bio-engineering elements	Awareness	Exposure	Level of competent										Experience in bio-engineering	Currently working in bio-engineering
			Knowledge					Skill to design and implementation						
			Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert		
1. Slope instability and types	56%	25%	7%	44%	31%	12%	6%	50%	19%	6%	19%	6%	13%	13%
2. Landslide /slope instability assessment procedure	50%	25%	7%	44%	31%	12%	6%	56%	19%	7%	12%	6%		
3. Bio-engineering principle and design aspects	44%	12%	56%	25%	19%	-	-	82%	12%	6%	-	-		
4. Bio-engineering design	44%	6%	63%	31%	6%	-	-	88%	6%	6%	-	-		
5. Bio-engineering plants	56%	19%	31%	56%	7%	6%	-	76%	6%	6%	12%	-		
6. Bio-engineering nursery design and construction, and plant production	50%	12%	63%	25%	6%	6%	-	75%	13%	-	12%	-		
7. Bio-engineering site implementation	50%	12%	63%	6%	25%	6%	-	82%	6%	-	12%	-		
8. Bio-engineering management	44%	12%	63%	12%	25%	-	-	82%	6%	6%	6%	-		
9. Bio-engineering site maintenance	44%	12%	63%	12%	25%	-	-	82%	6%	6%	6%	-		

COMPETENCY LEVEL OF SENIOR ASSISTANT ENGINEERS IN DIFFERENT AREAS OF BIO-ENGINEERING

Bio-engineering elements	Awareness	Exposure	Level of competent										Experience in bio-engineering	Currently working in bio-engineering
			Knowledge					Skill to design and implementation						
			Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert		
1. Slope instability and types	100%	33%	-	34%	33%	33%		34%	33%	-	33%	-	33%	67%
2. Landslide /slope instability assessment procedure	100%	33%	33%	67%	-	-	-	67%	33%	-	-	-		
3. Bio-engineering principle and design aspects	67%	33%	67%	33%	-	-	-	67%	33%	-	-	-		
4. Bio-engineering design	67%	-	67%	33%	-	--	-	67%	33%	-	-	-		
5. Bio-engineering plants	100%	33%	67%	33%	-	-	-	67%	33%	-	-	-		
6. Bio-engineering nursery design and construction, and plant production	100%	-	67%	33%	-	-	-	67%	33%	-	-	-		
7. Bio-engineering site implementation	33%	-	67%	-	33%	-	-	67%	33%	-	-	-		
8. Bio-engineering management	33%	-	67%	-	33%	-	-	67%	33%	-	-	-		
9. Bio-engineering site maintenance	33%	-	67%	-	33%	-	-	67%	33%	-	-	-		

COMPETENCY LEVEL OF ASSISTANT ENGINEERS IN DIFFERENT AREAS OF BIO-ENGINEERING

Bio-engineering elements	Awareness	Exposure	Level of competent										Experience in bio-engineering	Currently working in bio-engineering
			Knowledge					Skill to design and implementation						
			Novice	Basic	Moderate	Competent	Expert	Novice	Basic	Moderate	Competent	Expert		
1. Slope instability and types	-	25%	-	50%	25%	25%	-	25%	75%	-	-	-	50%	50%
2. Landslide /slope instability assessment procedure	25%	-	-	25%	75%	-	-	25%	75%	-	-	-		
3. Bio-engineering principle and design aspects	25%	-	-	50%	50%	-	-	50%	25%	25%	-	-		
4. Bio-engineering design	25%	-	25%	50%	25%	-	-	50%	50%	-	-	-		
5. Bio-engineering plants	-	25%	-	25%		75%	-	25%	75%	-	-	-		
6. Bio-engineering nursery design and construction, and plant production	25%	-	-	50%	25%	-	25%	50%	25%	-	25%	-		
7. Bio-engineering site implementation	25%	-	50%	25%	25%	-	-	50%	-	50%	-	-		
8. Bio-engineering management	25%	-	-	50%	50%	-	-	50%	-	50%	-	-		
9. Bio-engineering site maintenance	25%	-	25%	25%	50%	-	-	50%	-	50%	-	-		

COMPETENCY LEVEL OF SUB-ASSISTANT ENGINEERS IN DIFFERENT AREAS OF BIO-ENGINEERING

Bio-engineering elements	Awareness	Exposure	Level of competent										Experience in bio-engineering	Currently working in bio-engineering
			Knowledge					Skill to design and implementation						
			Novice			Competent	Expert	Novice	Basic	Moderate	Competent	Expert		
1. Slope instability and types	50%	-	50%	50%	-	-	-	100%	-	-	-	-	-	-
2. Landslide /slope instability assessment procedure	50%	-	50%	50%	-	-	-	100%	-	-	-	-		
3. Bio-engineering principle and design aspects	50%	-	100%	-	-	-	-	100%	-	-	-	-		
4. Bio-engineering design	50%	-	100%	-	-	-	-	100%	-	-	-	-		
5. Bio-engineering plants	50%	-	50%	50%	-	-	-	100%	-	-	-	-		
6. Bio-engineering nursery design and construction, and plant production	50%	-	100%	-	-	-	-	100%	-	-	-	-		
7. Bio-engineering site implementation	50%	-	100%	-	-	-	-	100%	-	-	-	-		
8. Bio-engineering management	50%	-	100%	-	-	-	-	100%	-	-	-	-		
9. Bio-engineering site maintenance	50%	-	100%	-	-	-		100%	-	-	-	-		