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EROSION AND SEDIMENTATION ON HIGHWAY SYSTEMS

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16. Abstract

The specific aim of the research was to develop an expertise in the latest technology and state-of-the-art for the control of soil erosion and sedimentation; evaluate the effectiveness and economics of practices/methods used by NJDOT; and develop/promote technology transfer products/media for implementation at NJDOT, At this stage the Department has resolved some of the related issues, but a number of prevailing problems of erosion and sedimentation still remain on our highway system. There are research and technology transfer opportunities associated with complex coastal and tidal flow and hydraulic problems due to engineering judgment latitude in spite of the availability of modern computer programs.

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EROSION AND SEDIMENTATION ON HIGHWAY SYSTEMS

NJDOT – RESEARCH PROJECT- 7560

KAL SATIJA- PROJECT MANAGER

Summary Report – December, 1997

ABSTRACT

This Research Project was approved by FHWA on 4/19/90. The specific aim of research was to develop an expertise in the latest technology and state-of-the-art for the control of soil erosion and sedimentation; evaluate the effectiveness and economics of practices/methods used by NJDOT; and develop/promote related technology transfer products/media for implementation at NJDOT. At this stage, the Department has resolved some of the related issues, but we still have a number of prevailing problems of erosion and sedimentation on our highway system.

INTRODUCTION

The effectiveness and economics of current practices/methods of soil erosion and sediment control used during and after construction are not fully known. There is a need to monitor selected projects designed with NJDOT Soil Erosion and Sediment Control Standards; so that we can determine the effectiveness of various designs within the projects.

There is significant problem of erosion around piers, abutments, and wing walls of some NJDOT bridges; which can lead to undermining and structural failure. There is also extensive problem of sediment built up along abutments and wing walls of some NJDOT bridges. Trees and vegetation grow on this sediment and their roots lead to spalling and cracking of the structure. Sedimentation also results in non-uniform stream flow with differential pressure on the bridge elements. For optimal solution to these problems, we need to integrate necessary research that will result in quality improvements based on function, cost and value.

Significant damage to the environment is brought about by uncontrolled water and wind erosion resulting from construction activities. The sediment that is produced pollutes lakes and reservoirs, restricts drainage, pollutes surface waters, damages adjacent property, and upsets the natural ecology of streams. Oftentimes they further lead to delays, repairs, and increased construction costs.

The problem of erosion/sedimentation on bridge sites is related to stream instability that arises out of an imbalance in the energy regime of the flow/discharge and sediment and fluvial processes of the channel. This stability is affected by mankind's use of watershed land, channel, bed materials and water and changes in the climate and flow regime of the river itself.

River channels continually adjust to changes in water and sediment discharges in order to maintain a dynamic equilibrium. These adjustments involve changes in channel geometry over a substantial region of the river. These changes in channel form may have significant consequences at a bridge site. Therefore an analysis of river morphology is necessary to understand the effect of potential changes in regime on geometry and channel pattern.

The problem of soil erosion and sedimentation is interrelated and has to be considered in a comprehensive manner during planning, design, construction, maintenance, operation, and rehabilitation of highway systems.

ACTIVITIES

The following activities were performed on this project:

- Inspected a number of potential sites with problems of erosion and sedimentation.
- Performed a review of related NJDOT standards, manuals, specifications and procedures. This indicated significant scope for their improvement.
- Co-ordination was developed with the related personnel of NJDEP, State Soil Conservation Committee, FHWA, NJ Department of Agriculture, U.S.G.S., U.S. Corps Of Engineers, U.S. Soil Conservation Service, National Weather Service, NJ Department of Community Affairs, Rutgers University, Ohio University, Drexel University, University of Maryland, Maryland Department of Transportation, etc.
- Research work was suitably integrated with the prevailing problems of NJDOT:
    - Difficulties experienced on the sensitive contract of Route 287
    - Storm design criteria used to establish the erosion control measures
    - Optimal techniques in areas of restricted R.O.W.
    - Restrictive erosion control boundaries
    - Optimal techniques near wetlands.
    - Erosion and sedimentation on NJDOT bridges; especially in the tidal areas.

- Discussed our problems with the related experts of other States and FHWA. This developed into the necessity of a pool-fund research project on Tidal Hydraulics and Scour Processes. This was considered to be highly beneficial in the determination of waterway openings for the design of bridges and for the evaluation of bridges for scour in tidal zones. Processed the required request for NJDOT participation to FHWA on 12/20/91.

- During 1/92, the main research finding was an urgent need to develop an extremely close working relationship with the related Federal Agencies especially the U.S.G.S., U.S. Soil Conservation Service, U.S. Corps of Engineers, and National Weather Service. This unique research finding was highly appreciated and implemented by the Division of Project Development/ Bureau of Preliminary Engineering. Detailed negotiations were processed with the above Federal Agencies and unique Agreements were developed with them. All these Federal Agencies have special expertise in various aspects of our problems of erosion and sedimentation. The Agreement with U.S.G.S. had since been executed. The proposed Agreements with other Federal

Agencies need further review in the interest of the Department. Keeping in view the functions of the current Research Unit, there is significant potential for its suitable integration into the above Agreements.

- During this research project, I had made extensive study of the problems of Bridge Scour and Channel Stability. I made detailed discussions with the national and International experts at the TRB conference in Washington, D.C. My work was highly appreciated by the senior management and I was scheduled for a detailed presentation to the related personnel of the Department. A large number of related persons actively participated in my presentation.(1992)
- While working on the above research project, it was inferred that a number of our problems were due to our inadequate land in our R.O.W. and restrictive erosion control boundaries. The Bureau of Preliminary Engineering/ Project Scope Development has since been ensuring during Excess Property Review; that we have adequate control on our lands; which have the potential for mitigating our problems of erosion, sedimentation, flooding and drainage.

Thus the research work was adjusted to meet the dynamic requirements of the Department. All concerned were kept abreast of the potential problems of the Department and the latest advances in technology and state-of-the-art. The research findings were processed in an optimal manner in the interest of the Department.

The problem of erosion and sedimentation on highway systems covers a vast interdisciplinary area. Though the Department has handled its problems in an optimal manner keeping in view the available knowledge and resources; there is still an urgent need to review our performance at national and International level. We also need to ensure sustainable development with our current accelerated programs.

We have certain ethical responsibilities toward sustainable development, which is said to be a long- term commitment to our projects; in that they do not degrade our natural resource base. The word "sustain" implies nourishing or building up the resource base for later benefit. The word "develop" means increasing the use of natural resource for immediate benefit. Despite this contradiction, sustainable development can exist, but only when respect for the biosphere guides our pattern of production. A balance of depletion and replenishment is essential. The ethical responsibilities toward sustainable development include having a sincere concern for the public well-being, ensuring sustainability and retaining a high standard of excellence compared to national and International standards.

SPECIAL ISSUES

Highway crossings of coastal inlets or channels that connect wetlands to oceans or tidal rivers experience two floods daily, from both directions, with each passing tide. Those daily tides coupled with the occasional hurricane, storm surge or other flood event cause untold damage to bridges, culverts, causeways and highway systems. Coastal and tidal flow and drainage systems are the most complex hydraulic scenarios known and the problem is compounded by direction and height of wind driven waves, height of tides, local circulation patterns, multiple and additive flood events, high flow velocities and

turbulence. Sediment transport and scour processes are superimposed on top of these complex flow and hydraulic problems, further confounding the issue. The coastal drainage network is powerful, dynamic, and capable of dramatic adjustment during a major storm surge. Inlets migrate laterally, adjust in depth and width for flow capacity, and even open new or close old connecting links. Scour evaluations of bridge foundations on tidally influenced systems have a number of unknown parameters. The latest available computer programs do call for a number of assumptions leading to significant engineering judgement. These issues have great potential for future research in the interest of the Department.

RECOMMENDATIONS

It is proposed that the current research project no. 7560 should be closed out. A new research project should be started at the earliest feasible to cover our prevailing problems/issues of soil erosion and sedimentation by suitable integration of related Federal Agencies. Optimal erosion and sediment control on our highway systems will lead to significant savings in construction/maintenance costs, improvement in structural safety, environmental impact and public relations. The present Research Unit has to play a pivotal role in quality improvements based on function, cost and value.