Program Profile		
Program	Program name	IMPACT OF SAND GRADATION ON THE PACKING DENSITY AND STRENGTH OF CONCRETE.
	Category	A3, A8 & B3

Summary of Program	
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Category	A3, A8 & B3
Abstract of Program	Concrete is the most widely used construction material in the world, and its performance depends greatly on the characteristics of its constituents. Among these, fine aggregate (sand) plays a crucial role in the overall behavior of fresh and hardened concrete. The gradation of sand influences the packing density, which directly affects workability, density, and mechanical strength of concrete. However, there is a lack of focused research that systematically quantifies the relationship between sand gradation, packing density, and resulting concrete strength. This study aims to bridge that gap by analyzing how variations in sand gradation affect the packing density and compressive strength of concrete. The research findings are expected to contribute to better concrete mix design practices and optimal use of natural resources.

Details of Program		
Planning		
Objectives	Long-term Goals	The long-term goals of this research are to optimize concrete mix designs by understanding the impact of sand gradation on packing density and strength, leading to more efficient, cost-effective, and sustainable construction practices. By utilizing locally available sand and minimizing cement content, the study aims to reduce environmental impact and costs, aligning with SDG 9 and SDG 11. Additionally, the research will fill a critical knowledge gap, providing guidelines for better concrete mix design and encouraging innovation in material usage. It also aims to foster collaboration with other institutions and expand opportunities for student involvement in practical, research-driven experiments.
	Short-term Targets	The short-term goals of this research focus on conducting a detailed experimental study to assess the effect of sand gradation on concrete's packing density and mechanical properties. The immediate objectives include preparing and testing various sand gradation profiles, evaluating their impact on packing density, and determining the optimal gradation for improving concrete strength. In the initial stages, the research will involve sample collection, gradation setup, and conducting workability and strength tests at specific intervals (7, 14, and 28 days). These efforts will contribute to the foundational understanding required for optimizing concrete mix designs and setting the stage for more comprehensive, long-term studies.
	Rationale	The rationale for this research stems from the critical role that sand gradation plays in the performance of concrete, a material integral to construction worldwide. Despite its significance, there is limited research that systematically quantifies the relationship between sand gradation,

		packing density, and concrete strength. By addressing this gap, this study seeks to optimize the use of local materials, improve concrete mix designs, and reduce costs. Enhanced concrete performance through better sand gradation can lead to more sustainable infrastructure, aligning with global sustainability goals such as SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities). Furthermore, the findings can contribute to the advancement of engineering practices and support the use of locally available resources, reducing environmental impact and promoting economic efficiency in construction.
Subject (Leader)	Initiator(s)	PODDER, SAGOR KUMAR
	Champion(s)	PODDER, SAGOR KUMAR
	Major team member(s)	PODDER, SAGOR KUMAR; RAHMAN, TAIMUR
Environment	Nature/Society	The nature of this research is rooted in the intersection of engineering, material science, and sustainability. It focuses on understanding the behavior of concrete, a key construction material, through the lens of sand gradation, which influences its packing density and mechanical properties. By optimizing concrete mix designs, the study addresses both technical and environmental challenges in construction. From a societal perspective, the research contributes to building more sustainable infrastructure, promoting the use of locally sourced materials, and reducing the environmental footprint of construction practices. It aligns with broader societal goals of reducing resource consumption and improving the durability and cost-effectiveness of public and private infrastructure. The study's findings could benefit communities by enabling the construction of long-lasting, affordable, and environmentally friendly buildings, contributing to the overall development of resilient and sustainable cities.
	Industry/Market	This research has key implications for the construction industry by optimizing concrete mix designs through better sand gradation, improving cost-efficiency, and performance. By reducing cement usage and enhancing packing density, the study can lower production costs and make concrete more affordable. It also promotes the use of locally sourced sand, creating market opportunities for regional suppliers and reducing reliance on imports. As the industry shifts toward sustainability, the research supports eco-friendly practices, positioning companies to lead in green building initiatives.
	Citizen/Government	This research aligns with government and citizen interests by promoting sustainable and cost-effective construction practices. By optimizing concrete mix designs, the study supports the development of durable infrastructure, reducing long-term maintenance costs for public projects. The use of locally sourced sand also reduces reliance on imported materials, benefiting national resource management. For citizens, improved concrete quality can lead to more resilient buildings and infrastructure, contributing to safer, more sustainable communities. The research supports government goals of fostering innovation in the construction industry while encouraging environmental responsibility.
Resources	Human resources	This research will enhance human resources in the construction and engineering sectors by providing valuable insights into optimizing concrete mix designs, which will directly benefit engineers, construction

		professionals, and students. By engaging students in experimental research, the study fosters skills in material science, concrete technology, and sustainability practices. It also encourages innovation and practical problem-solving, empowering the next generation of engineers with hands-on experience. Additionally, the findings can help train professionals in the industry to adopt more efficient and sustainable construction methods, strengthening the workforce's ability to meet evolving infrastructure demands.
	Financial resources	This research has the potential to optimize the use of financial resources in the construction industry by reducing material costs, particularly cement, through improved concrete mix designs. By identifying the most efficient sand gradation for concrete, the study can lower overall production costs, providing long-term savings for construction companies. Additionally, the use of locally sourced sand minimizes dependency on imported materials, further reducing costs. For government and private sector stakeholders, the research could lead to more affordable, sustainable infrastructure projects, offering financial benefits while supporting the broader goal of economic efficiency in construction.
	Technological resources	This research leverages technological resources to enhance concrete mix designs and improve construction practices. It utilizes advanced methods for assessing sand gradation, packing density, and concrete strength, employing laboratory techniques such as ASTM standard sieving and strength testing. Additionally, statistical analysis and data-driven approaches will be used to identify optimal sand gradation for improved concrete performance. The study also aligns with the growing use of technology in sustainable construction, supporting the integration of scientific innovations that can lead to more efficient and eco-friendly building materials. This research helps advance technology in both academic and industry settings, fostering innovations that can drive future developments in construction materials and processes.
Mechanism	Strategy (Weight/Sequence)	The strategy for this research is structured in a logical sequence to ensure systematic analysis and meaningful outcomes. The weight of the strategy is placed on achieving a balance between experimental design, data collection, and practical applications in the construction industry. Literature Review and Preliminary Research: Initial efforts focus on reviewing existing literature to understand the relationship between sand gradation and concrete performance. This provides the foundation for hypothesis formulation and experimental setup (weight: 20%). Sample Collection and Gradation Setup: After establishing the theoretical background, the next priority is collecting sand samples and setting up varying gradation profiles. This stage is critical for ensuring accurate testing conditions (weight: 20%). Experimental Testing: Testing the prepared concrete mixtures for packing density, workability, and strength at various intervals (7, 14, and 28 days) is the core of the strategy. This stage contributes directly to the empirical data needed to analyze the effect of sand gradation (weight: 30%). Data Analysis and Statistical Evaluation: Once the testing phase is completed, the data will be statistically analyzed to identify trends and

		correlations between sand gradation and concrete performance, guiding the identification of the optimal gradation (weight: 20%). Report Writing and Manuscript Preparation: The final stage involves compiling the results and preparing a comprehensive report and manuscript for publication, ensuring the research can contribute to both academic knowledge and industry practices (weight: 10%).
	Organization	World University of Bangladesh (WUB)
	Culture	This research promotes a culture of innovation, sustainability, and collaboration within the construction and engineering sectors. By focusing on optimizing concrete mix designs through improved sand gradation, the study encourages a culture of resource efficiency and environmental responsibility. It fosters a mindset of scientific inquiry among students and professionals, promoting continuous learning and the adoption of advanced technologies in material science. The collaborative nature of the research, involving institutions and encouraging student participation, further contributes to a culture of knowledge-sharing and interdisciplinary engagement. This aligns with broader cultural values of sustainability and innovation in the development of infrastructure that benefits both society and the environment.
Doing		
Launch date		May, 2025
Responsible organization		World University of Bangladesh (WUB)
Program content and process		The program will focus on investigating the impact of sand gradation on concrete performance, structured around the following key steps: Literature Review: Conduct a comprehensive review of existing research on sand gradation and its effects on concrete properties to build the theoretical foundation. Sample Collection and Gradation Setup: Collect sand samples and create different gradation profiles, adhering to ASTM standards for consistency. Experimental Testing: Prepare concrete mixes with various sand gradations and conduct tests for packing density, workability (slump test), and strength (compressive and tensile strength at 7, 14, and 28 days). Data Analysis: Analyze the collected data statistically to identify trends, correlations, and determine the optimal sand gradation for enhanced concrete mix design. Report Writing and Manuscript Preparation: Document the findings in a detailed report and prepare an academic manuscript for publication.
Key highlights of the content/process		Key highlights of the content and process include: Theoretical Foundation: A thorough literature review to understand the relationship between sand gradation and concrete properties.

	Experimental Design: Collection of sand samples and creation of various gradation profiles for consistent testing based on ASTM standards. Comprehensive Testing: Concrete mixes will be tested for packing density, workability (slump test), and compressive and tensile strength over 7, 14, and 28 days. Data Analysis: Statistical evaluation to identify the optimal sand gradation and its effect on concrete performance. Outcome Documentation: Detailed reporting of findings and preparation of a manuscript for academic publication.
Differences from traditional approaches	-
Progress as of today	-
Problems in implementation	The implementation of this research may face several challenges: Sample Variability: Variations in the quality and source of sand could affect the consistency of gradation profiles, leading to inconsistencies in test results. Experimental Constraints: Ensuring uniform mixing and curing conditions across different concrete batches can be difficult, which may impact the reliability of results. Resource Limitations: The availability of equipment for precise testing (e.g., slump tests, compressive strength tests) and access to standardized materials could be limited by budget or institutional resources. Data Interpretation: Interpreting complex data and drawing meaningful conclusions from statistical analysis may be challenging, especially with large datasets. External Factors: Unpredictable factors like lab conditions, weather, and delays in sample collection or testing could hinder the project timeline. Collaboration and Communication: Coordination with external institutions or researchers for broader study may face logistical or communication hurdles, impacting collaborative efforts.
Approaches to solve the problems	To address implementation challenges: Sample Variability: Standardize sand sources and use samples from consistent, reliable batches. Experimental Constraints: Develop detailed procedures for mixing and curing, ensuring uniformity with quality control measures. Resource Limitations: Seek additional funding, optimize equipment usage, and consider low-cost alternatives. Data Interpretation: Use robust statistical software and collaborate with data

	analysts for accurate analysis. External Factors: Create a project timeline with buffer periods and monitor lab conditions for consistency. Collaboration and Communication: Set clear communication channels and use project management tools for smooth coordination.
Completion date, if completed	-
Seeing	
Impacts on students	This research will have several positive impacts on students: 1. **Practical Learning**: Students will gain hands-on experience in experimental design, material science, and concrete technology, enhancing their understanding of theoretical concepts. 2. **Skill Development**: They will develop critical skills in data analysis, statistical evaluation, and laboratory techniques, preparing them for future careers in civil engineering and construction. 3. **Innovation and Research Exposure**: Students will be encouraged to engage in innovative problem-solving, fostering a research-oriented mindset and contributing to advancements in sustainable construction practices. 4. **Collaboration**: The project offers opportunities for students to collaborate with faculty, industry experts, and other institutions, promoting teamwork and communication skills. 5. **Career Opportunities**: Exposure to cutting-edge research could improve students' employability, particularly in the growing field of sustainable and resource-efficient construction.
Impacts on professors	This research will have several positive impacts on professors: 1. **Research Advancements**: Professors will contribute to expanding knowledge in concrete technology and sustainable construction practices, enhancing their academic profile through publications and innovative research findings. 2. **Academic Leadership**: Leading this project allows professors to mentor students, fostering a research-oriented academic environment and promoting their role as experts in their field. 3. **Collaboration and Networking**: The project will create opportunities for collaboration with industry partners, other academic institutions, and researchers, expanding professional networks and enhancing interdisciplinary connections. 4. **Curriculum Development**: The findings can be integrated into the curriculum, allowing professors to enrich their teaching with the latest research developments, offering students a more up-to-date learning experience. 5. **Recognition and Funding**: Successful implementation of the research could lead to increased recognition in the academic community, along with potential opportunities for securing further research funding and grants.
Impacts on university administration	This research will have several positive impacts on university administration:

	1. **Academic Reputation**: The project will enhance the university's standing in the field of civil engineering and construction, particularly in sustainable practices, contributing to its global academic reputation. 2. **Research Excellence**: By supporting innovative research, the administration will foster a culture of research excellence, attracting prospective students and faculty interested in cutting-edge academic pursuits. 3. **Industry Partnerships**: The research opens doors for collaboration with industry partners, which can lead to sponsorships, internships, and further collaborative opportunities, benefiting both the university and its stakeholders. 4. **Accreditation and Rankings**: Successful research projects contribute positively to university rankings, particularly in areas related to innovation and sustainability, impacting both national and international accreditation processes. 5. **Funding Opportunities**: The research can lead to additional funding sources from governmental bodies, private sectors, or international organizations, supporting further academic initiatives and infrastructure development.
Responses from industry/market	The industry and market are likely to respond positively to this research for several reasons: 1. **Improved Concrete Mixes**: The research offers valuable insights into optimizing concrete mix designs through better sand gradation, potentially leading to cost reductions and enhanced concrete performance in construction projects. 2. **Sustainability**: Industry stakeholders focused on sustainability will appreciate the research's emphasis on reducing cement usage and promoting the use of locally sourced materials, aligning with green building initiatives and eco-friendly practices. 3. **Cost Efficiency**: Construction companies may adopt the findings to reduce material costs by using optimized sand gradation, leading to more affordable and competitive pricing in the market. 4. **Innovation in Construction Practices**: The study introduces innovative approaches to concrete technology, positioning companies that adopt these methods as leaders in cutting-edge construction practices, potentially giving them a competitive advantage. 5. **Collaborations and Partnerships**: The research could attract collaborations with suppliers of concrete and aggregates, creating business opportunities and potentially opening new markets for regional sand suppliers.
Responses from citizen/government	The responses from citizens and government are likely to be positive for several reasons: 1. **Cost-Effective Infrastructure**: The government will appreciate the potential for reducing construction costs through optimized concrete mix designs, which can result in more affordable public infrastructure projects, aligning with budgetary constraints. 2. **Sustainability and Resource Management**: Citizens and government stakeholders focused on environmental sustainability

	will value the research's emphasis on using locally sourced sand, which reduces reliance on imported materials and minimizes the environmental footprint of construction projects. 3. **Long-Term Durability**: The focus on improving concrete strength and durability through optimized sand gradation will benefit citizens by contributing to safer, longer-lasting public buildings and infrastructure, reducing maintenance costs over time. 4. **Policy and Regulatory Impact**: The findings could influence government policy regarding construction materials, encouraging the adoption of more sustainable practices in public construction and infrastructure development. 5. **Economic Growth**: By promoting the use of local materials, the research could stimulate local economies and support small businesses, benefiting both the construction industry and local sand suppliers.
Measurable output (revenues)	-
Measurable input (expenses)	-
Cost-benefit analysis for effectiveness	-
Future Planning	
Where does the project go from here?	The project will progress with sample collection and preparation of sand gradation profiles, followed by experimental testing to assess packing density, workability, and strength of concrete. Data analysis will identify optimal sand gradation for improved concrete mix design. The findings will be compiled into a report and manuscript, which will be shared with the academic and construction industries. The project may lead to further collaboration with institutions or industry partners to apply the research in real-world construction projects.
Addendum	
Exhibits, pictures, diagrams, etc.	-
Reports, mimeos, monographs, books, etc.	To validate the scientific merit of this project, the research team intends to publish at least one article in a Scopus-indexed journal.
Others which may help explain the program (including website links)	A final report will be submitted to the university for record-keeping purposes.