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GROUND IMPROVEMENT IN ROAD CONSTRUCTION: TIME AND IMPLEMENTATION CHALLENGES BASED ON A SURVEY STUDY

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ABSTRACT

This study explores stakeholder perceptions of **time intensity** and **execution challenges** associated with various ground improvement methods in road construction, based on survey data from 214 respondents representing both investors and contractors. Such comparison is strongly recommended since surprisingly little attention has been paid so far to how the practitioners assess the workability of ground improvement methods on actual job sites. The findings from this study will help efficient planning and delivering infrastructure projects, offering a basis for more accurate method selection, realistic risk forecasting, and improved communication between investors and contractors.

No.	Methods	Scale						
		Very short	Short	Rather short	Neither short nor long	Rather long	Long	Very long
1.	Stone and gravel columns	1.4	14.0	20.1	36.9	20.1	6.5	0.9
2.	Concrete columns	0.9	8.9	20.1	31.8	27.1	9.3	1.9
3.	Cement-soil columns	0.9	8.4	20.6	36.9	22.0	10.7	0.5
4.	Deep drainage (drains)	1.9	7.0	18.7	23.8	35.0	9.3	4.2
5.	Dynamic and impulse compaction	5.1	11.7	27.6	38.8	14.0	1.9	0.9
6.	Piles (CFA, prefabricated)	0.9	9.8	19.6	30.8	27.1	10.3	1.4
7.	Chemical- and hydraulic binders stabilization	2.3	20.6	23.4	35.0	11.7	6.1	0.9
8.	Grain size improvement and compaction	5.1	23.4	25.7	32.7	8.4	4.2	0.5
9.	Geosynthetics	5.1	22.0	29.0	29.4	10.7	3.3	0.5
10.	Soil replacement	1.9	11.7	23.4	33.2	17.3	8.4	4.2
11	Preloading embankments	0.5	0.9	4.7	25.4	22.5	24.9	21.1

Table 1. Distribution of Respondents' Ratings on the Execution Time of Ground Improvement Methods (*values in %*)

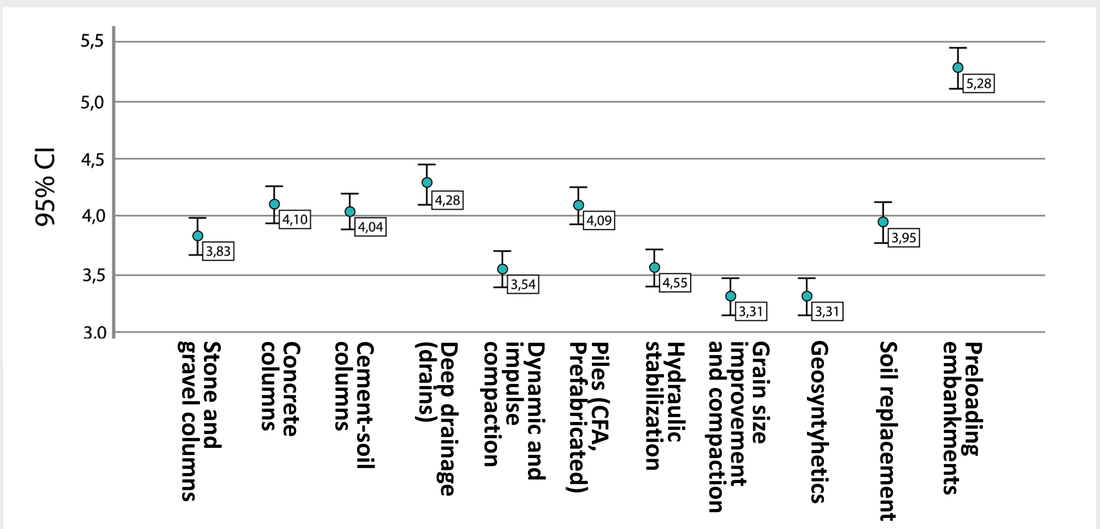


Figure 1. Execution Time of Ground Improvement Methods According to Respondents' Opinions

No.	Project Stage	Investors		Contractors		Statistical test	
		Mean	Std. Dev.	Mean	Mean	U	P
1.	Procurement of materials and raw resources	3.47	1.30	2.89	1.27	4032.500	0.001
2.	Earthworks and preparatory works	3.72	1.11	3.80	1.13	5390.000	0.912
3.	Design works	3.66	1.21	3.77	1.45	5249.000	0.661
4.	Machinery and equipment works	3.89	1.10	4.23	1.44	4692.500	0.078
5.	Preliminary and geotechnical investigations	3.63	1.25	3.94	1.55	4909.500	0.219
6.	Project management and supervision	3.66	1.17	3.84	1.42	4840.500	0.161
7.	Documentation and administration	3.44	1.19	2.71	1.42	3663.500	0.001

Table 2. Comparative Analysis of Respondents' Assessments of Execution Difficulties During Ground Improvement Works

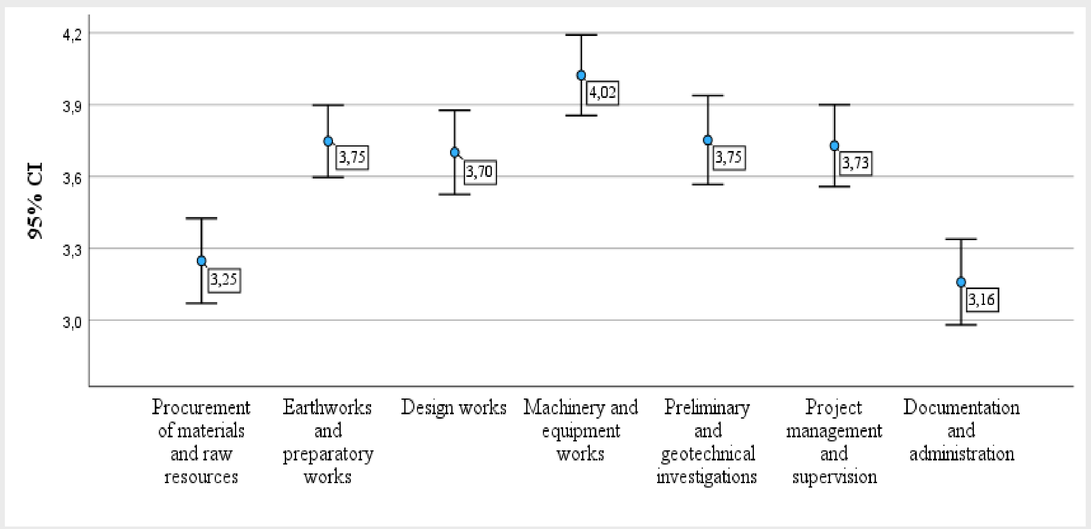
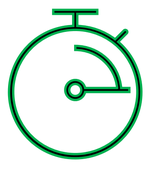
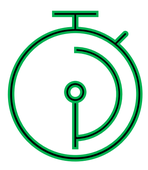


Figure 2. Assessment of Execution Difficulties at Various Stages of Ground Improvement Works

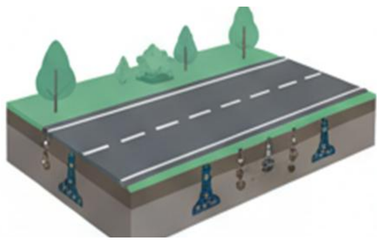


The Main Challenge Is Time-Related, Not Technological. Our research reveals that the biggest obstacle to implementing modern ground improvement methods is not a lack of technology, but the **fear of delays and schedule unpredictability**. This concern hinders progress far more than financial issues.



The Industry Still Defaults to Traditional, Unsustainable Soil Exchange. Geosynthetics and grain size improvement with compaction emerged as the fastest methods to implement, consistently receiving the lowest average ratings for execution time. Geosynthetics are considered environmentally friendly due to their ability to reduce the use of natural resources, **lower carbon emissions**, and extend the lifespan of infrastructure.

This Directly Supports Decarbonization. Shorter project time span **reduces CO_2 emissions** by decreasing the number of truck trips. The use of geosynthetics also minimizes the need for virgin materials, conserving water, and reducing energy consumption in construction. Furthermore, some geosynthetics are made from recycled materials, and some biodegradable versions are available. By sticking to this method, the industry is actively using a key opportunity to **decarbonize earthworks**.



A Shift in Mindset, Not Just Technology, Is Crucial. For the goals of decarbonization and recycling to become a reality, we must stop focusing solely on the lowest initial cost. It is essential to **factor in time-related risks and environmental benefits** from the earliest planning stages. Our research proves that overcoming these mental and organizational barriers is a prerequisite for sustainable road construction.