GERMAN HIGHWAY DESIGN

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SYNOPSIS

Germany is constructing an entirely new system of limited access, high speed highways superimposed upon the existing road system The roads constituting the Reich's Autobahnen, are on new right-of-ways and are designed for maximum speeds of from 80 miles per hour in mountainous regions to 100 miles per hour in flat country Most safety features known to highway engineers have been used, opposing traffic streams are completely separated and there is no crossing of lines of traffic

Design and construction practices follow modern principles generally in vogue in the United States, application naturally varying somewhat with different conditions The whole right of way is treated to give asthetic value as well as maximum utility for high speed through transport

GERMAN MOTORWAYS

When the new economic program was started in Germany, one of the first activities to get under way was the construction of a system of superhighways The plan called for the ultimate construction of 4500 miles at the rate of about 650 miles per year The program which to date has resulted in the construction of 1900 miles of highways has stimulated business and automotive transportation and has furnished continuous employment to 250,000 men in the road material and machinery industries

RIGHT-OF-WAY

Inasmuch as the plans for the new highway system were formulated to exclude the old system and utilize new locations throughout, it was necessary to acquire new right-of-way for the greater percentage of the mileage The land in most cases was acquired by purchase although in case of disagreement, condemnation proceedings could be put into effect

There has been no difficulty in the acquisition of right-of-way in Germany and more than two thirds of the necessary right-of-way has been acquired and is ready for construction This situation is simplified throughout most of Europe by the very compact grouping of the houses in towns and villages, which leaves no buildings scattered along the countryside The highways easily skirt the centers of population and the only obstacles to be considered are of a topographical nature

LOCATION

Highways have been located to provide for the maximum safe speed for each kind of topography In flat territory the roadways have been designed for speeds of one hundred miles an hour, which limit is reduced to ninety miles in the more rolling country and to eighty miles in the mountainous sections The maximum grades for these classifications are respectively four, six, and eight percent The minimum radius for horizontal curves is 1800 ft in mountainous country, 3000 ft in hilly country and 6000 ft in flat country Minimum visibility ranges from 900 ft on the plains to 500 ft in the mountainous regions

Most of the safety features that have long been recommended by highway engineers in the United States have been built into the German highways, including the elimination of all highway and railroad grade crossings, all pedestrian, bicycle, and animal traffic is excluded An effort has been made to fit the highway into the landscape, which has involved roadside development and wide shoulders sloping to an adequate drainage system.

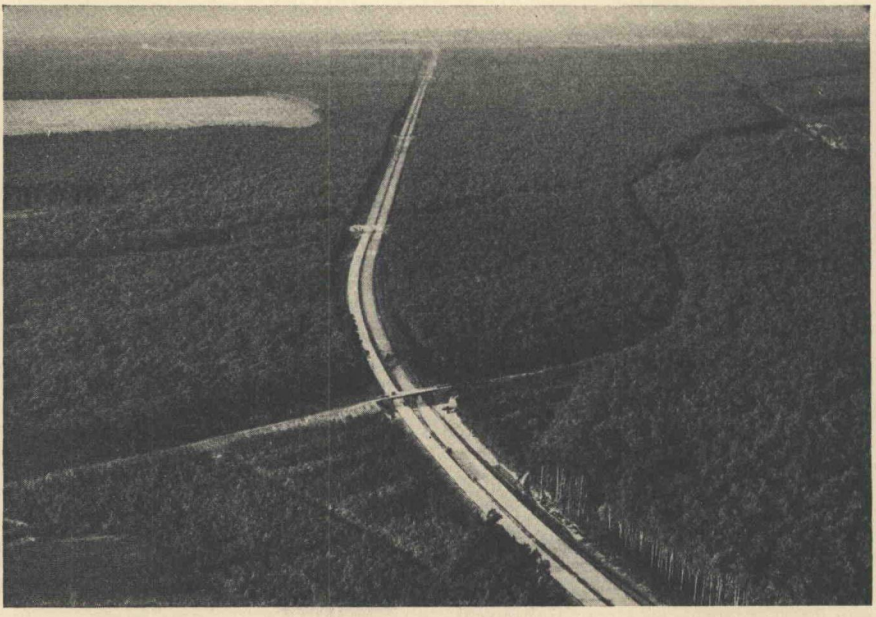

Figure 1. Reichs Autobahnen

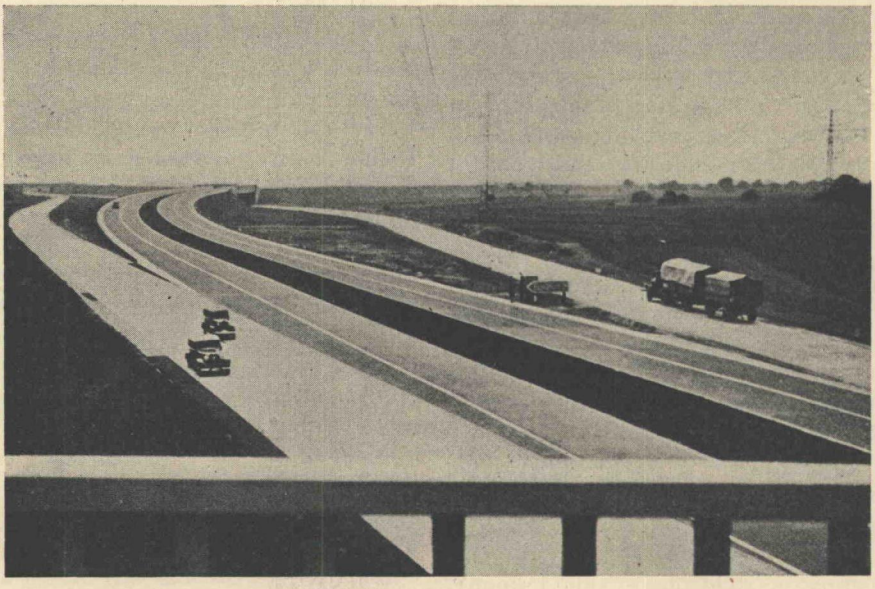

Figure 2. A Typical Layout

There is complete separation of opposing traffic streams and there are no collision points caused by the crossing of lines of traffic. There are no means of direct access to the highways system, but parking places are provided about two miles apart.

Careful attention has been paid to

aesthetic effects. There are no telegraph poles or advertising signs to disturb the pleasing effect of alignment, and necessary buildings such as rest rooms, filling stations, repair shops, etc., are built to harmonize with the surroundings.

For the purpose of preserving the natural beauty of the roadway area there has been rigid conservation of existing trees and shrubs. All new planting has conformed to existing agricultural development and wherever the local topsoil and turf has been removed, it has been saved and utilized.

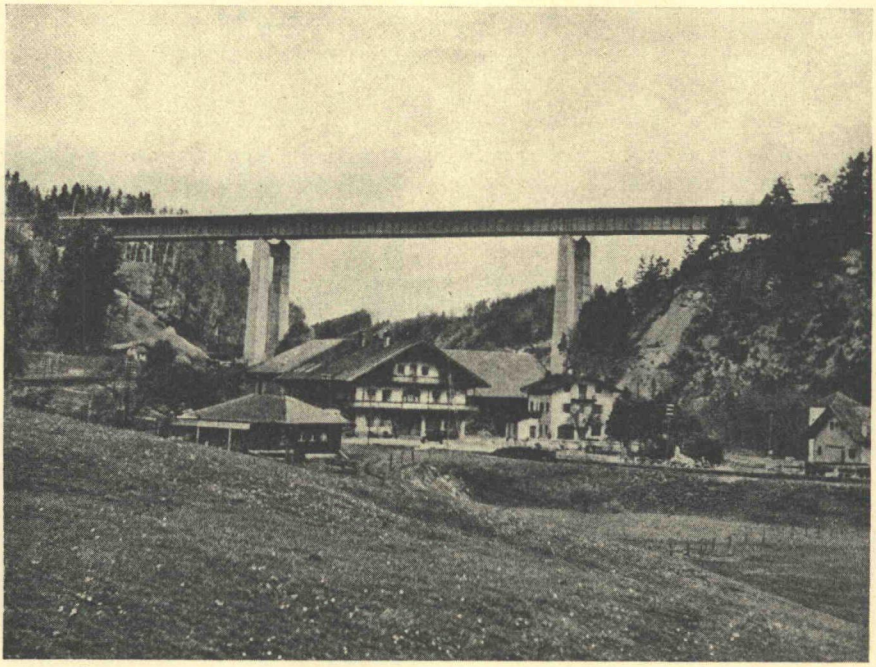

Figure 3. A High-Level Highway Bridge

DETAILS OF DESIGN

Beginning with the early construction steps, much attention has been paid to details. Early grading methods included the placing of fills in layers three ft. thick which resulted in poor compaction. These methods were revised and compaction is generally obtained by the use of a piece of equipment known as the "Leaping Lena," a one ton weight equipped with a Diesel piston, which is moved by a discharge set off by the impact of the weight jumping into the air. The equipment has handles and is moved about by the operator. This method of compaction has proved quite successful, as proven by the use of 600 of them on the various contracts.

The prevailing road cross section calls for two double lane roadways each 25 ft. wide, with opposing traffic completely separated by a 16 to 20 ft. safety island.

Ninety per cent of the surfacing is concrete, six per cent is bituminous, and four per cent is durax or a similar type. Concrete surfacing is $8\frac{3}{4}$ in. thick, usually placed in two layers without reinforcement. The bottom layer is 5 in. thick, and the top is $3\frac{3}{4}$ in. The top course is laid not more than 20 ft. behind the bottom course thus eliminating any line of

cleavage and yet making possible more uniformity than would otherwise be obtained. Wooden expansion joint material with dowel bars is installed in the lower five inches of the expansion joint. The upper section of the joint is filled with a hollow steel section, 3 in. high and $\frac{3}{4}$ in. wide, covered with bitumen which is left in place for several days. This steel shell is finally removed by means of steam heat and the joint is then filled with a mixture of asbestos and bitumen. The steel casing is thus available for continuous use.

Figure 4. "Leaping Lena"

Mixing and curing are done scientifically. All finishing machines are equipped with vibrators and the initial curing is by placing canvas tents over the slab.

The average daily output is 220 yd. for a width of 20 ft. 6 in. and the riding surface is checked with a machine which indicates irregularities in excess of $\frac{1}{6}$ of an inch in 13 ft. Such irregularities must be taken out by the contractor. Two cores are taken every half mile. The strength requirement is 5000 lb. per sq. in. at 28 days.

The equipment being used is not so far advanced as that in use in the United States although there is evidence that the German engineers are aiming for higher standards.

OPERATION

As a result of the new highway transportation system the use of the automobile has been greatly stimulated. This is proved by the fact that in 1933

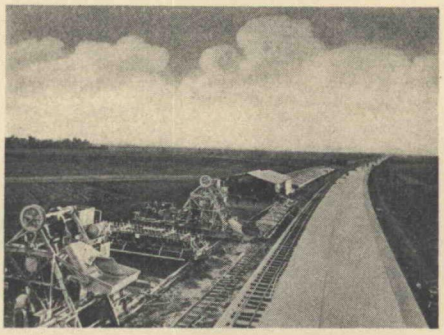

Figure 5. Concreting Operation

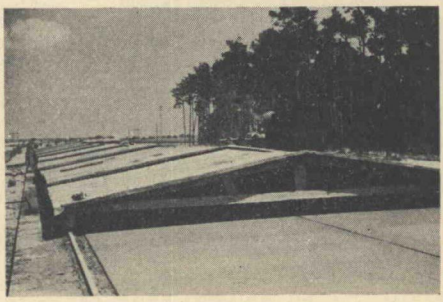

Figure 6. Curing Sheds

there were only 8.6 passenger automobiles per 1000 population while in 1937 this number had doubled.

From the safety standpoint the highway system as designed and constructed in Germany is conclusive proof that if highways are built, eliminating all danger points, the accident toll can be reduced to almost a negligible figure.

Traffic has been largely diverted from the old road system. This diversion in

some instances has been as high as 65 per cent Partly as a result of this and partly as a result of operation over the modern highway system, accidents have been reduced 83 per cent

Accidents as recorded and which were not in any way caused by faulty highway design have been principally of three classifications One type of accident is caused by lack of attention to overtaking cars resulting in what is familiarly termed a "side-swipe " A second type is caused by the careless obscuring of the tail light of a car parked by the roadside, and a third is caused by heavy snow obscuring the roadway limits resulting in the car running off the road.

There are only four kinds of signs and signals along German superhighways These are directional signs, filling station signs with distances, parking signs and distance signs. Inasmuch as there are no danger hazards on the highways, the danger signs have been eliminated. All signs are the reflector button type

COST

The approximate cost per mile for highways of the super type in Germany is $185,000, which includes the acquisition of land, grading operations, and bridge and road construction During the three year period 1934–1936, expenditures on the super-highway system amounted to $270,000,000 Highway and bridge construction took about 35 per cent of the expenditure and grading operations, took about 35 per cent. The remainder was used for the purchase of land, administration, freight, etc