Criteria for Contour Grading and Drainage Plans for Interchanges and Other Special Areas—A Total Design Concept

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•A MAJOR TASK and challenge today is the creation of an environment worthy of man, in which responsible freedoms are compatible with the dignity of human ideals. It ought to be an environment in which our culture and civilization can flourish and progress. Highways are a relatively small but significant and conspicuous element of our environment, requiring special consideration. Today, a stronger emphasis is being placed on aesthetics and the amenities in the development of highways and the environment through which they pass. Highway officials urge the development of highways with pleasing appearance along with traffic safety, efficiency, and structural adequacy.

The location, design, construction and maintenance of highways should achieve unity resulting from the fulfillment of the four basic qualities: utility, safety, beauty and economy. These qualities, together with the design and construction elements, must be integrated with the topography and environment. A total design concept in three dimensions is required to achieve unity and pleasing appearance for highways.

According to the 1962 Conference on Freeways in the Urban Setting held at Hershey, Pa.:

> The construction of efficient, effective, and attractive freeways demands a total design concept. This means the integration of all aspects of the design into a whole that is satisfying and effective, and integrated with its surroundings. Design which is simple and natural will largely alleviate confusion in the use of freeways.

Contour grading and drainage plans, when properly prepared, are a great aid to the achievement of these objectives. They provide a three-dimensional total design concept and design method, and give visual proof of the correlation of proposed construction with the existing topography and adjacent environment. They facilitate the visual study of design and the review and approval of plans. They provide a basis for the design of planting plans. They should be used for field review, inspection, construction, and later for maintenance.

It is recommended that contour grading and drainage plans be prepared for all interchange areas, and other special areas as required. Such special areas should include at-grade intersections, grade separations, bridge sites, roadside service and rest areas, and borrow and waste areas. Contour grading and drainage plans would be very advantageous for entire highway projects, particularly for complex urban and rural expressways and parkway design.

The development of contour grading and drainage plans is a technique long practiced by landscape architects and engineers in the design of a wide variety of projects. Its application to parkway and expressway design has achieved outstandingly good re-

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Paper sponsored by Committee on Roadside Development.

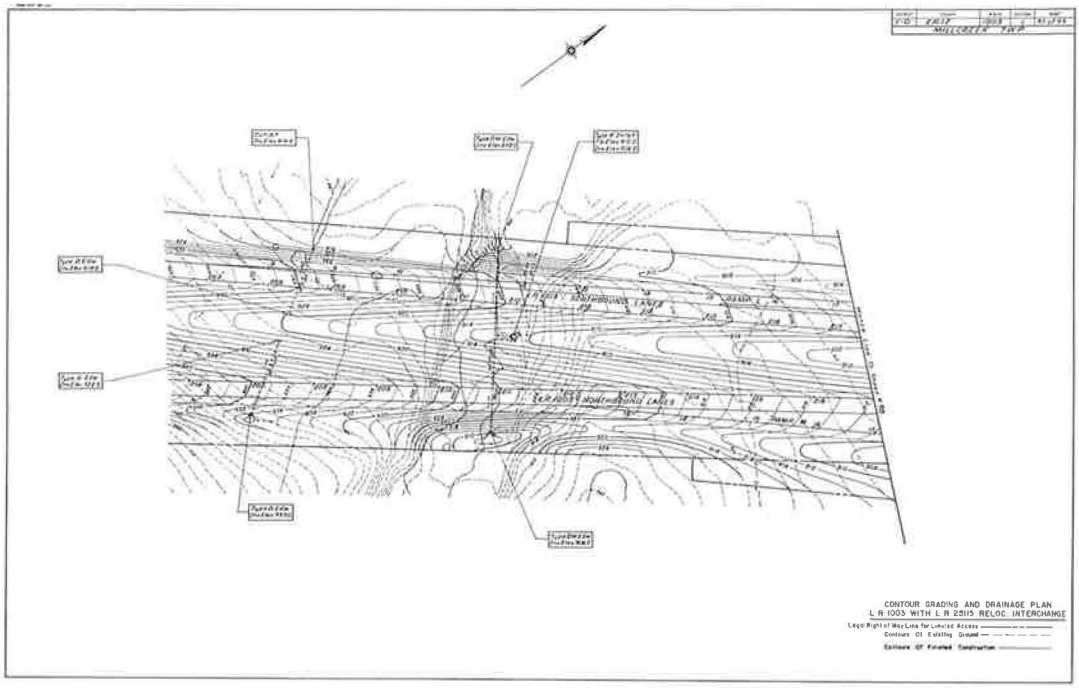

Figure 1. Representation of contour grading and drainage plan (not to original scale).

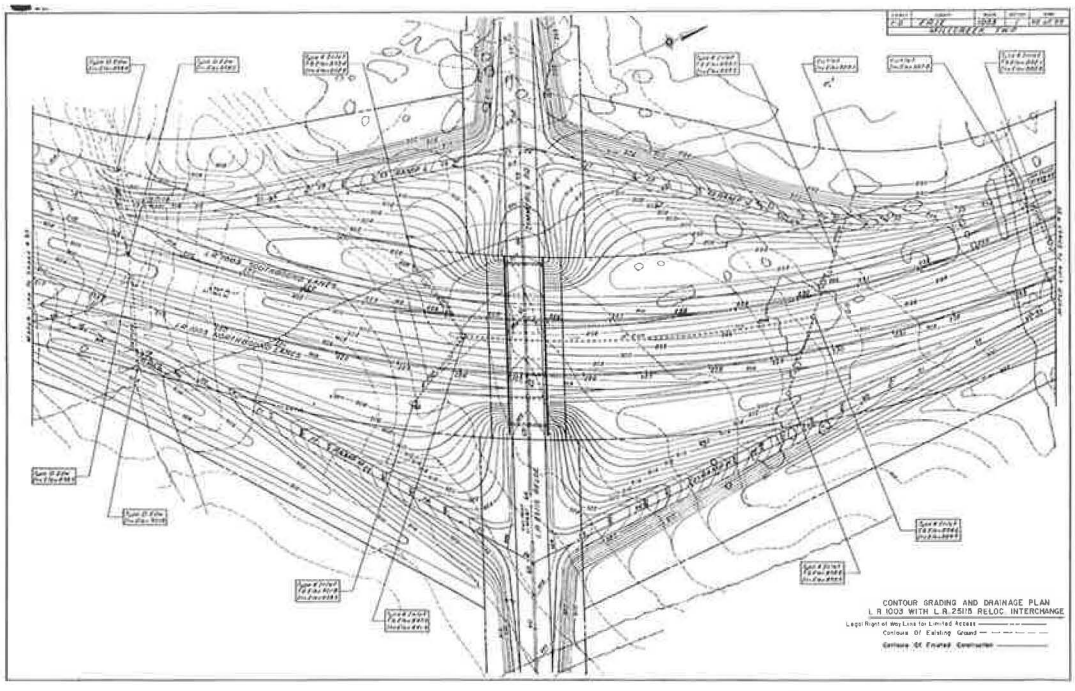

Figure 2. Representation of contour grading and drainage plan (not to original scale).

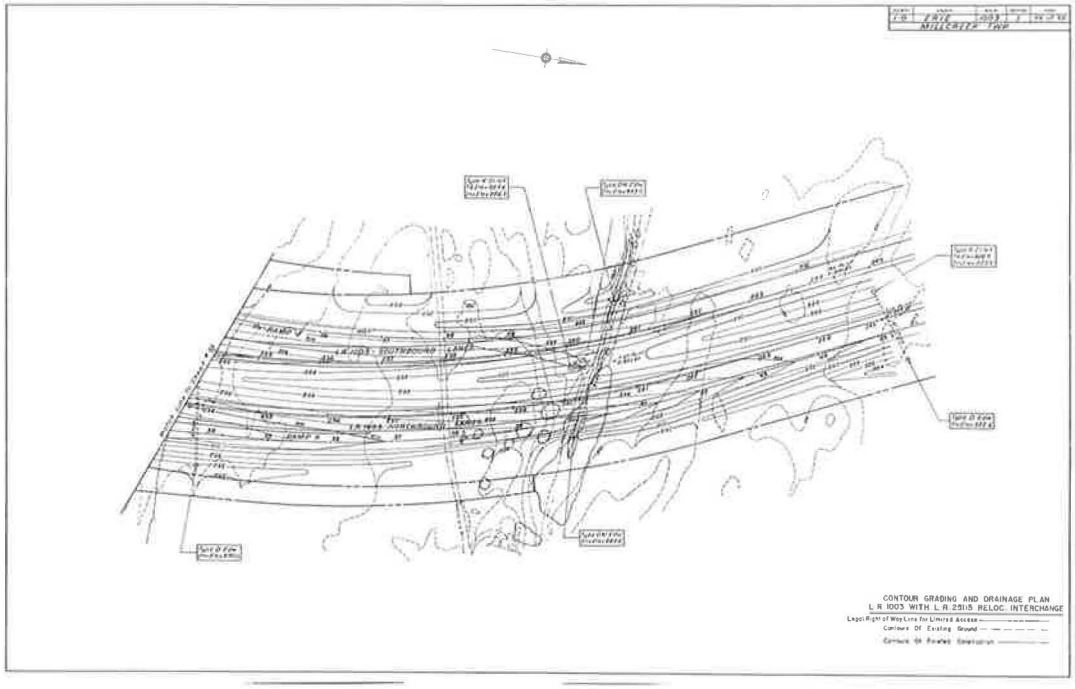

Figure 3. Representation of contour grading and drainage plan (not to original scale).

sults in some areas. This design technique was extensively used for the development of parkways and expressways for New York and New Jersey and is now being used elsewhere with good results. A much wider use of this technique is recommended for the development of integrated design throughout the states.

The Pennsylvania Department of Highways requires the preparation of contour grading and drainage plans for all interchange areas, and other special areas as directed. These plans are included with the construction plans. The objective is to correlate the design and construction elements with each other and with the topography, to reduce maintenance, to increase safety, and to improve the appearance of the entire area. These plans must be competently prepared, reviewed, and approved during the preliminary stage, and finalized for inclusion with the construction plans. Representation of typical contour grading and drainage plans is shown in Figures 1, 2, and 3.

The preliminary geometric design layout of the designated area should be prepared first, usually at a scale of 1 in. = 50 ft. It should indicate the existing topography, including 2-ft contours in short dashed lines throughout the proposed construction and right-of-way area to facilitate review and design approval. The contour grading and drainage plans should be prepared supplementary to, or in conjunction with, the preliminary geometric design layout and drawn to the same scale. Both sets of plans must be submitted to the proper authorities for review and approval or recommendations.

It is imperative that the contour grading and drainage plan be developed to the highest engineering and aesthetic standards feasible for the areas designated, and in accordance with policies set forth by the American Association of State Highway Officials (1, 4).

The contour grading and drainage plan data should show the existing topography and 2-ft contours in short dashed lines throughout the proposed construction and right-of-way area. The following are to be included: drainageways, trees and wooded areas, structures above and below ground, utilities, springs and wells, control elevations, right-of-way lines, north point and coordinate grid, if used, and other cultural and

land-use information which will help in design layout. It may be advantageous to show these existing features on the back of the tracing to permit modification in design layout, grading, or drainage of the area during the preliminary stages without loss of ground data. The use of diluted black or colored ink to show existing data aids in differentiating between existing and proposed conditions.

The entire horizontal and vertical geometric design of roadways, roadsides, drainage, structures, and proposed right-of-way must be correlated with each other and with the topography during the preliminary design stage. Piecemeal or advance approval of any design aspect may preclude good correlation. Adjustment of alignment and profiles, superelevation, transitions, pavement and shoulder cross slopes and warps, roadside grading, drainage, and right-of-way lines must be made before final approval. The entire area should have a well-fitted, natural, and pleasing appearance from the point of view of the road as well as from the road.

All proposed work should be shown on the front face of the drawing. Features to be included are the edges of roads, ramps, shoulders, station control base lines with their station equalities, all drainage pipes with their respective sizes and invert elevations, drain inlets with their top of grate (T. G.) elevations, headwalls, box culverts, and other structures. Road and ramp identification, the curve radius or degree of curve, right-of-way lines and other pertinent information must be shown. Proposed contours should be drawn in continuous lines on the front face of the drawing (in pencil for preliminary plans and in black ink for final plans).

Proposed 1-ft contours must be plotted on all roads, ramps, and shoulders, including those under and over bridges. To define flat and warped areas, $\frac{1}{2}$-ft contours may be used. These contours must be in agreement with computed profiles, cross slopes and superelevation rates, transitions and warped surfaces. The even-foot pavement contours should be labeled parallel and above or below the contour. The pavement contour line must not be broken. The plan profile line should show the computed station and elevation values for high and low points on crest and sag vertical curves.

Accurate plotting of pavement and shoulder contours is an aid to the design and visual proof of the relationships of alignment, profiles, superelevation rates and transitions, cross slopes, and warped pavement junctions. They reveal the direction of surface drainage flow. They are very useful in the design of at-grade intersections and road junctions.

For proposed roadside grading and drainage the contour interval should be 2 ft. These contours must be connected with their respective existing contours to establish limit of grading. Variable and well-rounded slopes, drainage ways, and swales should be designed where feasible. The drainage system should not be independently determined. Grading and drainage must be designed together to work together and the entire drainage system, including all related structures, must be shown. Invert and T. G. elevations must be indicated and correlated with the contour grading.

Bridge site grading and drainage ought to be given special attention for safety, good appearance, and ease of maintenance. Flattened slopes and flowing contours can greatly enhance the appearance of bridge approach sections.

Throughout interchange areas, roadside earth slopes steeper than 2:1 should be avoided. A ratio of 3 or 4:1, or flatter, may be indicated for economical construction and maintenance, increased safety, and a more pleasing appearance in the area. Flattened slopes with flowing contours, broad rounded drainage ways or swale-like depressions are desirable where possible to encourage good turf and to facilitate power maintenance. They also reduce the need for guardrails. V-ditches, and small ditches with steep side slopes, should be avoided where possible. They are difficult to construct and maintain, are unsightly, and may become hazardous. Transition grading between cut and fill slopes should be well rounded and streamlined to blend the highway into the adjacent terrain. Transitions between slope ratios ought to be long and natural in appearance.

Slopes in the area being contoured should not be contoured from typical predrawn cross-sections. The contour grading and drainage plan must be designed first; the cross-sections for the proposed grading should be drawn later. Adjustment of contours and/or cross-sections may be required to achieve a desirable relationship. Earthwork quantities can be obtained from plotted cross-sections.

The final contour grading and drainage plan must be accurately drawn, should agree with the final alignment and profiles, and should include all features reviewed and approved in earlier submission. The sheets should be standard construction plan size, and at the same scale as that used for the construction plans. The plan may be prepared on a reproduction of the applicable sheet (s) of the construction plans, and should be included with the final construction plans.

The Pennsylvania Department of Highways requires contour grading and drainage plans and has made significant improvement in the total design of interchange areas in the state. They are effectively used, not only as a design method, but also as a visual proof of the correlation of construction elements with each other and with the topography. For instance, in the review of plans, pavement contours have revealed examples of poor correlation of contiguous pavement surfaces in areas where ramp pavements are merging with, or diverging from, through pavements. Roadside contours have revealed examples of poor correlation of slope grading, surface drainage, drainage structures, and existing topography. Therefore, competent and thorough preparation and review of these plans is required if the four basic qualities—utility, safety, beauty, and economy—are to be achieved in highway design and construction.

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