AESTHETICS OF BRIDGES

by

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The Bridge Branch of the Province of Alberta has, in the last few years, made an attempt to design grade separation structures that provide greater safety for the motorist from the point of view of increased clearance and motorist interest. Almost without intention we have in fact employed some of the rules of highway aesthetics which is a relatively new concept, yet generally recognized for the value it offers.

Ten years ago there were 360,000 vehicles registered in the Province. Within the succeeding five years this number increased to 440,000 and then to the present 610,000. With this increase in traffic it became necessary to incorporate grade separations at many points in our highway system to carry traffic over main routes and to safely interchange traffic between routes.

Until 1962 our grade separations had been the most economical structures for the situation. Piers were placed close to the shoulder of the road and then protected by guardrail. This resulted in a three span structure if the road were undivided or, if the structure crossed a divided highway, an additional pier was placed in the median, resulting in a 4 span structure.

In our attempts to improve our bridge designs we were constantly trying new ideas and features in our structures. One kind of structure that showed promise consisted of steel frames with legs sloping inward from the approach fills and two legs forming Vs supporting the centre from the middle of the median. It offered greater horizontal clearance from the supporting components at the outside shoulder, and only a small decrease in the horizontal clearance to the centre support. The sloping supports also reduced effective span lengths. The whole effect was a pleasing structure which gave the motorist an unrestricted feeling while passing under it.

At that time we were preparing proposals for a grade separation on a divided 4 lane highway near Red Deer. Included was a steel frame structure with welded, built-up legs and beam members in the negative moment region and rolled shapes in between.

Even with the reduced amount of material required because of the greater continuity in the frame type, we felt the more intricate fabrication required surely would cost more than the usual rolled beam type structure. As it turned out the structure received favourable acceptance and at a cost of $12.70 per square foot of deck area compared to the going rate of about $11.00 per square foot for the simplest rolled beam structures at that time.

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The success of the Red Deer grade separation led to another of the same type but with considerable modification in detail. The major differences were that the frames were completely welded and the haunches involved none of the curved lines which had caused problems in the design and fabrication of the earlier structure. The reduced weight afforded by tailoring the sections to correspond more closely to the moment envelope was offset by the increased cost of the additional welding. The end cost result of $11.70 per square foot was comparable to its predecessor. This structure was the Wetaskiwin grade separation.

These two designs still required a support near the outside highway shoulder and it was not difficult to imagine a time when it would be necessary to increase the traffic capacity of our divided highways by adding lanes. With the Red Deer and Wetaskiwin designs, our only choice would be to add a lane in the median in the region of the structures. This approach had two main disadvantages: first, it would reduce the clearance to the supports in the median and second, it would preclude the possible addition of acceleration or deceleration lanes if a simple fly-over structure were required to become an interchange structure.

The obvious solution was then to eliminate the outside piers or legs altogether. Two grade separations were subsequently built with a frame in the median providing the only support between abutments. The final silhouette permits the addition of a thru lane or an acceleration or deceleration lane on the outside by the addition of a small retaining wall. In the extreme case, the addition of a larger retaining wall permits the addition of two lanes on the outside. The centre frame still provides for one lane to be added on either side of the median but at a reduced clearance.

From a construction point of view the two structures are completely different. One, the Menaik grade separation, has a welded steel frame in the centre with rolled sections field bolted on either side spanning the roadways and supported on the abutments. The design sacrifices some structural economy and the unit cost increased to $13.90 per square foot. The other structure, the Highway 2 grade separation North West of Hobbema, has a poured-in-place centre section with prestressed, precast channel shaped, concrete units suspended between the cantilevers of the frame and the abutments. The structure was quite economical with a unit cost of $10.80.

It was obvious after the two grade separations were completed that they were an improvement over the others from a highway aesthetics point of view. We have since built 4 quite different structures which have incorporated the feature of a clear head slope.

Although our climate is not so severe that we are unable to build bridges throughout the year, it is a definite advantage to be able to start construction of a grade separation in the early spring and open it to traffic in the late fall. Firstly, summer construction is cheaper and secondly, since most of the
earth work and paving is done during the summer and fall, the availability
of the structure for traffic better fits the overall schedule for the highway.

To reduce the length of time required for construction, the plant phase
of the work was emphasized in the building of two of our most recent grade
separations. The Jumping Pound grade separation consists of a self supporting
U shaped welded steel member erected in the centre of the median which supports
rolled beams running the entire length of the structure. Erection is almost
as simple as that of a rolled beam bridge and yet it requires no centre pier.

The Ardrossan grade separation consists of outward sloping precast con­
crete legs set in holes provided in a foundation block built in the centre of
the median. Channel shaped, prestressed, precast concrete units are centred
on top cantilevering over the roadways. Drop-in spans of a similar section,
span from the ends of the cantilevers to the abutments at the tops of the head
slopes. The field work is limited to a construction of a simple centre founda­
tion and abutments and erection of the precast concrete. It is expected the
cost will be $14.35 per square foot.

There are a number of guides to good aesthetic design, however the aesthe­
tics of bridges cannot be completely separated from those of the highway of
which they form a part. In general, structures should be designed to provide
the least interruption to the continuity of the highway section. A grade sepa­
ration should have headslopes that are open and as similar as possible to the
general slopes of the highway it is crossing. Generally the structure should
be as thin as possible and have uninterrupted horizontal lines. The abutments
should be as unobtrusive as possible unless they are in fact retaining walls
in which case they should be unadorned and kept a considerable distance up the
headslope.

A traffic structure should preferably be of the deck type. If a through
structure is required, the overhead bracing should be kept to a minimum. Rail­
ings should be designed to obstruct the view as little as possible.

Color is an important aesthetic feature. Where structures are closely
spaced they should be similar and probably painted the same color in order to
maintain the continuity of the road. However in Alberta, the survey system
provides a north-south road allowance every mile and an east-west allowance
every two miles and because of this and much level country, it has been exped­i­
tent to build roads with many miles of continuous tangent. Curvilinear align­
ment and other aesthetic features cannot always be introduced sensibly and, to
introduce variety for interest and to provide landmarks, we have painted steel
bridges in a variety of bright colors.

The foregoing remarks apply in particular to the heavily travelled main
highways. However, by far the greatest number of our bridges are on secondary
and market roads where the practical solution for a stream crossing has neces­
sarily been dictated by economics. There is little that can be done with these
bridges in regard to aesthetics other than to maintain clean simple lines. This applies in particular to beam spans.

Here again we have taken advantage of color to give a more pleasing appearance by painting the steel bridges a variety of bright colors. By painting the chord members of a truss span a dark color and the web members a light color the main carrying components are accentuated. Also, the bright colors bring out the horizontal lines of a steel girder bridge.

Throughout the whole province there is a great deal of oil drilling activity which is accompanied by the hauling of unusually heavy and high loads. Very often the upper wind bracing of the some 200 odd through truss spans is struck and bent or torn out necessitating repairs to the bracing members and frequently to the main truss members.

A program was started about 6 years ago to replace all portal bracing members with a single box section member and to raise sway bracing members to provide at least an additional foot over the portal clearance or to make them the depth of the top chord on parallel chord trusses. Although aesthetics is not really a consideration, we have seen that the revision provides a more attractive structure and gives the motorist a greater feeling of freedom while crossing the bridge.

The Alberta Department of Highways is similar to many state and provincial highway departments in North America with the usual branches of planning, road construction, road maintenance and bridge construction. It has an annual budget of $80,000,000 of which $10,000,000 is allotted to the construction and maintenance of bridges. All bridges in the province except those in the cities, fall under the direction of the Bridge Branch. This amounts to some 10,000 bridges.

In conclusion gentlemen, I would like to say that I hope this discussion of Alberta bridge design with particular regard to aesthetics has been of interest and that our experience may in some small way be of value to you.