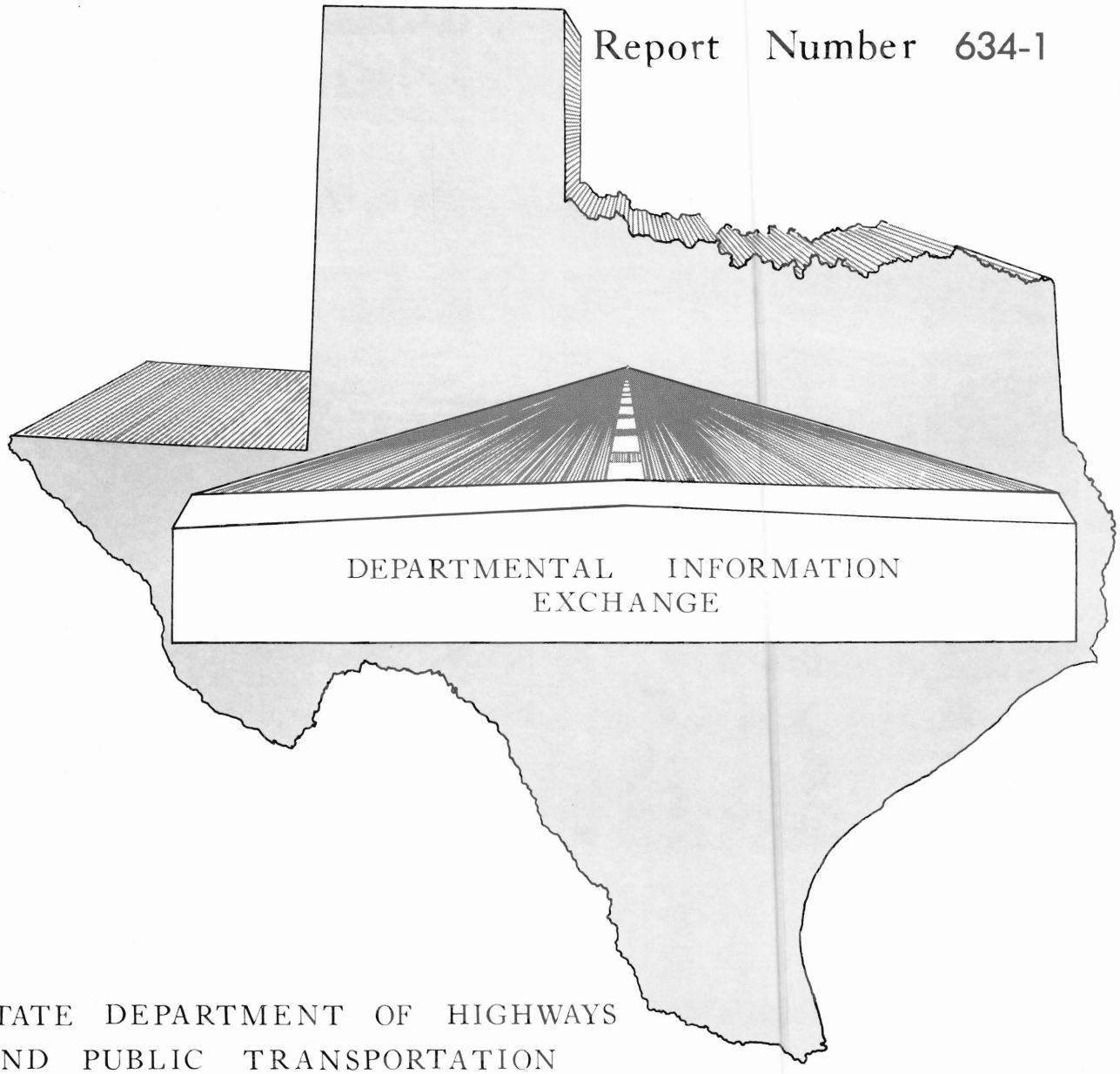
EXPERIMENTAL PROJECTS
IN-HOUSE

INVESTIGATION OF COST-EFFECTIVE MANAGEMENT OF EMBANKMENT VEGETATION

Report Number 634-1



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16. Abstract

The mowing of turf grasses on steep embankments can be dangerous and expensive. This study investigates cost-effective alternative erosion control strategies from steep slopes in Texas. Difficulties in mowing are discussed and alternatives such as the use of non-mow areas, the application of herbicides, the establishment of vegetation other than turf grasses, and the application of physical methods of slope management are covered. In addition to a literature search, information was gathered from district vegetation managers and from highway departments in several neighboring states.

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INVESTIGATION OF COST-EFFECTIVE MANAGEMENT OF EMBANKMENT VEGETATION

Introduction

The prevalent method of embankment slope stabilization is the utilization of vegetation to resist erosion. Grasses are the most common vegetation used and their maintenance involves periodic mowing. Mowing can be costly, difficult and dangerous at bridge ends and in other areas with steep slopes. The purpose of this study is to investigate alternative slope management strategies.

Two computerized literature information searches of the HRIS subfile were made. The searches concerned erosion control on steep embankments and vegetation on steep embankments. Of the approximately 200 articles listed in the literature search, most were not pertinent to this study or were concerned with vegetation types not suitable for use in Texas. Several reports, all from neighboring states, proved relevant and will be referred to later in this report. In addition, the D-10 R technical library was utilized for the literature search.

A survey was taken to six states with climates comparable with Texas. Oklahoma, Louisiana, and Mississippi responded. The vegetation manager and .three landscape architects in D-18, the Safety and Maintenance Division, were contacted concerning the use of alternative vegetation management methods on slopes. In addition, the persons in charge of vegetation management in the 24 districts of SDH&PT were contacted.

Mowing Problems on Steep Slopes

Most districts reported difficulties with mowing on steep slopes. Slopes can be damaged by the slipping tires of mowers and by the cutting of ground by mower blades on uneven terrain. Both situations lead to erosive conditions. Mowing steep slopes can be dangerous because of the potential for equipment overturning. The Department has specifications for low center of gravity tractors to reduce the hazard. Also several districts use slope mowers (which employ hydraulic levelling), but most do not. Difficulties in transporting the few slope mowers to the needed places and low cost effectiveness were cited. In general, mowing slopes is expensive because special treatment is needed for relatively small scattered locations. In some cases, contract mowers have been reluctant to mow steep slopes, leaving the mowing to the district maintenance personnel.

Some districts reported little difficulty with mowing steep slopes. These districts generally have few steep slopes, or have no mow policies, or are located in West Texas where erosion of slopes is a less serious problem and where vegetation is sparse, making mowing unnecessary.

Oklahoma, Louisiana, and Mississippi highway and transportation departments all described serious problems with mowing on steep slopes. The Louisiana Department of Transportation and Development cited 19 overturning accidents within the last two years.

Non-mow Areas

One solution to the problem of mowing steep slopes is not to mow them. Until recently, it has been Departmental policy to mow the full right-of-way width throughout the state. This policy was costly and energy intensive. Therefore, a vegetation management system was begun in 1982 to facilitate the use of appropriate landscaping methods for each site. One result has been the setting aside of non-mow areas where the development of a climax community of native vegetation is desirable. The Vegetation Management System stresses the blending of right-of-way vegetation with surrounding vegetation. For example, for cultivated farm areas, full-width mowing is required to avoid the spreading of weeds. The establishment of non-mow areas is often the solution to mowing problems on steep slopes, particularly in rural areas.

As a result of the vegetation management system, there has been a rapid shift from mowing to non-mowing at many sites. Most districts are designating non-mow areas on steep slopes and in places where it is difficult to mow. A number of districts also designate non-mow areas on rural right-of-ways. In these rural areas, a strip of up to 15 feet from the roadway is mowed and the remainder of the right-of-way is left unmowed.

Grassy steep slopes in urban areas are generally mown so that their appearance will blend with that of the surrounding area. Several districts, however, maintain non-mow areas on steep slopes within urban areas. In Abilene, District 8 is leaving steep slopes unmown. The same is true in San Angelo, where District 7 is also considering mowing flat areas less frequently. In Austin, District 14 has instructed mowers to mow only up to the toe of the slope at a major highway intersection.

In District 14, combinations of mowing and non-mowing are maintained in some areas. With this "sculptural mowing," tall grass is seen as a planting set off from the mowed area.

The rapid change from full-width mowing to selective non-mowing has resulted in some complaints from the public. Accustomed to right-of-ways having a lawn-like appearance regardless of the nature of the surrounding terrain, some members of the public have had a negative initial reaction to the new vegetation management practices. This problem can be alleviated by providing information to the public. For example, District 14 has distributed information for newspaper articles. The information includes an explanation of the vegetation management system, of the monetary savings of reduced mowing, and of the resulting increase in wildflower production.

A potential problem associated with non-mow areas is the growth of undesirable brush--a problem cited most frequently by south Texas districts. The use of herbicides to control brush is being studied. Another potential problem is lessened wildflower displays.

The Louisiana Department of Transportation and Development designates most areas at grade separations along interstate highways as non-mow areas. Steep slopes along the interstate, primary, and secondary systems received at most one mowig per year. The State of Oklahoma Department of Transportation does not mow slopes of easily disturbed soils. The Mississippi State Highway Department has a non-mow policy for rural areas.

Herbicide Overspraying

The practice of herbicide overspraying compliments a program of less frequent mowing, mowing at a greater height, or not mowing at all. Reducing or eliminating mowing gives desirable species such as bermuda grass a chance to compete with less desirable grasses such as Johnson grass. The Department is encouraging the overspraying of a combination of Oust and Roundup herbicides. Oust is a contact herbicide with a relatively short soil residual half-life and Roundup is a non-selective, post-emergent herbicide. Overspraying kills tall, undesirable grasses, allowing bermuda and other desirable grasses to successfully compete with the undesirables. The process, which can take up to several years, results in the establishment of shorter grasses. Eventually, mowing in these areas will be unnecessary and the areas can be designated as non-mow.

Since the start of the vegetation management system, most districts have been, or soon will be utilizing overspraying to an increased extent. Computerized spray trucks are needed to precisely measure out small quantities of Oust and Roundup, forming a dilute spray. Many districts have been purchasing these trucks. A few district vegetation managers reported that the 30 foot range of the computerized spray truck does not cover all necessary areas, requiring augmentation by other herbicide application methods.

The use of overspraying and concurrent lessening of mowing can result in substantial savings. District 13 has tabulated mowing and herbicide expenditures on a county by county basis for fiscal year 81-82 through fiscal year 83-84. The use of overspraying substantially increased and the amount of mowing substantially decreased throughout the District during the three year period. The cost of mowing in the District decreased from $1,362,000 to $1,018,000 while herbicide costs increased from $269,000 to $469,000, resulting in a net savings of $144,000 for 83-84 compared with 81-82.

The Louisiana Department of Transportation and Development reports that the use of Roundup and Oust has been very successful and economical.

A report from Oklahoma State University* shows that with increasing mowing costs and decreasing herbicide costs, by 1980 mowing costs were $11.56 per acre and herbicide costs were $7.65 per acre, a savings of almost $4.00 per acre.

Plant growth regulators (growth retardants) have been used with success to reduce mowing in northern states. The SDH&PT does not use growth regulators since the long Texas growing season would require several applications per season and growth regulators tend to lose effectiveness with repeated applications. Also, not all roadside plants respond to growth regulators.

Alternative Vegetation

Another alternative to mowing steep slopes is to promote the growth of vegetation other that turf grasses. Pampas grass is a bunch grass which reaches heights of six feet. It has served as an ornamental plant on highway right-of-way since the 1960's. In the last several years, it has been used as a low-maintenance cover on steep slopes in East Texas. District 20 has had good results by planting pampas grass at a 6 foot spacing to cover slopes. For the first year after planting, pampas grass may require watering and mowing between plants. When the plants become established in a few years, they cover the entire slope and require no maintenance. Pampas grass is hardy and comes back when inadvertantly mowed. Another advantage is that plantings of pampas grass block litter from view. Some district vegetation managers have suggested that clumps of pampas grass may serve as crash attenuators or safety barriers.

To obtain material for new planting, District 12 personnel break up large, existing clumps of pampas grass. They simply plant the grass in winter or spring and water one time to establish it. When pampas grass is purchased, the cost is estimated by District 20 at $3 per plant and $1 per plant for labor, equipment, and watering.

Experience seems to indicate that plantings of pampas grass are successful at controlling erosion on slopes of less that 3:1 or 2:1. Pampas grass cannot be used where its tallness limits sight distance.

Jasmine has been planted on slopes in District 14 and 15 with very good results. It is a cascading woody shrub that is resistant to freezes and keeps its leaves in winter. Jasmine is attractive, and its aggressiveness keeps other plants out. One planting in District 15 grew well for ten years, reaching a height of 3 or 4 feet before a recent winter with extremely low temperatures froze the plants. After the freeze, District 15 personnel cut the plants to within 6 inches of the ground. Wintin one year they have regrown to over 2 feet in height. Although Jasmine may require some watering at first, both districts agreed that it requires no maintenance once established.

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*"Implementation of Roadside Erosion Control Research Results," MP-111, Agriculture Experiment Station, Division of Agriculture, Oklahoma State University, January 1982.

Lovegrass has been used as a ground cover in Districts 17 and 20. It reaches 18 inches to 2 feet in height and is prolific. Lovegrass is hardy, requiring no care after planting. Once it is established, lovegrass is difficult to eliminate. Distsrict 17 has some plantings that have been thriving for a number of years. District 20, however, reported an unsuccessful experience with lovegrass in which slope erosion continued to occur.

Bahia is prolific and considered a weed when it grows in lawns. It has already established itself on right-of-ways in East Texas. Its leaves grow to a height of 4 inches with 16 inch tall stems.

The use of native vegetations was uncommon until recently. But now the hardiness, low maintenance requirements, and aesthetic value of natives are being recognized. The Safety and Maintenance Divsion, D-18, is encouraging the establishment of native plants to the extent practical. Until recently the market for native plants was very small, so there were very few commercial supplies of seeds and plants. But supplies have been increasing in recent years as the demand for native vegetation materials grows.

Non-mow areas combined with herbicide overspray encourage the growth of native grasses. Some promising native grasses include little bluestem, beargrass, buffalo grass, and many others. District 5 reports that buffalo grass, a clump grass, is a good choice for steep slopes in West Texas. There is a very large number of native plants with potential for use on highway right-of-ways. A few of them are sotol, cenizo, hollies, and retama.

Propagation of native plants can be done by transplanting or sprigging from wild-growing plants, planting commercially grown plants, and spreading native plant seed mixtures by methods including hydromulching.

The development of dwarf grasses to reduce the need for mowing was mentioned in a paper presented by Dr. Wayne G. McCully at a vegetation management workshop hosted by Arizona DOT in 1984. The author stated that "biotypes occurring naturally in northern latitutes do not grow as tall as local biotypes. We are examining biotypes of blue grama, sideoats grama, switchgrass, and little bluestem."

In an eight-year study of 200 different kinds of plants for use on non-mowable areas on Louisiana interstate highways,* it was concluded that 32 of the ground cover showed promise. The Louisiana Department of Transportation and Development reports that weed competition and difficulties in finding sufficient numbers of plants were problems associated with the study. A review of the report by an SDHPT landscape architect indicated that the Department has had experience with some of the groundcovers, and that others were not suited for conditions in Texas.

*"Establishing of Ground Covers for Non-Mowable and Locked-In Areas on Louisiana Interstate Highways" by Stadtherr, Richard J., et al. Louisiana State University Department of Horticulture for Louisiana Department of Transportation, 1981.

The State of Oklahoma Department of Transportation has used low growing shrubs as ground covers. They also report promoting native grasses, but note that native grasses are more difficult to establish than other types. On newly constructed projects, substantial erosion can occur before the native vegetation is established.

The Mississippi State Highway Department keeps mowers from mowing certain areas to encourage native vegetation.

Arkansas State Highway and Transportation Department personnel have found that sumac establishes itself readily on sites which have been denuded of vegetation.

Physical Methods of Slope Management

This section concerns approaches to slope management which involve non-biological materials. The most commonly used physical method is the construction on steep slopes of concrete riprap at overpasses or bridge ends. Most of these involve a relatively small amount of riprap, but in District 24 some riprap extends along steep side slopes to where the slope becomes more gentle. In some cases, the riprap extends from one overpass to the next, even up to a length of two miles. The decision to employ riprap instead of some form of vegetation depends on the steepness of the slope, the stability of underlying soils, and a comparison of effectiveness, initial costs, difficulty of maintenance, maintenance costs, and aesthetics.

Other than the use of riprap and retaining walls where necessary, most districts do not employ physical methods of slope management. Erosion control fabrics on steep slopes have been used sucessfully by some districts. The fabrics prevent erosion while grass grows through the fabric. Materials to blanket shrubs are also available. A slot is made in the blanket to allow shrubs to grow, while preventing the growth of other vegetation, Gabions (wire baskets filled with rock) have been used by several districts to slow overland flow and prevent erosion.

The use of stair-stepped retaining walls on steep slopes is receiving some consideration for use by the Department. Construction of retaining walls would lessen the slope between walls and plantings could hide the walls from view. However, vegetation requiring watering or other maintenance would create problems when used with the stair-stepped walls.

Turfstone is the proprietary name for a specally shaped concrete block that can be installed on slopes. The block has openings, from which vegetation may grow. Tri Lock is another concrete block configuration with two differently shaped blocks which interlock to form a grid. Gaps in the grid allow vegetation to grow up through it.

The Louisiana Department of Transportation and Development has conducted a study* of an experimental revetment for overpasses. The revetment consists of lightweight cellular concrete clocks (Gobimat). According to the study report, the results of a field test indicated that the blocks can be used to protect areas around bridge and overpass ends from erosion from surface runoff from above and seepage from within the embankment. The cellular openings prevent hydrostatic pressure from lifting the flexible structure.

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* "Paving Block Study" by Allen L. Cox, Louisiana Department of Highways, October 1971.