Chemical and Mechanical Stabilization

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In the construction and maintenance of transportation facilities, geomaterials—soils and rocks—must be stabilized through chemical and mechanical processes. Chemical stabilization includes the use of chemicals and emulsions as compaction aids to soils, as binders and water repellents, and as a means of modifying the behavior of clay. It also includes deep mixing and grouting. Chemical stabilization can aid in dust control on roads and highways, particularly unpaved roads, in water erosion control, and in fixation and leaching control of waste and recycled materials. Mechanical stabilization includes compaction, and fibrous and other nonbiodegradable reinforcement of geomaterials to improve strength. In applying these techniques, it is necessary to ensure the properties of stabilized geomaterials and their mixtures as applicable for use in the design of foundations, embankments, shoulders, subgrades, bases, and surface courses.

The disparity between countries with excellent roads and highway networks and those with poor ones can be expected to increase. This gap will be due primarily to differences in the funding base resulting from socioeconomic and geopolitical conditions. At the same time, regions throughout the world share a common need to maintain and rebuild aging transportation system infrastructure. Yet if past policies prevail, money will be used primarily to build new facilities, with a smaller share of funds being allocated to maintaining and rebuilding existing facilities.

The world already has many miles of unpaved and marginally paved roads. In many areas worldwide, new roads will be unpaved as well. In places where roads are paved, they will be replaced or repaired from the ground up. Because of age, broken-down pavements may require recycling and rebuilding but more likely they are the result of poor support conditions combined with higher traffic loads. New roads, both paved and unpaved, will probably be placed in locations where there were no roads before because of less-than-ideal subgrade conditions. In all of these situations, less-than-desirable materials are likely to be used. Use of these materials will in turn require the application of stabilization techniques presently available, as well as those likely to evolve in the next century.

Hence in the new millennium, we will face the challenge of developing better chemical stabilizers and mechanical stabilization techniques; new, quicker, and better testing methods; and better and environmentally safe methods for using waste materials for highway construction. Research is needed in a number of areas to develop the materials and methods required to meet this challenge.

Development of New Chemicals for Stabilization. As technology advances and economic conditions change, many more chemical agents will be introduced into subgrades to improve their compactability, durability, and strength. At the same time, more performance-based testing will be necessary to prove the effectiveness of these stabilization agents. In addition, there are chemicals being used today in the petrochemical industry whose use in soils is as yet unexplored. Another area for research is such processes as injection and spray-on techniques for more economical treatment.

Application of Recycled and Waste Products. Improved chemical and mechanical stabilization techniques are needed for such waste materials as crushed old asphalt pavement, copper and zinc slag, paper mill sludge, and rubber tire chips. In Finland, for example, attempts have recently been made to mix paper mill sludge with fly ash for use in the construction of roads, liners for landfills, and stabilized layers in areas where slope stability is of concern. Experiments in South Korea involve mixing waste lime that is produced as a by-product in the manufacturing of sodium carbonate with weathered granite for the stabilization of offshore reclaimed land. At present, the pressure to use waste materials for construction is much higher in Europe than in the United States. With increased emphasis on environmental protection, however, this situation is likely to change.

Risk Evaluation of Recycled and Waste Materials. In meeting the need to recycle many potentially hazardous materials, it will be necessary to develop a realistic, economical, and effective means of assessing the risk of pollution posed by these materials through leachates and emissions. In some cases, risk evaluation is hampered by restrictive environmental constraints, and this issue needs to be addressed as well.

Evaluation of Properties of Stabilized Materials. Since many of the traditional materials design criteria are empirical and inappropriate, increased emphasis is likely to be placed on the development of mechanistic evaluation tests and techniques for stabilized materials (e.g., triaxial repeated loading tests and criteria). Materials will need to meet or exceed appropriate standards in both performance-based tests conducted in the laboratory and large-scale field tests.

Transfer of Testing Procedures from Other Fields. There is an increasing need to encourage immediate technology transfer of testing procedures from other fields for application to the test and evaluation of materials and techniques for chemical and mechanical stabilization of soils and rocks. Among the potential benefits of such technology transfer is the possibility that the transferred procedures may require less-qualified personnel.

Development of Simplified Methods for Soil Stabilization Under Adverse Conditions. Such methods are needed, for example, in areas prone to flooding. The need is especially pressing in areas with limited availability of sophisticated permanent equipment and in developing countries where the effects of natural catastrophes must be minimized.

Use of Nonbiodegradable Reinforcing Materials. Past research has shown that the strength and load-bearing capacity of subgrades and base course materials can be improved through the inclusion of nonbiodegradable reinforcing materials, such as fibers, geotextiles, geogrids, and geocomposites. Use of these materials can improve the performance and durability of future highways and may reduce the cost of construction. At present, most of the research on these materials is based on tests conducted in the laboratory that are only partially complete. Further laboratory tests and evaluations will be necessary to develop design specifications based on material properties, and these specifications will need to be verified using large-scale field tests.

Need to Consider Global Climate Change. Global climate change may affect the durability and application of stabilizers. It may be desirable to consider these potential changes in the development of future soil stabilization techniques.

Finally, if the results of the above research are to be implemented successfully, technology transfer will be essential. Communication of research results to practitioners worldwide in a variety of formats—written, spoken, televised, and electronic—will help move these advances from the research setting to the construction site.