EROSION CONTROL - DESIGN

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Erosion of highways, roadsides and contiguous land areas involves not only a study of the destruction of these areas by surface water, wind and traffic, but also a study of subsurface water and soils characteristics. The desired objective is to have intentional physical control at all times of falling, seeping and flowing water. Limiting conditions, of course, are dictated by land usage, budgets and economics of construction.

Soil

The soil itself, being the basic factor, must be classified, analyzed and studied for its inherent characteristics and behavior under variable conditions. Michigan has developed a technique for obtaining reliable soil information. The designs of erosion control structures and methods follow the recommendations of the soils engineers, who survey the proposed line, locate and classify the various soil types.

Standard Gutter Section

In Michigan the more or less standard side ditch is at a depth of 1½ ft. below the shoulder grade, and at a distance out from the shoulder on a 1 on 4 slope. Two-ft. ditches are used mostly in the upper Penninsula when building over soils of flat topography and indifferent drainage. Through swampy land independent swamp ditches are often constructed 50 to 70 ft. from the centerline to a depth of 4 or 5 ft. Shallow paved gutters placed along the edge of a paved surface will control surface water flow. A recent Michigan design ruling now requires such paved gutters on the inside of super-elevated curves on 40-ft. pavements. In no case should water be carried so far that heavy rains would overflow the gutters before water is conducted to the side ditches, underdrains or sewers.

Curbing Control

Lip curb serves a similar purpose but tends to reduce the traveled width, whereas a shallow gutter tends to widen it. In California, on some cuts and many fills, the State is bituminizing the shoulders. Near the edge they are building what amounts to a

bituminous curb on the shoulder line. The object is to keep water from running off the slab and eroding the shoulders and fill. The water is collected at frequent intervals and carried through flumes down the embankment to the ground level.

Soil Map Factors

Field men making the Michigan soil surveys are trained to consider vegetation, topography, drainage and surface geology in addition to analysis of the soil profile. The designing engineer can thus visualize treatment required for necessary cuts and fills and their accompanying erosion and drainage problems. A typical soils department profile sheet is shown by the accompanying figure.

On locations where soils are very sandy or subject to wind erosion, deposits of clay are sometimes used as shoulder and slope stabilizing materials. Rains have a tendency to wash the clay off the slope before vegetation has become established. Top soil is superior in that it contains plant food necessary for the growth of ground cover to be established by sodding, transplanting and seeding. The soil survey locates suitable top soil and lists native plant material for use in erosion control.

Subsurface Water

Designing engineers are especially interested in the position of clay strata in areas where sand lies directly on clay beds, because of the water table. Subsurface water may be responsible for erosion of side ditches as well as for subgrade instability. Such water also causes sloughing of ditch slopes, depositing of silt and sand in the bottom of the ditch, as well as plugging of smaller drainage structures.

Soil Analysis

The Design Division can have only a very sketchy knowledge of its erosion problems or the methods of treatment until it knows with what soils it is dealing. To lower maintenance costs successfully erosion problems must be accurately anticipated in design. Location and design engineers should avail themselves of information obtained from soil studies; which ordinarily is not evident from location reconnaissance surveys. The soil survey is used as a basis for estimating quantities of tile edge drains in all cuts in order that a contract unit price may be established before construction operations start. This prevents excess force account extras during construction

Control Methods

From the standpoint of design, erosion may be controlled by structures or methods that keep the volume and velocity of surface water below its capacity for carrying soil particles of various sizes. No sodding or ditch control is required for a normal amount of water if the rate of grade is lower than 2½ per cent, provided subsurface water is properly controlled. Beyond this, sodding and native planting are employed to reduce velocities and hold the soil by root mats. In Virginia a particularly effective method of controlling backslope erosion has consisted of the planting of native vines in furrows arranged in a so-called "herring bone" pattern.

Sandpapering Backslopes Wasteful

It has been customary practice to "sandpaper" backslopes of cuts as part of the finishing operations of grading construction. This is a needless waste of funds that might better be used in erosion control methods for those backslopes.

Slope Grading and Treatment

Landscaping is a fundamental part of balanced engineering. The foundation for roadside improvement and erosion control is an adequate right-of-way. Rounding of cut slopes aids grasses and ground cover to take root. This vegetation retards and diminishes water velocity. The soil type will indicate to a large extent the degree of steepness of back and fill slopes. Top soil on areas to be covered by fills should be saved for use in planting or seeding on slopes. Treatment for ditches and slopes should be indicated on the design, but because of seasonal conditions under which plantings must be made, it would probably not be a part of the construction projects.

Classification Of Operations

Seasonal and non-seasonal operations of erosion control may be classified as follows:

Non-Seasonal

1. Stripping and storing of topsoil
2. Rounded and transition slopes
3. Obliteration of old roads
4. Roadside cleanup
5. Fine grading slopes and shoulders
6. Replacing topsoil
7. Furnishing and placing loamy topsoil
8. Selective landscape cutting
9. Tree pruning and trimming (existing trees)
10. Tree wells and tree root protection
11. Rubble masonry (in mortar)
12. Dry stone masonry
13. Riprap
14. Cobble gutter
15. Rustic guard rail
16. Boulder guard rail
17. Special landscape structures

Seasonal

1. Seed and seeding
2. Sod and sodding
3. Furnishing of plant materials
4. Installation of plant materials
5. Transplanting of large trees (salvage)
6. Transplanting of existing plants (salvage)
7. Disposal of surplus materials

Check Dams

On grades up to 6 per cent in fairly stable soils, check dams not dropping water over 2½ ft. are of value, but beyond this the water should be picked up at 200 ft intervals and conducted away by sewers. In addition to proper spacing, height and notch capacity, check dams should be trenched into the shoulder, backslope and ditch bottom a sufficient distance (1.5 to 2.0 ft.) to prevent seepage around the structure or scour below it. They are often subjected to the impact of ice and debris.

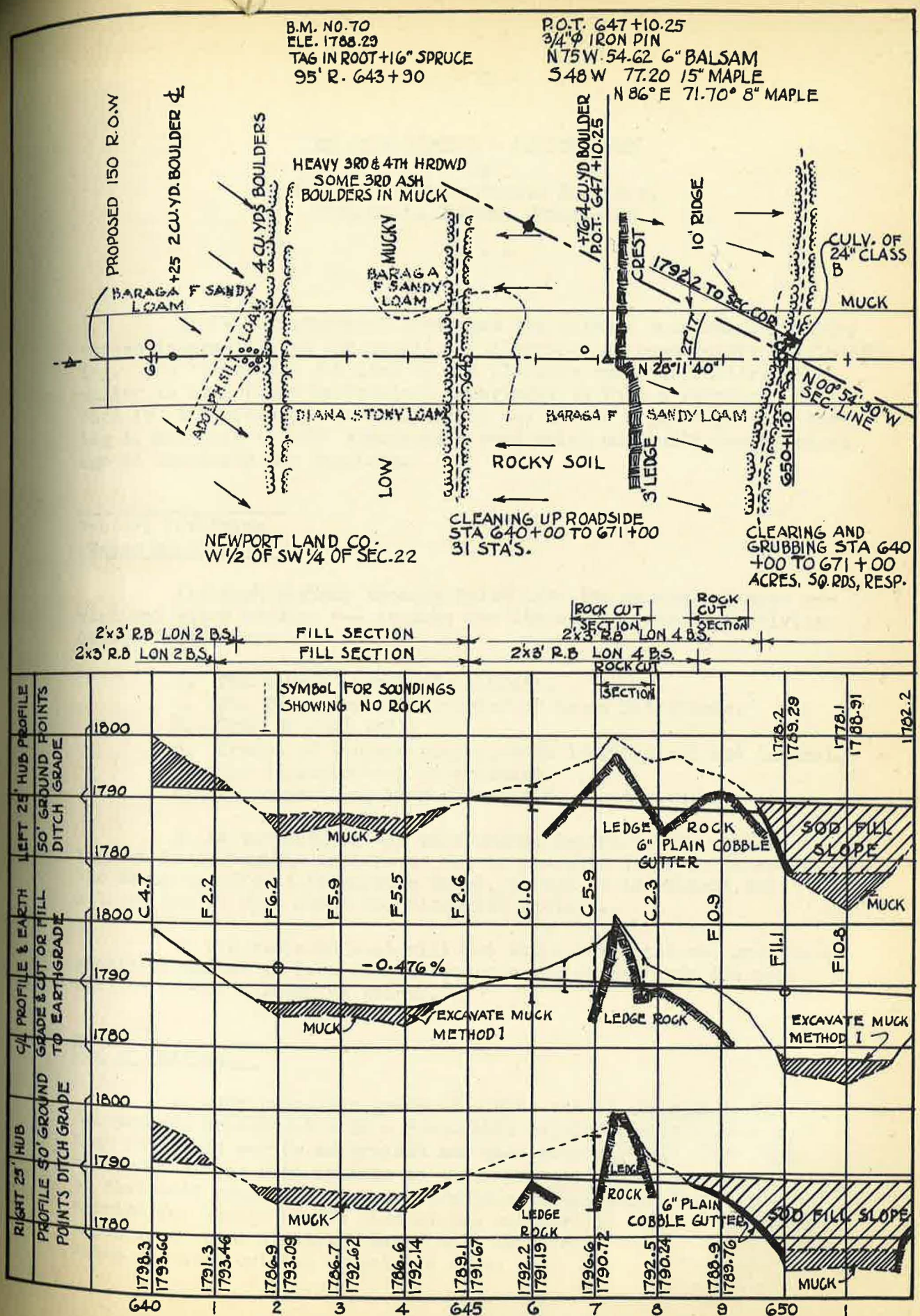
Diversion Ditches

The diversion ditch, a shallow trench excavated 3 or 4 ft. back from the top edge of a cut backslope, is a useful device for designers to help prevent backslope erosion. This ditch must be designed just as is a roadside gutter, to prevent formation of gullies and excessive erosion on contiguous lands.

Gully Erosion

Selection of the best methods of gully control depends upon the location of the gully, its dimensions, side or longitudinal slope, shape, prevailing cover, drainage conditions of watershed, land use, type of soil, and whether it is to be filled and restored to crop use, partially filled and used as a drainage course, or merely protected against enlargement. The designers' authority usually does not extend beyond the right-of-way lines of the highway. Up and downstream from the lines the lands must also be protected against erosion in order to fully protect the drainage structure. Economic factors which must be considered in regard to contiguous land protection are: system of farming practiced, debt on the land, size of the farm, and landlord-tenant relations.

The vital point in most gullies is at the upper end, where an abrupt drop or overhanging bank is generally found. Earth dams and drop flumes are found advantageous in these places. The head of a gully is usually on adjoining farm lands. Gully control should be considered at the time of the design of the highway project.


B.M. NO.70
ELE. 1788.29
TAG IN ROOT+16" SPRUCE
95' R. 643+90
P.O.T. 647+10.25
3/4"Φ IRON PIN
N75W 54.62 6" BALSAM
S48W 77.20 15" MAPLE
N 86° E 71.70° 8" MAPLE
PROPOSED 150 R.O.W
2 CU.YD. BOULDER
4 CU.YDS BOULDERS
HEAVY 3RD & 4TH HRDWD
SOME 3RD ASH
BOULDERS IN MUCK
MUCKY
BARAGA F SANDY LOAM
ADOLPH SILT LOAM
4 CU.YD BOULDER
P.O.T. 647+10.25
10' RIDGE
CREST
1792.2 TO SEC. COR.
27FT
CULV. OF 24" CLASS B
MUCK
N 28°11'40"
N 00°54'30"W SEC. LINE
640
645
650+11.0
DIANA STONY LOAM
BARAGA F SANDY LOAM
ROCKY SOIL
LOW
3' LEDGE
CLEANING UP ROADSIDE
STA 640+00 TO 671+00
31 STA'S.
NEWPORT LAND CO.
W1/2 OF SW1/4 OF SEC.22
CLEARING AND GRUBBING STA 640 +00 TO 671+00
ACRES, SQ.RDS, RESP.
2'x3' R.B LON 2 B.S.
FILL SECTION
2'x3' R.B LON 2 B.S.
FILL SECTION
ROCK CUT SECTION
2'x3' R.B LON 4 B.S.
ROCK CUT SECTION
2'x3' R.B LON 4 B.S.
ROCK CUT SECTION
SYMBOL FOR SOUNDINGS SHOWING NO ROCK
RIGHT 25' HUB
PROFILE 50' GROUND POINTS
C/L PROFILE & EARTH GRADE & CUT OR FILL TO EARTHGRADE
LEFT 25' HUB PROFILE
50' GROUND POINTS DITCH GRADE
1800
1790
1780
C4.7
F2.2
FG.2
F5.9
F5.5
F2.6
C1.0
C5.9
C2.3
F0.9
FIL.1
F10.8
-0.476%
MUCK
EXCAVATE MUCK METHOD 1
LEDGE ROCK
6" PLAIN COBBLE GUTTER
SOD FILL SLOPE
1798.3
1793.60
1791.3
1793.46
1786.9
1793.09
1786.7
1792.62
1786.6
1792.14
1789.1
1791.67
1792.2
1791.19
1796.6
1790.72
1792.5
1790.24
1788.9
1789.76
1778.2
1789.29
1778.1
1788.91
1782.2
640
1
2
3
4
645
6
7
8
9
650
1