Date: August 30, 2002

REVISION INFORMATION SHEET

FOR

GEOMETRIC DESIGN STANDARDS FOR ONTARIO HIGHWAYS

ATTACHMENTS: Revisions to
Chapter C – ALIGNMENT
Chapter D – CROSS SECTION ELEMENTS

REASONS: The 'Ontario Bridge Design Code, OHBDC' has been superseded by "Canadian Highway Bridge Design Code", designated as CAN/CSA-S6-00 published by Canadian Standards Association, effective June 1, 2002.
CHBDC does not prescribe structure clearances and cross section dimensions. The attached revisions are necessary to fill the gap.

DELETE		INSERT	
PAGES	**DATED**	**PAGES**	**DATED**
C4-9 to C4-12	**94-06**	**C4-9 to C4-11**	**02-08**
D7-1	**94-06**	**D7-1 to D7-3**	**02-08**

C.4.4 DESIGN CONTROLS

C.4.4.1 Intersections

Intersections are points of conflict and potential hazard. The grade of the intersecting roads, therefore, should permit drivers to discern and readily make the manoeuvres necessary to pass through the intersection with safety and with a minimum of interference between vehicles. To this end, gradients should be as low as practicable.

Combinations of grade lines that make vehicle control difficult should be avoided at intersections. It is desirable to avoid substantial grade changes at intersections, but it is not always feasible to do so. Adequate sight distance should be provided along both highways and across the corners even where one or both intersecting highways are on vertical curves.

At all intersections where there are "yield" or "stop" signs, the gradients of the intersecting highways should be as flat as practicable on those sections that are to be used as storage space for stopped vehicles. However, a 1% minimum gradient is desirable to allow for reduction in cross-fall without impairing drainage. Intersections controlled by signals or which might be at some future date, should be generally flat.

Most vehicle operators are unable to judge the increase or decrease in stopping or accelerating distance necessary because of steep grades. Their normal deductions and reactions thus may be in error at a critical time. Accordingly, grades in excess of 3% should be avoided, if possible, on intersecting highways.

The grade and cross-sections on the intersection legs should be adjusted for a distance back from the intersection proper to provide a smooth junction and proper drainage. Normally the grade of the major highway should be carried through the intersection and that of the cross-road adjusted to it. This requires transition of the crown of the minor highway to an inclined cross-section at its junction with the major highway. Changes from one cross slope to another should be gradual. Intersections of a minor road crossing a divided highway with a narrow median and superelevated curve should be avoided whenever possible because of the difficulty in adjusting grades to provide a suitable crossing. Grades of separate turning roadways should be designed to suite the cross slopes and grades of the intersection legs.

C.4.4.2 Railway Crossings

For information see Chapter E, Sections E.12 and E.3.6

C.4.4.3 Vertical Clearances

C.4.4.3.1 New Structures Over Roadways

POLICY

THE MINIMUM VERTICAL CLEARANCE OVER THE ROADWAY FOR NEW STRUCTURES SHALL BE:

- **4.8 m FOR SOLID OR CAST-IN-PLACE CONCRETE SLAB BRIDGES.**
- **5.0 m FOR ALL OTHER VEHICULAR BRIDGES.**
- **5.3 m FOR PEDESTRIAN AND BICYCLE BRIDGES.**
- **4.8 m FOR SMALL LANE DESIGNATION SIGNS PROVIDED WITH A PIVOT MECHANISM WHICH WILL PREVENT DAMAGE TO THE SIGN OR SIGN SUPPORT STRUCTURE.**
- **4.8 m FOR RAILWAY BRIDGES OVER ROADWAYS.**
- **5.3 m FOR FIXED ATTACHMENTS, SUCH AS SIGN PANELS, OF SIGN SUPPORT STRUCTURES.**
- **5.6 m FOR THE LOWEST STRUCTURAL MEMBERS, SUCH AS BOTTOM CHORD, OF SIGN SUPPORT STRUCTURES.**

THE MINIMUM VERTICAL CLEARANCE OVER SIDEWALKS, BIKEWAYS AND SNOWMOBILE TRAILS SHALL BE 2.5 m.

Consideration should be given to a higher clearance for snow grooming equipment where required.

These dimensions take into account two resurfacings, live load deflection, foundation settlement, differential heaving of pavement and vehicle bounce.

ALL STRUCTURES HAVING A VERTICAL CLEARANCE LESS THAN THAT SPECIFIED ABOVE, SHALL REQUIRE APPROVAL BY THE JURISDICTIONAL AUTHORITY.

C.4.4.3.2 Existing Structures over Roadways

POLICY
FOR EXISTING STRUCTURES WHERE THE HIGHWAY IS BEING RESURFACED OR RECONSTRUCTED, THE MINIMUM VERTICAL CLEARANCE OVER THE ROADWAY SHOULD BE:

(A) FOR STRUCTURES WHERE THE EXISTING VERTICAL CLEARANCE IS EQUAL TO OR GREATER THAN THOSE SPECIFIED IN C.4.4.3.1 THE FOLLOWING SHALL APPLY:

4.7 m FOR SOLID OR CAST-IN-PLACE CONCRETE SLAB BRIDGES

4.9 m FOR ALL OTHER VEHICULAR BRIDGES.

5.2 m FOR PEDESTRIAN AND BICYCLE BRIDGES.

4.7 m FOR RAILWAY BRIDGES

5.2 m FOR FIXED ATTACHMENTS.

(B) FOR STRUCTURES WHERE THE EXISTING CLEARANCE IS EQUAL TO OR LESS THAN THOSE SPECIFIED IN (A), THE EXISTING CLEARANCE SHALL BE MAINTAINED.

NOTE:
ALL EXISTING STRUCTURES WITH A CLEARANCE OF LESS THAN 4.5 m SHALL BE

SIGNED ACCORDINGLY. BRIDGES WITH A CLEARANCE LESS THAN 4.5 m MUST BE RECORDED IN THE ONTARIO STRUCTURE CLEARANCE AND LOAD INVENTORY SYSTEM (OSCLIS).

C.4.4.3.3 Bridges Over Railways

POLICY
MINIMUM VERTICAL CLEARANCE OVER RAILWAYS IS 7.2 m (23.5 feet) measured from the base of rail. Allowance should be made for curvature and superelevation of the track. Temporary clearances during construction, both vertical and horizontal, shall be as specified by the railway or railways having jurisdiction over the tracks.

C.4.4.3.4 Bridges Over Non-Navigable Waterways

POLICY
VERTICAL CLEARANCE BETWEEN THE LOWEST POINT OF THE SOFFIT AND THE DESIGN HIGH WATER LEVEL SHALL BE SUFFICIENT TO PREVENT DAMAGE TO THE STRUCTURE BY THE ACTION OF FLOWING WATER, ICE FLOWS, ICE JAMS OR DEBRIS, AND SHALL NOT BE LESS THAN 1.0 m FOR FREEWAYS, ARTERIAL ROADS AND COLLECTOR ROADS AND NOT LESS THAN 0.3 m FOR LOCAL ROADS. LOWER CLEARANCES OVER NON-NAVIGABLE WATERWAYS MAY BE USED FOR LOW VOLUME ROADS. LOWER CLEARANCES MAY ALSO BE USED, WITH APPROVAL FROM JURISDICTIONAL AUTHORITY, WHERE IT IS PROHIBITIVE TO USE THIS CRITERIA.
The design high water level referred to above includes the amount of backwater created by a bridge or culvert and is the higher of the water level corresponding to the design flood discharge under ice-free conditions and the highest recorded water level created by ice jams.

C.4.4.3.5 Bridges Over Navigable Waterways

POLICY
NAVIGATIONAL VERTICAL CLEARANCE IS DEPENDENT ON THE TYPE OF VESSEL USING THE WATERWAY AND SHOULD BE DETERMINED IN CONSULTATION WITH THE CANADIAN COAST GUARD, DEPARTMENT OF FISHERIES AND OCEANS.

Clearance should also conform to the requirements of the Navigable Waters Protection Act of Canada (NWPA). The water level used as a basis for measuring navigational clearance should be the maximum likely to occur during the navigation season.

C.4.4.3.6 Approach Grade Elevation

POLICY
WHERE GEOMETRIC AND OTHER NON-HYDRAULIC CONSIDERATIONS PERMIT, FREEBOARD FROM THE EDGE OF THROUGH TRAFFIC LANES TO THE DESIGN HIGH-WATER SHALL BE 1.0 m FOR FREEWAYS, ARTERIAL AND COLLECTOR ROADS AND 0.3 m FOR OTHER ROADS.

WHERE GEOMETRIC AND OTHER CONDITIONS PERMIT, THE APPROACH ROADWAY SHALL BE PLACED AT AN ELEVATION THAT WILL NOT BE OVERTOPPED DURING THE NORMAL DESIGN FLOOD BUT WILL MAXIMIZE RELIEF OVERFLOW DURING THE REGULATORY OR OTHER EXTREME FLOOD.

FREEBOARD FOR ROUTES UNDER STRUCTURES CROSSING WATER:

Freeboard for highways under bridges that cross water shall be in accordance with the freeboard criteria for the approach grade elevations.

Freeboard for walkways, cycle paths and maintenance access roads under structures crossing water shall be at least 1.0 m above the water level for spans of more than 6.0 m and at least 500 mm for spans of 6.0 m or less. These values shall be increased where high maintenance costs are likely to result from use of the minimum values.

C.4.4.3.7 Minimum Vertical Clearances for Aerial Cable Systems

POLICY
THE MINIMUM VERTICAL CLEARANCES FOR AERIAL CABLE SYSTEMS SHALL BE IN ACCORDANCE WITH THE ONTARIO PROVINCIAL STANDARD DRAWING OPSD – 217.03.

C.4.4.3.8 Airways Over Roads

POLICY
MINIMUM VERTICAL CLEARANCE TO AIRWAYS IS AS INDICATED IN FIGURE C4-3.
The dimensions are a guide only and specific dimensions should be approved by the Regional Superintendent, Airways, Transport Canada.

C.4.4.3.9 Construction Clearances

Construction clearances should conform to the requirements of the agency having jurisdiction over the roadway.

POLICY
THE MINIMUM VERTICAL CLEARANCES TO TEMPORARY FALSEWORK SHALL BE:

- **(I) 4.5 M FOR SOLID OR CAST-IN-PLACE CONCRETE SLAB BRIDGES OVER ROADWAYS.**
- **(II) 5.0 M FOR ALL GIRDER TYPE VEHICULAR BRIDGES OVER ROADWAYS.**
- **(III) 4.7 M FOR PEDESTRIAN OR BICYCLE BRIDGES OVER ROADWAYS.**
- **(IV) 4.5 M FOR RAILWAY BRIDGES OVER ROADWAYS.**

C.4.4.4 Drainage

Where uncurbed sections are used and drainage is effected by side ditches, there is no limiting minimum value for gradient or limiting upper value for vertical curves.

On curbed sections where storm water drains longitudinally in gutters and is collected by catch basins, vertical alignment is affected by drainage requirements. Minimum gradients are discussed in Section C.4.2.2.

On flat crest and sag curves, storm water might run sufficiently slowly so as to spread onto the adjacent travelled lane. There is a level point at the crest of a vertical curve, but generally no difficulty with drainage on curbed pavements is experienced if the curve is sharp enough so that the minimum gradient of 0.30% is reached at a point about 15 m from the crest. This corresponds to a K value of 50 m. Where a crest of K value greater than 50 m is used, special attention is needed to assure proper pavement drainage near the apex of the curve, for example, the application of more frequent catch basins.

For sag vertical curves the same criterion for crest curves applies, that is, the minimum grade of 0.30% is reached within 15 m of the level point. For a sag curve value of K greater than 50 m, special attention is required. Sag vertical curves normally occur in fill sections. In general, sag curves should be avoided in cut section since they often present drainage problems. If there are compelling reasons for a sag curve to occur in cut, for example, aesthetic considerations, precautions should be taken to ensure adequate drainage can be effected. This might be regrading the downstream side of a watercourse.

Long spiral curves on low gradient could produce flat areas with correspondingly poor drainage, and should be avoided.

C.4.4.5 Minimum Curve Length

POLICY

THE MINIMUM LENGTH OF A VERTICAL CURVE IN METRES SHOULD BE NOT LESS THAN THE DESIGN SPEED IN KILOMETRES PER HOUR.

Example;
If the design speed is 100 km/h, the vertical curve length should be at least 100 m, except where drainage is of primary consideration, see Section C.4.4.4. Vertical curves applied to small changes of gradient should have K values significantly greater than the minimum as shown in Tables C4-6 and C4-7.

C.4.4.6 Deviation From Standards

Vertical curves that provide less than minimum stopping sight distance as stated in Table C2-1 are hazardous only if the assumptions upon which the corresponding minimum curvature values were based apply. For example, in the case of a crest curve if the stopping sight distance is less than minimum, but there is no object in the path of an approaching vehicle, the curve is not hazardous. It is potentially hazardous because an object might be present. On the other hand, a substandard horizontal curve is one in which the lateral friction is insufficient to maintain dynamic equilibrium when driven at design speed. In short, it is hazardous to any vehicle driving at design speed and is not dependent on the presence or absence of any particular variable condition.

Isolated substandard vertical curves might be tolerated where there is no evidence of any geometric deficiency as indicated by the accident record. Such curves should have minimum K values for design speeds preferably not more than 10 km/h less than design speed and, in any case, not more than 20 km/h less.

In assessing the implications of employing substandard curves, the designer should be guided by the following principles:

- Substandard horizontal curves have a greater effect than vertical curves.
- Crest vertical curves are more critical than sag curves.
- Substandard vertical curves are hazardous when all the criteria on which the standards are based prevail.
- Substandard horizontal and vertical curves not be employed together.
- Substandard crest vertical curves should be avoided in the vicinity of intersections or areas where a large number of entrances may generate substantial turning traffic.

C.4.4.7 Earthworks

The extent and nature of earthworks required to construct a road might be a control and could influence the vertical design of a road. The profile should be adjusted to optimize earthwork costs without compromising on geometric and aesthetic quality. This might be achieved by designing for an earthworks balance. However, it might be more economical to design for overall borrow, surplus or even both, depending on availability, cost, and location of surplus and required borrow.

The mass-haul diagram is a technique to determine the quantity and location of excavation and fill in any particular design, and can be used to make adjustments to optimize earthworks cost. It is described in Section C.4.6.1.
System 050 is a program used to calculate earthwork quantities and may be used to generate a mass-haul diagram. See Section C.6.3.6.
Highway Optimization Program System (HOPS) is a package of computer programs capable of optimizing a profile to give the most economical profile based on a given set of controls and parameters. This is described in Section C.6.3.5.

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D.7 STRUCTURES AND CLEARANCES

D.7.1 GENERAL

The material contained in this section is intended to assist the designer when designing cross sections where bridges, retaining walls or other structures are required. This section gives direction in setting structure dimensions that influence geometric design of horizontal alignment, vertical alignment and cross sections.

In general:

- Bridges should be designed to match the geometric requirements of the roadway.
- Where practicable, the horizontal centreline alignment on bridges should be on tangent or of constant curvature.
- The cross section elements of roads on and under bridges should match those of the approach roadway.
- Sag curves on bridges should be avoided as much as possible.

D.7.2.1 – Deck Width and Traffic Lanes

The number and width of through lanes and auxiliary lanes should be the same on the bridge deck as on the approach roadway. Traffic lane widths should be in accordance with Section D.2.

In general, the minimum acceptable bridge deck roadway width for two way traffic is 8.5 m.
Single lane bridges shall be a minimum 5.0 m roadway width except for single lane ramp bridges that shall be a minimum of 4.75 m roadway width.

Provision of narrower or single lane bridges may be permitted on low volume roadways in accordance with the Ministry's Guidelines for the Design of Bridges on Low Volume Roads.

D.7.2.2 – Side Clearances on Bridges

Side clearances on bridge decks, defined as the distance between the edge of the traveled way and the adjacent curb or barrier, should be in accordance with Table D7-1 and Figure D.7-1 for urban and rural structures. Where the side clearances from Table D7-1 are greater than the approach roadway shoulder width/side clearance as specified in D.5, the side clearance should match that of the approach roadway. Provision of wider side clearances may be considered to accommodate future rehabilitation or future widening requirements.

Where the approach roadway has continuous curb or continuous traffic barriers, the side clearances on the bridge deck should match the shoulders on the approaches but, should not be less than the minimum side clearance per Table D7-1.

On bridges greater than 50 m in length, reduced side clearances may be considered. Before the reductions are applied, the cost savings due to the reduced clearances as well as the implications for future rehabilitation, re-paving or the possible addition of an extra driving lane should be considered.
All clearances should meet requirements for sight distance. Side clearances may be increased to a maximum of 3.00 m where it is necessary to provide for minimum stopping sight distances.

D.7.2.3 – Sidewalks, Bikeways and Curbs

Where required, the widths of sidewalks and bikeways on bridge decks should meet the following requirements:

- The edge of a sidewalk adjacent to the roadway on a bridge should match that of the approach sidewalk.
- Where the approach roadway is not provided with a curb, the sidewalk width should be at least 1.5 m.
- Paved bike lane and bikeway widths should be in accordance with the Ministry's Ontario Bikeways Planning and Design Guidelines. Bikeways should be at least 1.5 m wide for one way traffic.
- The height of curbs should not be less than 150 mm above the adjacent roadway except to match the height of curbs on the approach roadway.
- Curbs should not be used in conjunction with barrier walls except where the curb and the barrier wall are separated by a sidewalk.

D.7.2.4 – Median Widths

The width of a median on a bridge should match that of the approach roadway.

D.7.2.5 – Horizontal Clearances at Underpasses

Where practicable, underpassing roadway cross-sections should match that of the approach roadway.

Horizontal clearances from the edge of the through traveled way to the face of an abutment or pier should meet or exceed the minimum clear zone widths specified in the Ministry's Roadside Safety Manual.

Where auxiliary lanes are present, the horizontal clearances from the edge of the traveled way to the face of an abutment or pier should also meet or exceed the minimum clear zone widths specified in the Ministry's Roadside Safety Manual based on the design speed on the auxiliary lane at the start of the structure.
Additional information on horizontal clearances and

grading at abutments is available in the Ministry's Roadside Safety Manual and Structural Manual.

D.7.2.6 – Vertical Clearances

For vertical clearances refer to section C.4.4.3 of this Manual.

Table D7-1
Minimum Side Clearances at Bridges

	Design Speed (km/h)	Urban Roads Left	Urban Roads Right: No Sidewalk	Urban Roads Right: Sidewalk	Rural Roads Left	Rural Roads Right: No Sidewalk	Rural Roads Right: Sidewalk
FREEWAY 4-LANE DIVIDED	100 to 120	2.5a	3.0 a		2.5a	3.0 a	
FREEWAY MULTI-LANE DIVIDED	100 to 120	2.5 a	3.0 a		2.5 a	3.0 a	
ARTERIAL DIVIDED	90 to 110	2.0 a	2.5 a	1.5	2.0	3.0 a	
	80	2.0 a	2.5 a	1.5	1.5	2.5 a	
ARTERIAL UNDIVIDED	90 to 110	-	2.0	1.5	-	3.0 a	2.5 a
	80	-	2.0	1.5	-	2.5 a	2.0 b
COLLECTOR UNDIVIDED	90 to 100	-	1.25 c	1.0	-	2.5 a	1.5 c
	70 to 80	-	1.25 c	1.0	-	1.5 d	1.25
	60	-	1.0	1.0	-	1.5 d	1.25
LOCAL UNDIVIDED	60 to 80	-	1.0	0.5	-	1.25	0.5 d

Notes:

1. If a barrier is to be placed between the sidewalk and roadway, then clearance should be the same as when there are no sidewalks.
2. All clearance should meet requirements for sight distance.
3. The width of a median on a bridge should match that of the approach roadway.
4. L = Length of bridge between centreline of abutment bearings.

a - For bridges with L>50 m, consideration can be given to decreasing the clearances to 1.5 m.

b - For bridges with L>50 m, consideration can be given to decreasing the clearance by up to 0.5 m.

c - For bridges with L>50 m, consideration can be given to decreasing the clearance by 0.25 m.

d - For bridges with L>50 m, consideration can be given to increasing the clearance by up to 0.75 m.

e – The values of the clearances given above are the minimum values. Consideration may be given to providing more than the minimum if justification is provided.

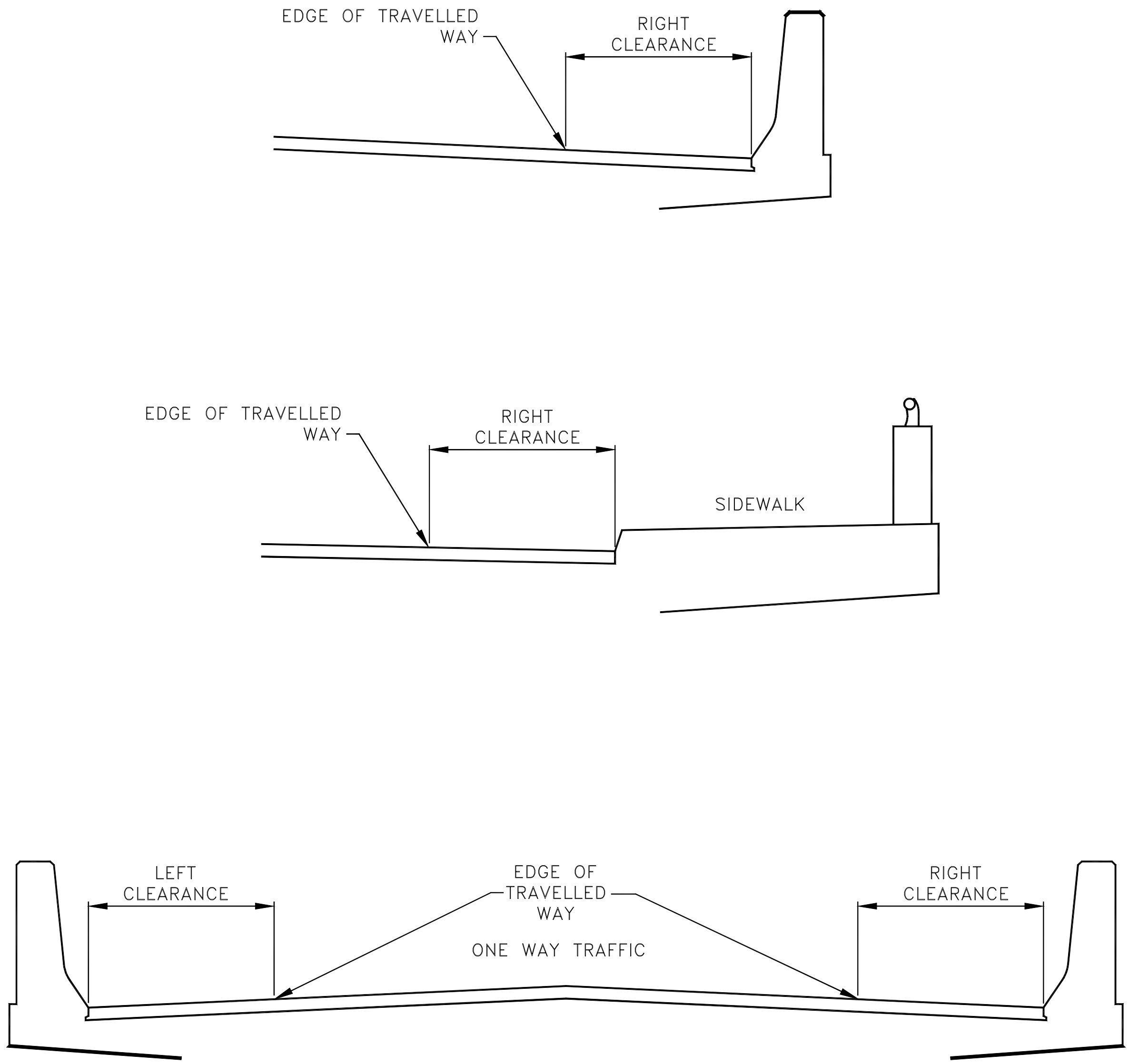

Figure D.7-1
Side Clearance on Bridges