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10. Arch Highway Bridge over the Old Dnieper River, Zaporozhiye

Designed by: TSNIIproektstalkonstructsiya
Dimensions:
Overall length: 320 m
Arched span: 204.8 m
Width of the roadway: 14 m
Width of the foot-way: 2 x 2.25 m
Material:
Grade of steel for main structures: C 60/45
C 46/33
Mass:
Consumption per m2 of effective area of steel: 340 kg/m2
of concrete (including supports): 0.54 m3/m2
Load:
Cars and trucks: H 30
Pedestrians: 400 kg/m2

The arch highway bridge over the Old Dnieper in Zaporozhiye, the Ukraine, was put into service in 1973. It was designed by G.D. Popov.

The overall clear length of the bridge between the abutment walls is 320 m which includes the four-span trestle on the left bank 51.2 m long, the main arched span over the river bed 204.8 m long, and the five-span trestle on the right bank 64 m long.

The width of the roadway is taken to be 14 m providing for four transport lanes, including one for trolleybuses. The width of the foot-ways is 2.25 m.

The rock base on both river banks, the large height from the water edge to the upper part of the bridge and the large depth made it possible to use a single-span arch system over the river bed.

Experience shows that in arch bridges the most economical design incorporates a combined system consisting of a girder framework supported by flexible strengthened arches; compared to a rigid arch system, it results in economy up to 20 per cent.

The existence of multispan trestles on the right and left river banks made it possible to develop a continuous stiffening girder restrained at the ends of the main span. This solution, as well as the combined behaviour of the stiffening girders and the prestressed reinforced concrete slab of the roadway allows the girders to have the depth of 2.4 m, i.e. 1/85 of the span, and at the same time to ensure appropriate rigidity and safety of the system.

The girder framework consists of four girders, each pair of girders supported by a single arch. The forces are transferred from the posts to the longitudinal girders by transverse membranes.

The horizontal rigidity of the bridge superstructure is provided by two systems. The first one incorporates the arches and their semidiagonal bracings. Since arch hinges are always pressed against the supports, the system is restrained at the supports; the second system consists of longitudinal girders which are connected by a reinforced concrete slab at the top and by the semidiagonal system bracings in the bottom. This system is supported on abutments and transverse frames spaced at a distance of two panels (25.6 m) from the posts placed above arch supports.

This type of positioning transverse frames allowed to prevent any additional loads acting on the highest posts, to considerably lower the deformability of the transverse frames and decrease their height more than two times.

The second system is designed as elastically restrained having the middle span 256 m long and two end ones, 25.6 and 38.4 meters.

Owing to these design solutions the horizontal rigidity of the whole system is very high: the maximum horizontal displacement of the midspan amounts to 1/3300 of the middle span length despite the fact that the distance between the arches is only 7.5 m.

It is of interest to note the technical characteristics of the bridge:

Spans: 4 x 12.8 + 204.8 + 5 x 12.8 m; bridge roadway clearance (Г14) – 14 m; width of the foot-ways: 2 x 2.25 = 4.5 m; distance from the water level to the arch dome – 33 m.

Consumption of the material per 1 m2 of the effective area:

a) overall steel consumption: 340 kg
b) overall consumption of concrete (including the supports): 0.54 m3
c) of steel in the arched span: 365 kg
d) of steel in the overhead spans: 201 kg
e) of reinforcement: 41 kg

Estimate cost of 1 m2 of the effective area: 402 roubles.

Design load of the class H–30.

Combined with the use of higher strength steels (the 15 XCHD steel in the longitudinal girder members and the 16Г2 АФ steel in the arch members) the present technical solutions allowed to save 1 thousand tons of steel and reduce the cost by 750 thousand roubles.

(Popov, Ruzhansky, Poliakova)

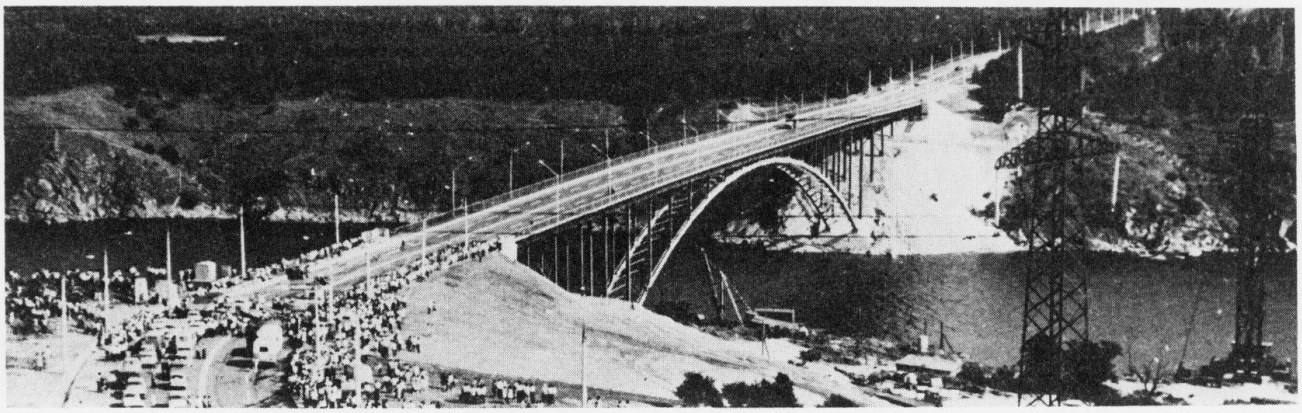

Fig. 1 General view of the bridge