



To: <p style="text-align: center;">SUPERSEDED BY EB 10-021 EFFECTIVE 1/6/11</p>		<p style="text-align: center;"><i>New York State</i> <i>Department of</i> <i>Transportation</i> ENGINEERING INSTRUCTION</p>	<p style="text-align: center;">EI 04-002</p>
Title: SUPPORT OF GUIDE RAIL OVER SHALLOW OBSTRUCTIONS			
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ADMINISTRATIVE INFORMATION:

- **Effective Date:** This EI addresses optional actions that may be taken on an as-needed basis, effective immediately.
- **Modified Issuances:** This Instruction modifies the barrier guidance in EI 02-036, *Highway Design Manual Chapter 19 - Reinforced Concrete Box Culverts and Similar Structures; Section 19.6.1 Contract Plans and Section 19.8 Guide Railing*. Other portions of that document are not affected by this EI.
- **Disposition of Issued Materials:** At present, a final 'home' for this guidance has not yet been identified. It is anticipated that construction personnel and, to a lesser extent, designers will periodically need access to this material. After this guidance has been in effect for a while, it should become clear whether it needs to be available in Construction or Design manuals, or both. Inclusion in a future Guide Rail VI is anticipated.

PURPOSE: The purpose of the EI is to issue guidance to construction and design forces on acceptable methods of dealing with situations where obstructions prevent driving posts to the recommended depths at locations where guide rail should be installed.

TECHNICAL INFORMATION: The attached guidance describes acceptable alternatives for dealing with shallow obstructions to guide rail post driving, but does not define the only acceptable options. These alternatives should only be used when it is appropriate to use guide rail at that location. For related guidance on one of the most commonly encountered shallow obstructions (concrete box culverts), refer to bridge rail guidance from the Structures Division for cases where conditions behind the rail make it inappropriate to use highway rail.

IMPLEMENTATION: Since the use of any of these options is permissive, rather than mandatory, these methods are approved for use immediately on an as-needed basis. The options may be employed in ongoing designs, projects under construction, maintenance work, etc., at the Region's discretion.

TRANSMITTED MATERIALS: "Support of Guide Rail Over Shallow Obstructions" guidance.

BACKGROUND: Although infrequent, obstructions to the driving of guide rail posts are periodically encountered, typically on secondary highways. While a number of intuitive field adjustments have been used, uncertainty over the acceptability of any given remedy has often interrupted the work effort while confirmation and approval were sought. Even when approval was obtained, it often lacked any official, documented basis. This guidance is intended to provide a documented basis for several acceptable treatment alternatives and to provide a ready reference so that field personnel may select an approved treatment option without having to delay the work while seeking approval. Additionally, where obstructions have been anticipated during design, this guidance should provide a basis for specifying acceptable details for addressing the obstructions.

CONTACT: Questions may be directed to Terry Hale in the Highway Design Manual Section of the Design Quality Assurance Bureau at (518) 485-7009 or by e-mail to thale@dot.state.ny.us.

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Support of Guide Rail Over Shallow Obstructions

Design Quality Assurance Bureau
January 2004

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Background: For several decades, it has been the Department's general practice to provide barriers where a highway crosses a culvert. These barriers could be guide rail, culvert rail or bridge rail, depending on the size and other geometric details of the culvert involved. Unfortunately, it was not always clear which type of rail should be used in a given circumstance. When the National Cooperative Highway Research Program issued their Report 350 –*Recommended Procedures for the Safety Performance Evaluation of Highway Features* (NCHRP 350), it was endorsed by FHWA. FHWA went one step further to require that all barriers and terminals used on federal-aid highway projects should meet the NCHRP 350 test criteria or be judged capable of passing them. As a result, extensive testing was performed on existing highway barrier systems. Acceptable bridge rail and highway guide rail systems were developed or existing systems were validated. Because the testing process is expensive and our culvert rail was relatively seldom used, it did not appear to make economic sense to perform the expensive testing necessary to confirm its ability to pass the new crash test criteria. Taking into consideration the possibility that it might not have passed, the decision was made to drop culvert rail as a barrier option at culverts. Consequently, any barrier placed at a culvert should now be provided either as highway guide rail or as bridge rail. This present guidance is intended to define the range of circumstances where it is appropriate to provide guide rail. Whenever the culvert size and geometry do not meet the conditions described herein, any barrier needs should be met with a bridge rail option. Guidance on the appropriate bridge rail for a given situation should be obtained from the Structures Division.

Since the use of guide rail at culverts often introduces the problem of the culvert preventing posts from being driven to their normal depths, it made sense to extend the guidance to include other obstructions to driving as well. Therefore, this guidance describes acceptable methods of dealing with situations where the presence of a shallow obstruction, such as a culvert, boulder, or utility line, prevents driving guide rail posts to their normal depths at their normal locations.

General: If the obstruction is identified early enough and is of limited extent, it may be possible to shift the entire run of rail slightly so that the obstruction is straddled and no other modifications are required. The most common choices for supporting guide rail over a shallow obstruction are to move, shorten, or add posts to support the rail system. However, these options may only be selected if there will be no fixed objects or snagging holes (see the fourth and subsequent paragraphs of this subsection, below) within the deflection distance of the guide rail. For conditions not meeting this requirement, refer to guidance from the Structures Division.

If posts cannot be moved or added to eliminate the conflict with the shallow object, then it may be reasonable to weld a base plate to the bottom of the post and bolt the base plate to a concrete base. This concrete base may be either one constructed for that purpose, or may be the obstruction itself, assuming it is acceptable to bolt to that specific culvert or footing. While providing base plates for multiple posts may be necessary in some cases, the practice should be avoided. Where a base plate and bolting option is used, it may be assumed that the resulting rail deflections will be similar to the standard deflections. The typical base plate details for weak posts are covered in Section E of this document. Base plates for heavy posts are covered on Standard Sheet M606-10R2.

In rare instances, shallow rock may be encountered over broad areas. When this occurs, post hole locations should be drilled to normal depth, posts should be inserted without soil plates, and the holes should be backfilled with gravel or sand. Alternatively, consideration may be given to using concrete median barrier in place of guide rail, since its embedment depth is only 230 mm. Refer to Section F for safety considerations related to concrete barrier.

Since some of the modifications identified in the following sections should be assumed to increase the deflection distance of the guide rail, that system should be reevaluated to determine if any rigid

fixed objects (such as headwall or wingwall projections, utility poles, or trees) would be within its deflection distance. Fixed objects within the deflection distance should be removed or a stiffer barrier system should be substituted, specifically one with a deflection less than the distance to the fixed object. See Highway Design Manual Table 10-3 for the standard highway guide rail deflections.

In addition to fixed objects that project above grade, consideration must be given to "holes" that a vehicle's wheel might snag in, possibly resulting in a rollover accident. For guiderail systems that have large deflections, there is the potential for high-speed errant vehicles to deflect the rail, slow, and then snag on fairly narrow "holes" in the embankment. For this reason, no openings with widths over 1.0 m, such as culvert ends, should be permitted within the deflection distance of rails with standard deflections of 1.5 m or more, unless the opening is covered with a grating to prevent a vehicle's tires from snagging.

For guide rail systems with standard deflection distances less than 1.5 m (HPBO and box beam with 0.915 m post spacings), the potential for vehicles snagging in holes is significantly reduced. If the vehicle is not going fast, the rail deflection is significantly reduced and the consequences of a snag are lowered. If an impacting vehicle is going fast, the vehicle usually loses contact with the ground at impact and it is over an opening for such a brief moment that its tires do not have an opportunity to move down into the "hole" enough to produce a snagging condition. For these reasons, wider openings are permissible within the deflection distances of more rigid rails. Therefore, for guide rail systems with standard deflection distances less than 1.5 m, no ungrated openings with widths over 3.0 m should be permitted within their deflection distance.

Regardless of the above allowances, unless peak flow and debris indicate otherwise, most culverts exposed to traversal by errant vehicles should be flush with the embankment surface and grated for traversability, if their width is greater than 0.5 m and less than 1.5 m. When these openings are behind guide rail and debris accumulation is judged to be a problem, it may not be necessary to cover the entire height of the opening, but it is desirable for the grating to extend 0.5 m beyond the deflection distance. For smaller transverse culverts, the minimum grating may consist of No. 25 reinforcing bars welded together on 0.3 m centers. This rebar mat was "crash" tested for transverse culvert configurations and judged satisfactory for covering openings up to 1.5 m by 2.3 m. Note that, by increasing the bar size to No.29, satisfactory results were calculated for openings measuring up to 3.05 m by 5.2 m.

Use of this Guidance: Sections A through G of this document describe options for supporting rail over shallow obstructions. Section H addresses payment for those measures. To use this guidance, select the best modification to address the shallow obstruction, check the deflection to verify that the barrier system choice is acceptable, and make any modifications to the post design as indicated. If a check of the deflection distance indicates that the barrier selection is not appropriate, a different barrier system should be used. In some instances, the extent of the obstruction and the proximity of openings (particularly at large, shallow box culverts) may require that bridge rail be used. Refer to guidance provided by the Structures Division for those treatments.

A. Cable Guide Rail Posts at Shallow Obstructions

Cable readily permits the longitudinal repositioning or addition of posts, because a post may easily be fastened to the rail at any point along its length. Slight longitudinal repositioning of individual posts will not have a significant effect on the deflection distance. Therefore, if the obstruction to driving a post is fairly narrow, such as a small culvert or boulder, the post should be moved longitudinally by up to 750 mm. See Detail 1-B. Note that aesthetics may be an issue where the guide rail is being used on a tight radius (minimum radius for cable is 135 m). If the post relocation introduces an objectionable jog in the curve, consideration should be given to using the additional post arrangement shown in Detail 1-C.

If the obstruction requires movement of a post by more than 750 mm, an extra post should be added, such that the moved post and the added post straddle the obstruction. Ideally, the posts should be spaced evenly at the third points of the length between the posts on either side. See Detail 1-C.

If the obstruction is wider than two-thirds of the normal post spacing, the span width between the moved and the added post may be increased, but should not be more than 750 mm wider than the normal post spacing for the run. Some minor adjustment of the posts outside of the moved and added posts may be needed, but it should be remembered that more support is needed near the wider span. See Detail 1-D.

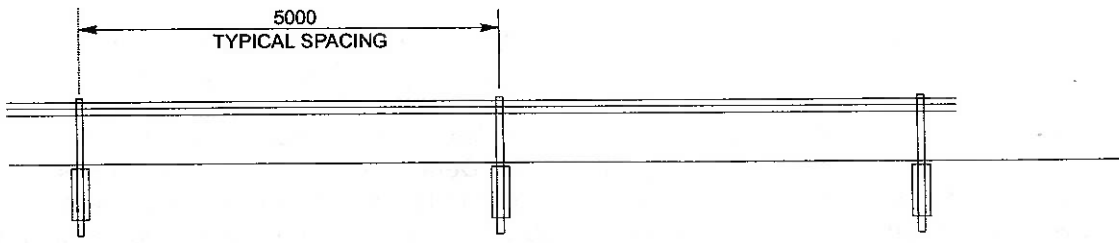
If the obstruction to post driving is more than 750 mm wider than the normal post spacing, then the use of shortened posts should be considered. A maximum of 300 mm of post and soil plate may be cut off the bottom of a single post assembly without significantly affecting the deflection distance. See Details 1-G and 1-H. This amount applies to either standard posts, which have a normal embedment depth of 840 mm, or to extra long posts, which have a normal embedment depth of 1375 mm. The amount cut off the bottom of any one post should not significantly exceed the amount needed to permit driving the post so that its top is at the correct height.

To maintain the normal deflection distance in an area where two posts need to be shortened by up to 300 mm, additional posts should be added. Post spacing for shortened posts should not exceed $\frac{2}{3}$ of the typical post spacing and the length of the spanned area should not exceed twice the normal post spacing. See Details 1-E and 1-F for examples.

If a cable run with 2.5 m post spacings (standard deflection = 2.4 m) has a single post that needs to be shortened by more than 300 mm and all spacings are kept to the normal dimensions, then the deflection in that immediate area between the normal posts should be assumed to be 3.3 m. See Detail 1-J.

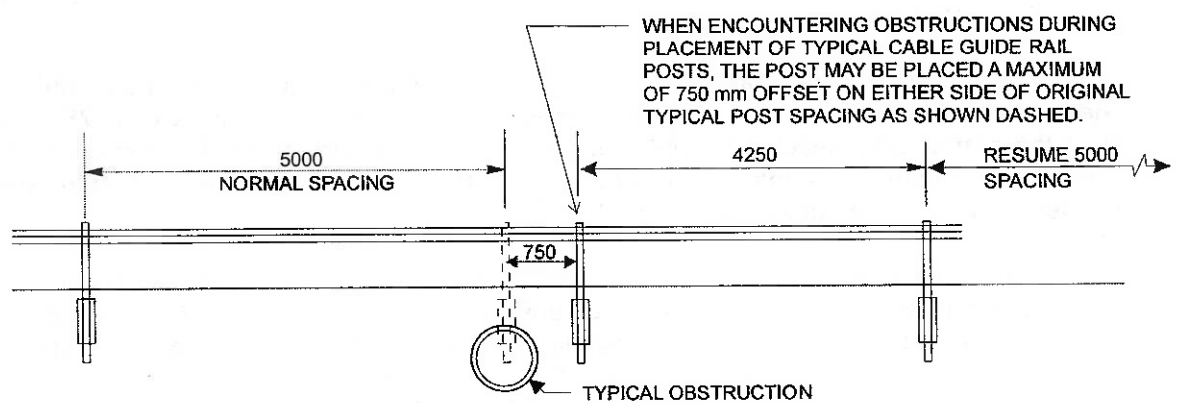
If the extent of the shallow obstruction(s) prevents the use of any of the above options, consideration should be given to modifying or removing the shielded feature, switching to a different barrier system, or bolting the posts to the obstruction or a constructed foundation as described in Section E. Consultation on selecting an option is available by contacting the Design Quality Assurance Bureau.

Cable Guide Rail Adjustments over Narrow Shallow Obstructions to Post Driving

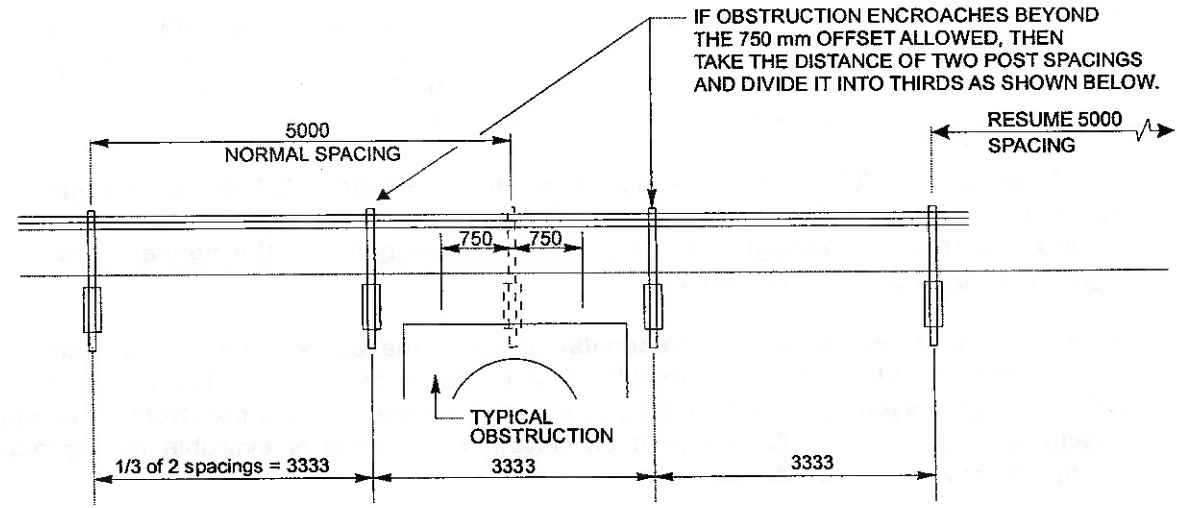


FOR DETAILS 1-A, 1-B, AND 1-C,
ASSUME STANDARD
DEFLECTION OF 3.3 M

DETAIL 1-A
(Normal Configuration)



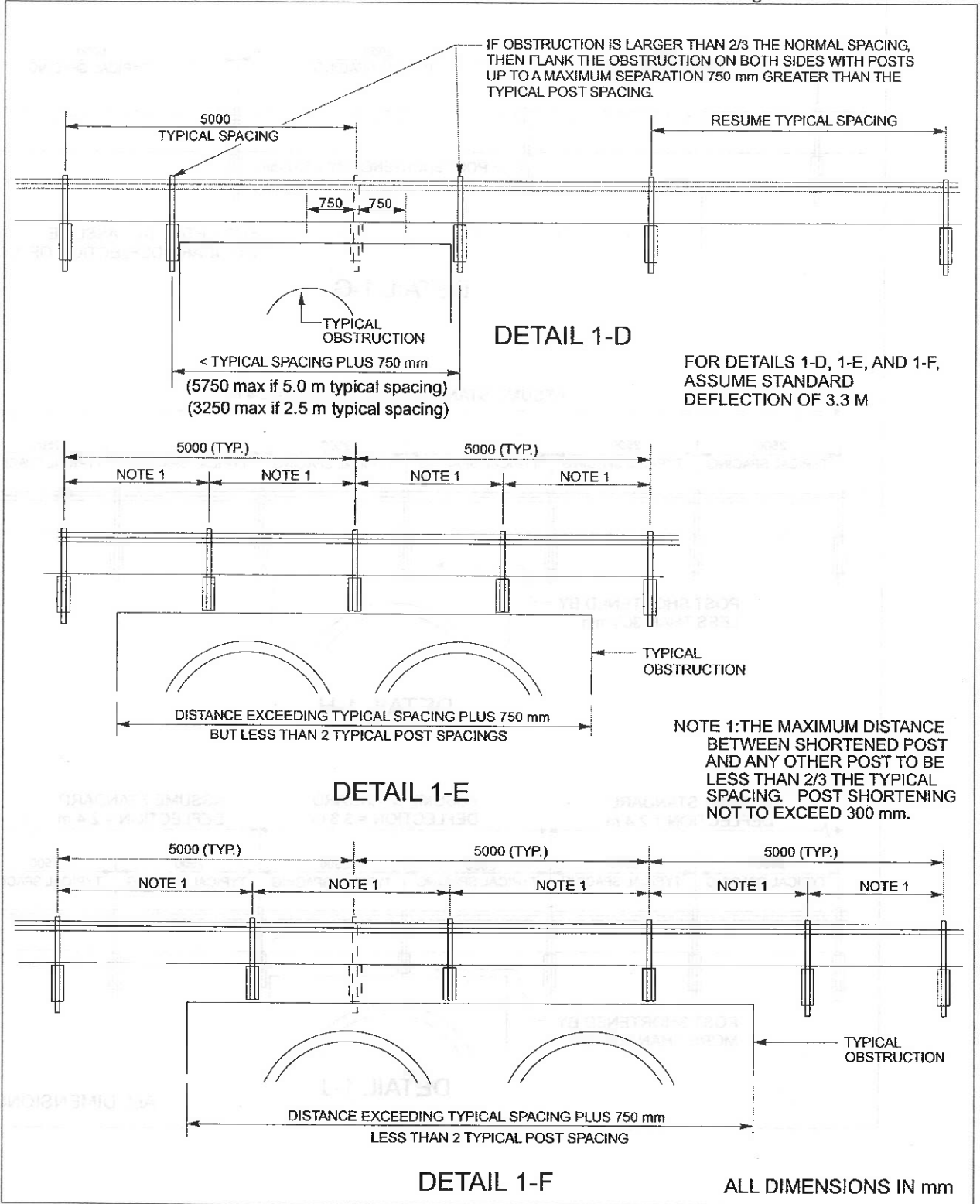
DETAIL 1-B



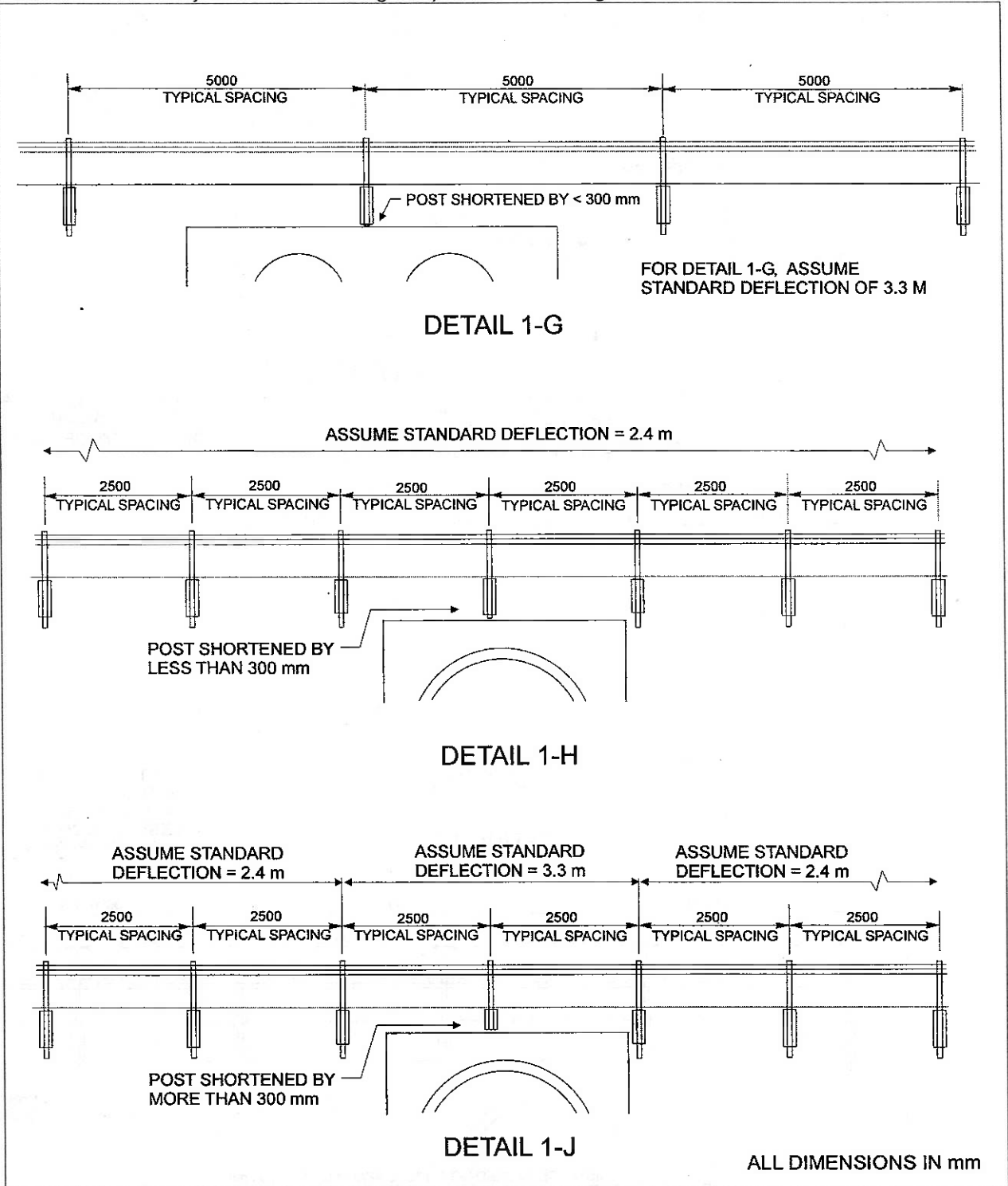
DETAIL 1-C

ALL DIMENSIONS IN mm

Cable Guide Rail Adjustments over Wide Shallow Obstructions to Post Driving



Cable Guide Rail Adjustments Involving Only Post Shortening



B. W-Beam on Weak Posts at Shallow Obstructions

Unlike cable guide rail, W-Beam is fabricated with bolt holes that only permit fastening to posts at predefined points, 1905 mm apart. Posts may be spaced at either 3810 mm or 1905 mm, depending on the deflection distance available behind the rail. In the following paragraphs, options for 3810 mm spacings will be described first, followed by those for 1905 mm spacings. As indicated on Standard Sheet 606-6, additional posts may be placed for added backup support and they need not, and actually should not, be fastened to the rail. (NOTE: Revisions to the weak post W-beam system will place beam splices between posts that are on 3810 mm spacings. The details herein show the traditional splice locations.)

Normal Post Spacing of 3810 mm: If a single post encounters a shallow obstruction, that post may be shortened by cutting a maximum of 300 mm of post and soil plate off the bottom of the post assembly. See Detail 2-A.

If a single post encounters a shallow obstruction that would require shortening the post by more than 300 mm, two additional posts should be added, one in each of the adjoining bolt holes on either side of the obstruction. The shortened post should be included for aesthetics. See Detail 2-B.

If a shallow obstruction is found that would require shortening a post by more than 300 mm and the obstruction would also require shortening of a post placed at one of the adjoining bolt holes 1905 mm away, backup posts should be provided on either side of the obstruction, provided they will not have to be spaced more than 3810 mm apart. The post location that would require a shortened post should receive that post, as it is needed for vertical support. See Detail 2-C.

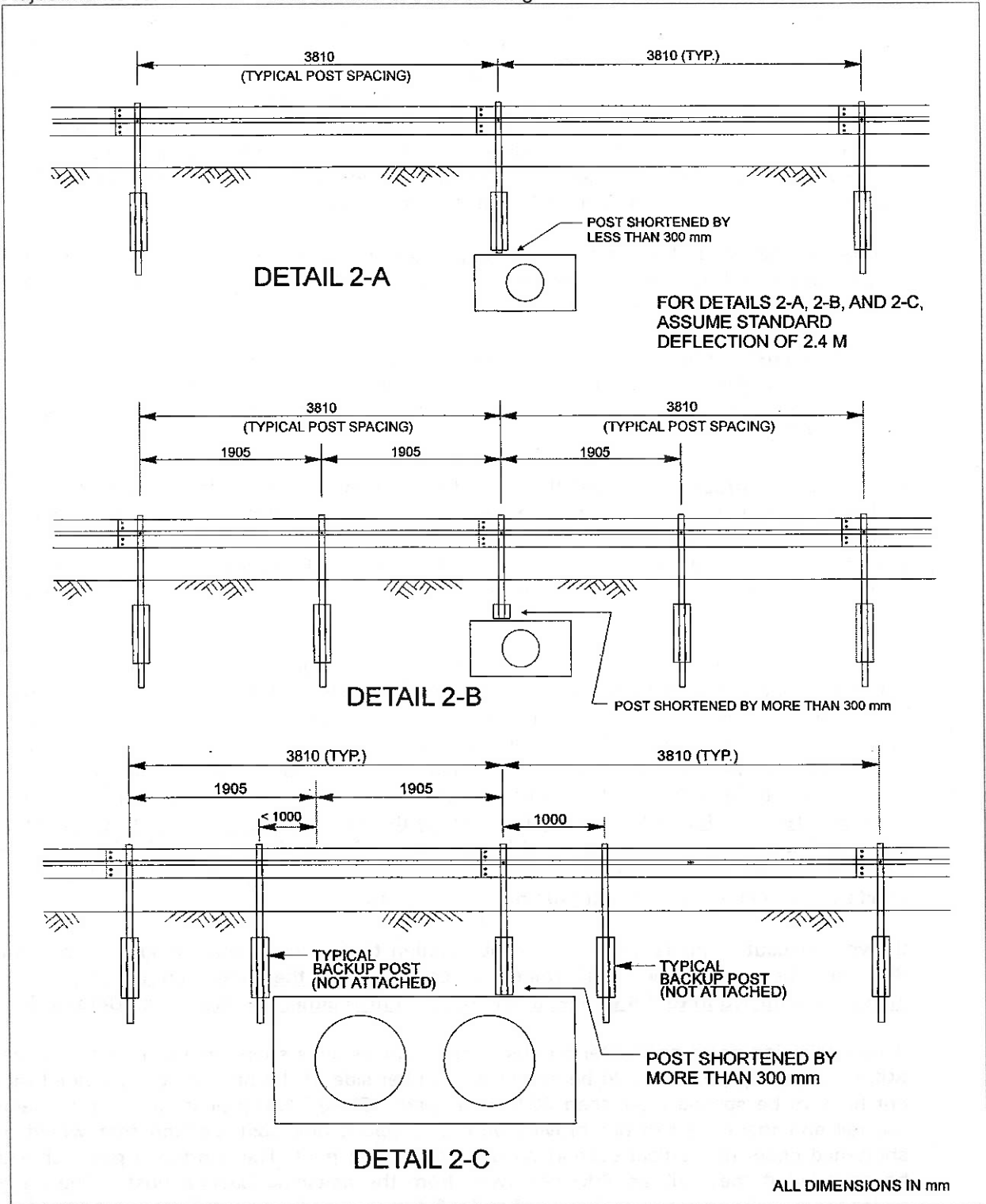
Normal Post Spacing of 1905 mm: If a post encounters a shallow obstruction, a maximum of 300 mm of post and soil plate may be cut off the bottom of the post assembly before it is driven, and an additional piece of W-beam added behind the other rail sections, centered on the shortened post. See Detail 2-D. (If the shortened post occurs at a splice, extra holes will have to be drilled in the backup rail to accommodate the splice bolts. See Detail 2-E.) If the post would have to be shortened by more than 300 mm to drive it to the appropriate height, the clear area required for deflection distance behind the doubled rail, and for 3 m on either side of the affected post, should be increased from 1.8 m to 2.4 m. See Detail 2-F. If the post would have to be shortened by over 450 mm to drive it to the appropriate height, the above conditions would apply, but that post may be eliminated.

If two consecutive posts encounter an obstruction that requires shortening each by less than 300 mm, the posts may be shortened accordingly, but the deflection distance should be increased from 1.8 m to 2.4 m over a length of 3.0 m in either direction. See Detail 2-G.

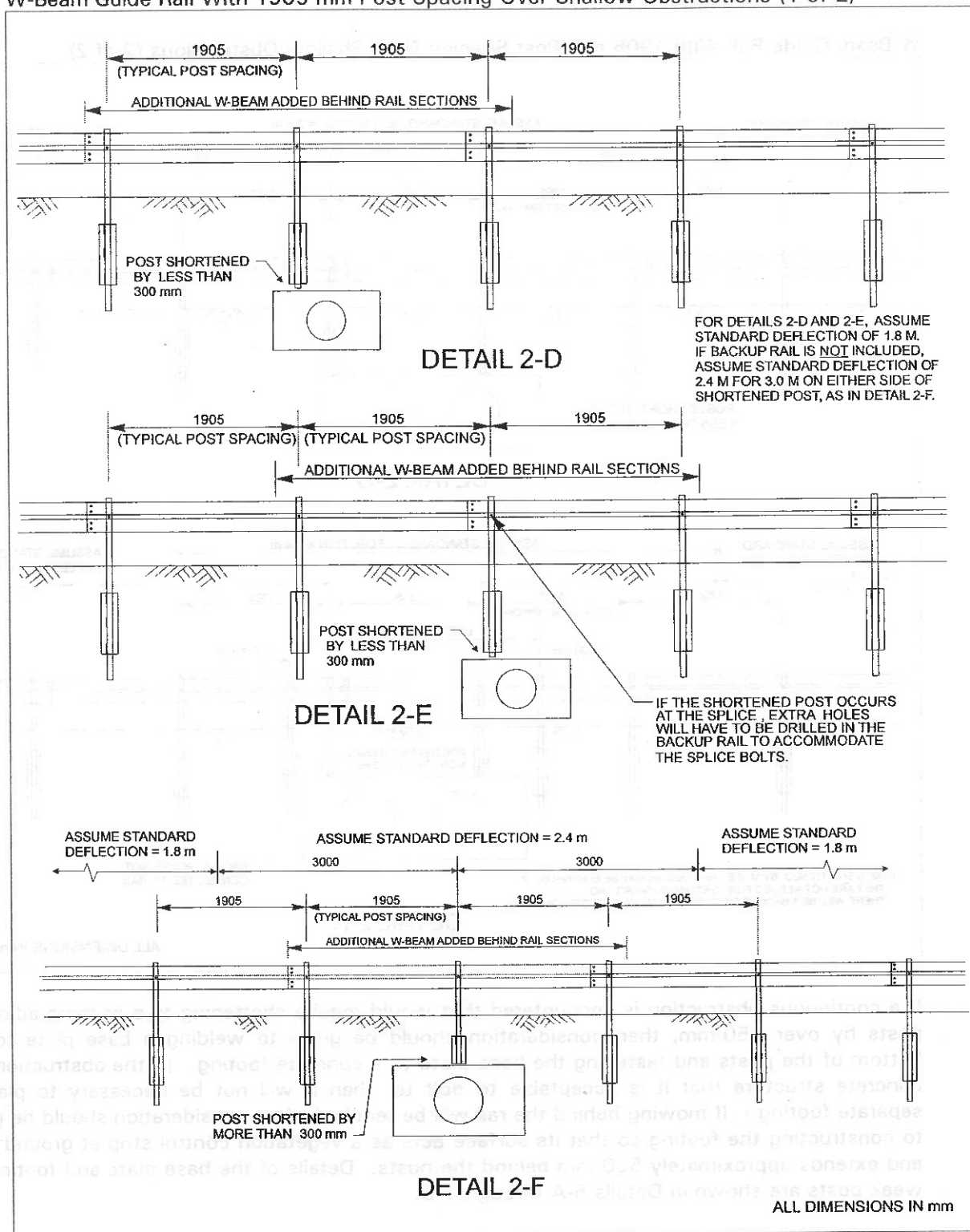
If two adjoining posts encounter an obstruction that requires shortening of either by more than 300 mm, backup posts should be provided on either side of the obstruction, provided they will not have to be spaced more than 3810 mm apart. Since backup posts are not connected to the rail and therefore can not provide vertical support, any post location that would require shortened posts for vertical support should receive that post. The shortened posts should also be provided if they will be 600 mm away from the adjoining backup post. The deflection distance should be increased from 1.8 m to 2.4 m over a length of 3.0 m in either direction. See Detail 2-H.

Support of Guide Rail over Shallow Obstructions

Weak Post W-Beam Guide Rail with 3810 mm Typical Post Spacings –
Adjustments for Shallow Obstructions to Post Driving

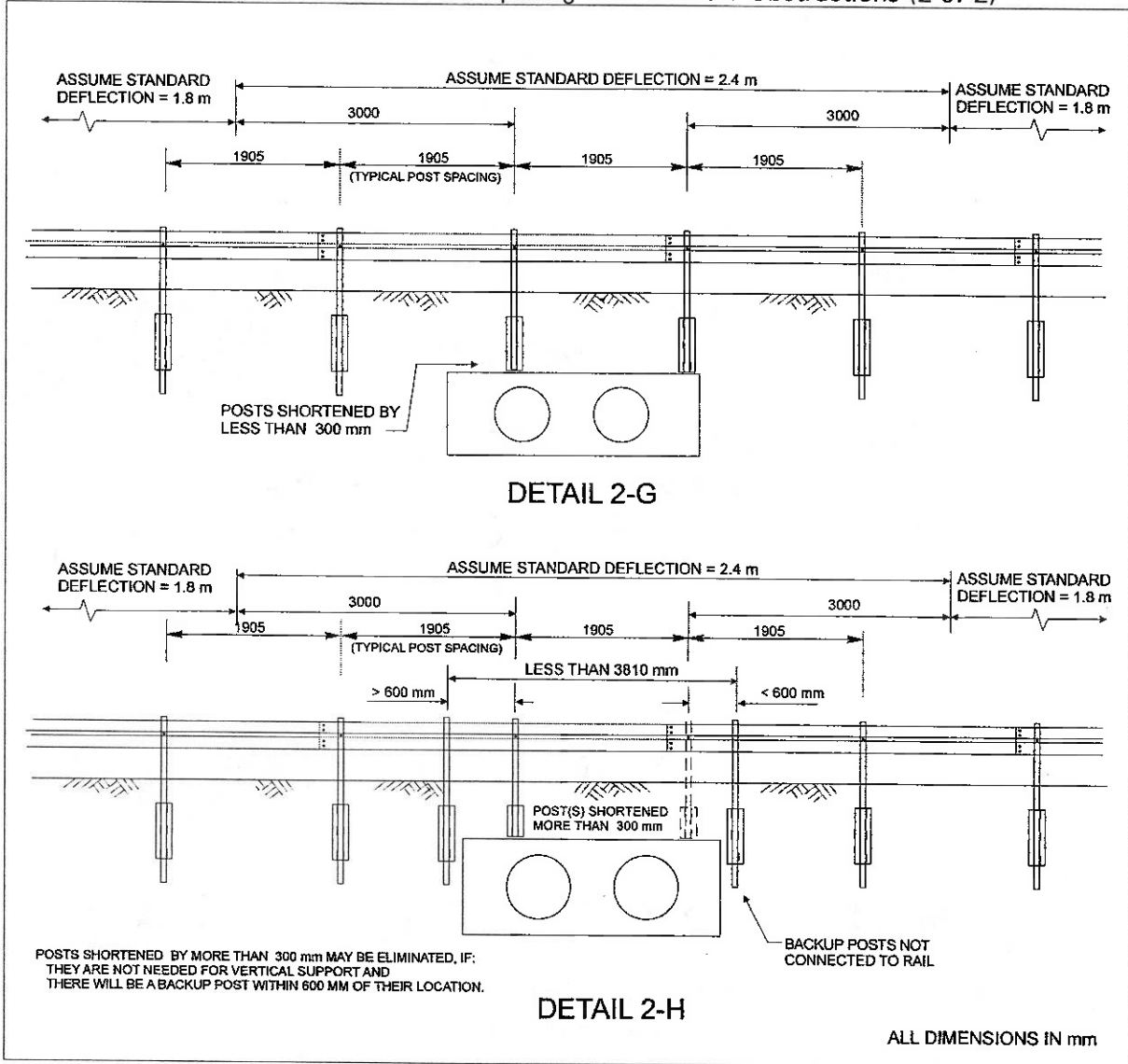


W-Beam Guide Rail With 1905 mm Post Spacing Over Shallow Obstructions (1 of 2)



Support of Guide Rail over Shallow Obstructions

W-Beam Guide Rail With 1905 mm Post Spacing Over Shallow Obstructions (2 of 2)



If a continuous obstruction is encountered that would require shortening two or more adjoining posts by over 450 mm, then consideration should be given to welding a base plate to the bottom of the posts and fastening the base plate to a concrete footing. (If the obstruction is a concrete structure that it is acceptable to bolt to, then it will not be necessary to place a separate footing.) If mowing behind the rail will be required, then consideration should be given to constructing the footing so that its surface acts as a vegetation control strip at ground level and extends approximately 500 mm behind the posts. Details of the base plate and footing for weak posts are shown in Details 5-A through 5-D.

C. Box Beam Posts at Shallow Obstructions

Box beam guide rail is designed to have significantly less deflection than either cable or weak post W-beam guide rail. The rigidity and mass of the beam contributes to the system's stiffness, allowing beam action to span across several posts at the same time. Because of this combined action of the posts, it is acceptable, where necessary, to shorten a single post by as much as 300 mm, as in Details 3-A and 3-G, without assuming any significant increase in deflection distance. (Post shortening should not be done where extra length posts are needed due to the proximity of steep slopes.)

Normal Post Spacing of 1830 mm: Where 1830 mm post spacings are being used, posts may be repositioned (but not removed) without increasing the assumed deflection distance, provided the following spacings are not exceeded: 3.05 m when no beam splice is included (Detail 3-B), and 2.44 m when a beam splice is included (Detail 3-C). New holes drilled in the box beam to permit fastening to the posts should be field galvanized (in accordance with the Standard Specifications) soon after drilling and prior to mounting the rail.

While the rigidity of box beam permits repositioning of its supporting posts up to the limits indicated in Details 3-B and 3-C, longer spans between supporting posts introduce the risk that the rail will bend too much when struck, allowing a vehicle to pocket. To minimize this possibility, it is permissible to stiffen the spanned area by bolting an additional length of box beam rail to the back side of the primary rail. The fastening should be done using four M20 x 2.5 button head bolts with washers. With the rail reinforced in this manner, a span of 4 m may be used between supporting posts as indicated in Details 3-D and 3-E. Note that the supporting posts will have to be set back 150 mm to accommodate the width of the backup piece of box beam rail.

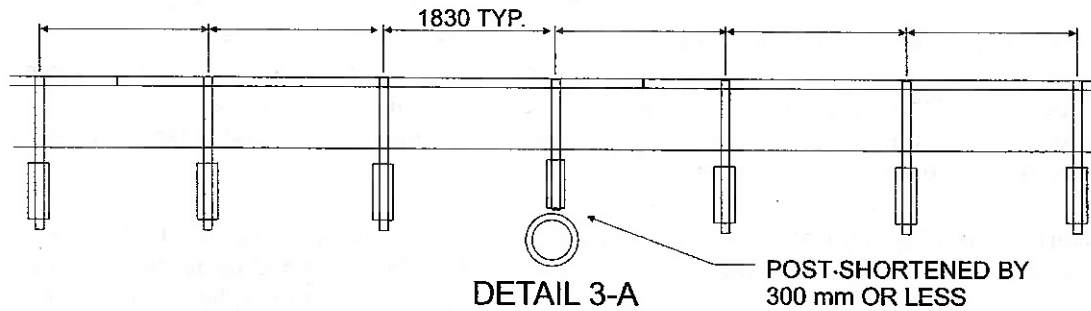
If a shallow obstruction extends for up to 6.0 m under a run of box beam with 1830 mm post spacings and does not require shortening any of the posts by more than 300 mm, then shortened posts may be used, but with 915 mm post spacings above the obstruction, and an additional full length post(s) placed on either side of the obstruction as may be needed to ensure that the split spacing extends beyond the sides of the obstruction. See Detail 3-F for an instance where a full-length post is needed to extend the split spacing on the right side.

Normal Post Spacing of 915 mm: Where 915 mm post spacings are being used, it is acceptable to skip a single post, if a shallow obstruction is encountered that would require shortening that post by more than 300 mm, but the deflection for 3.0 m on either side of the removed post should be assumed to increase from 1.2 m to 1.5 m. See Detail 3-H.

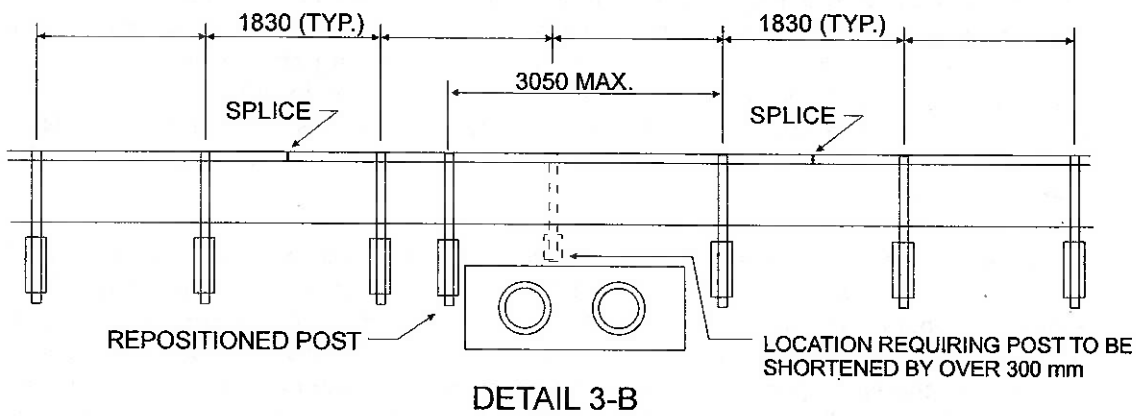
If a shallow obstruction extends for up to 6.0 m under a run of box beam with 915 mm post spacings and does not require shortening any of the posts by more than 300 mm, then shortened posts may be used, but the deflection for 3.0 m on either side of the outside shortened posts should be assumed to increase from 1.2 m to 1.5 m. See Detail 3-J.

Support of Guide Rail over Shallow Obstructions to Post Driving

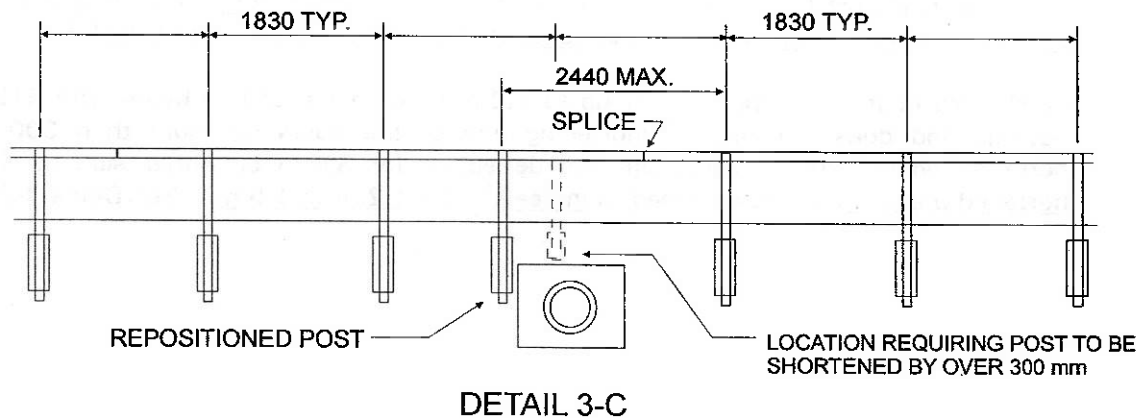
Box Beam Guide Rail with 1.83 m Post Spacings over Narrow Obstructions to Post Driving



FOR DETAILS 3-A, 3-B, AND 3-C,
ASSUME STANDARD DEFLECTION = 1.5 M

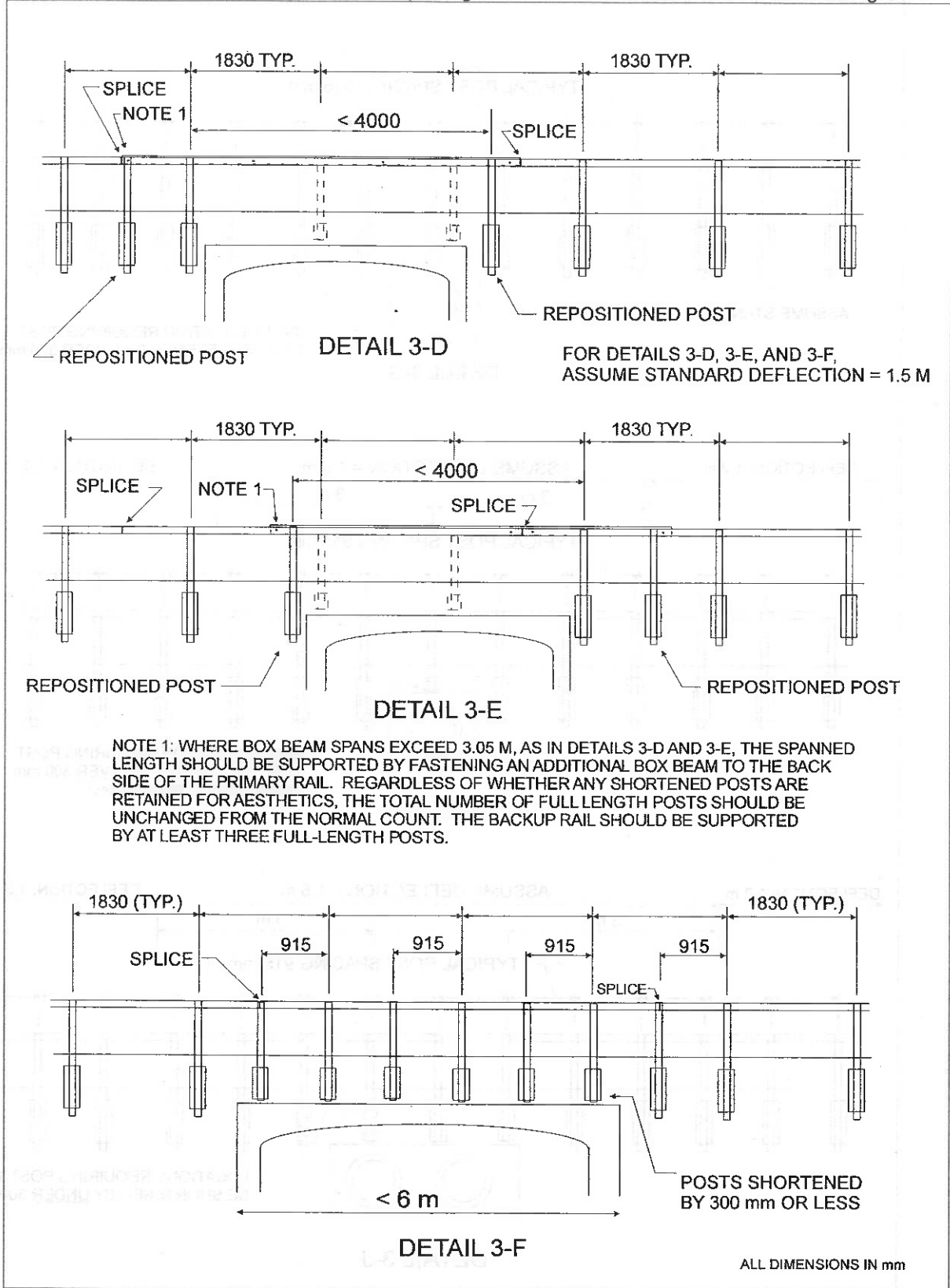


DETAILS 3-B AND 3-C DIFFER IN THE
LOCATION OF THE BEAM SPLICE.



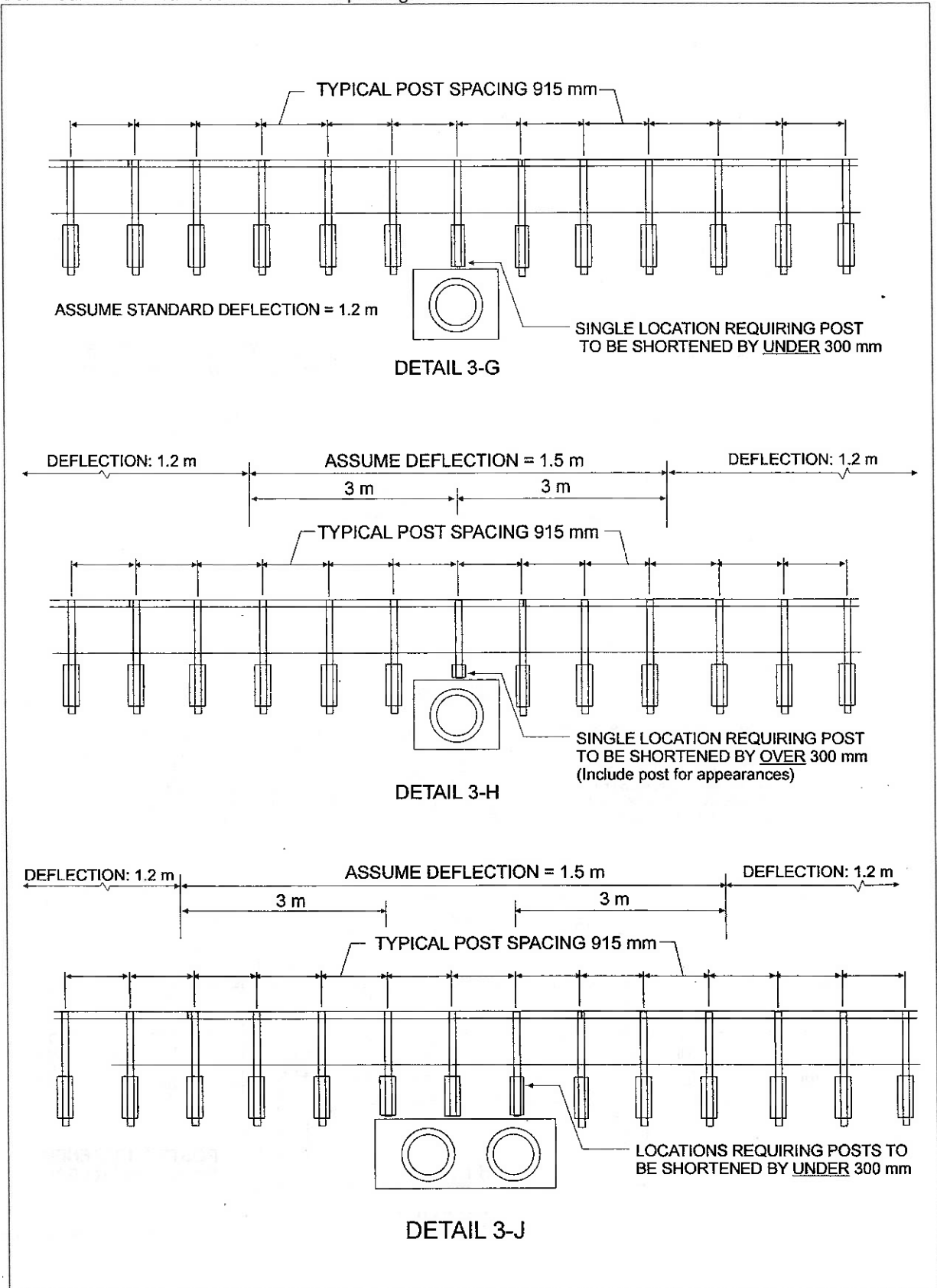
ALL DIMENSIONS IN mm

Box Beam Guide Rail with 1.83 m Post Spacings over Wide Obstructions to Post Driving



Support of Guide Rail over Shallow Obstructions

Box Beam Rail with 0.915 m Post Spacings Over Shallow Obstructions



D. W-Beam on Heavy Posts at Shallow Obstructions

W-beam does not possess great beam strength when impacted, particularly since the impacting vehicle has a tendency to flatten the corrugations, which essentially produces a sheet of steel with very low section modulus. To limit the anticipated deflection of the HPBO system, it is designed with frequent strong posts that individually and successively act to redirect vehicles. These heavy posts might snag some impacting vehicles, so blockouts are provided to hold the rail well in front of the post and thereby limit the chances of that occurring.

For similar reasons, it is important that the posts provide consistent lateral support to the rail, as a "soft" spot could permit an errant vehicle to penetrate into the line of the rail and contact a subsequent post. (That would be an example of the process referred to as "pocketing".) Because of this significant reliance on each individual post, the removal, overshortening, or relocation of posts should be avoided. The normal heavy post is both wider and longer than the normal weak post. Where necessitated by shallow obstructions, up to 420 mm may be cut from the bottom of a single heavy post (leaving 640 mm of embedment) without assuming any significant increase in the deflection of the guide rail system. Because of the possibility of pocketing, post spacings should not be significantly increased and, where they need to be, the rail should be reinforced to minimize the existence of "weak spots."

Normal Post Spacing of 1.905 m: With 1.905 m typical spacings, the posts are typically not provided with soil plates. As mentioned above and illustrated in Detail 4-A, up to 420 mm may be cut from the bottom of a single post without increasing the assumed deflection beyond the normal 1.2 m. Where up to three successive posts need to be shortened by up to 420 mm, each shortened post is to have a soil plate added and the amount removed from the bottom of each post should be minimized. See Detail 4-B.

If a single post must be shortened by more than 420 mm, then backup reinforcement may be used to maintain the deflection distance. If the shortened post is not at a beam connection, the reinforcing may be done by nesting an additional W-beam behind the rail, as in Detail 4-C, or, where the shortened post is at a beam connection, as in Detail 4-D, by including a reinforcing channel, preferably a C230 x 30 or an MC200 x 27.8, behind the rail. In the latter case, the posts on either side of the obstruction should have soil plates added to provide extra support for the channel-spanned area.

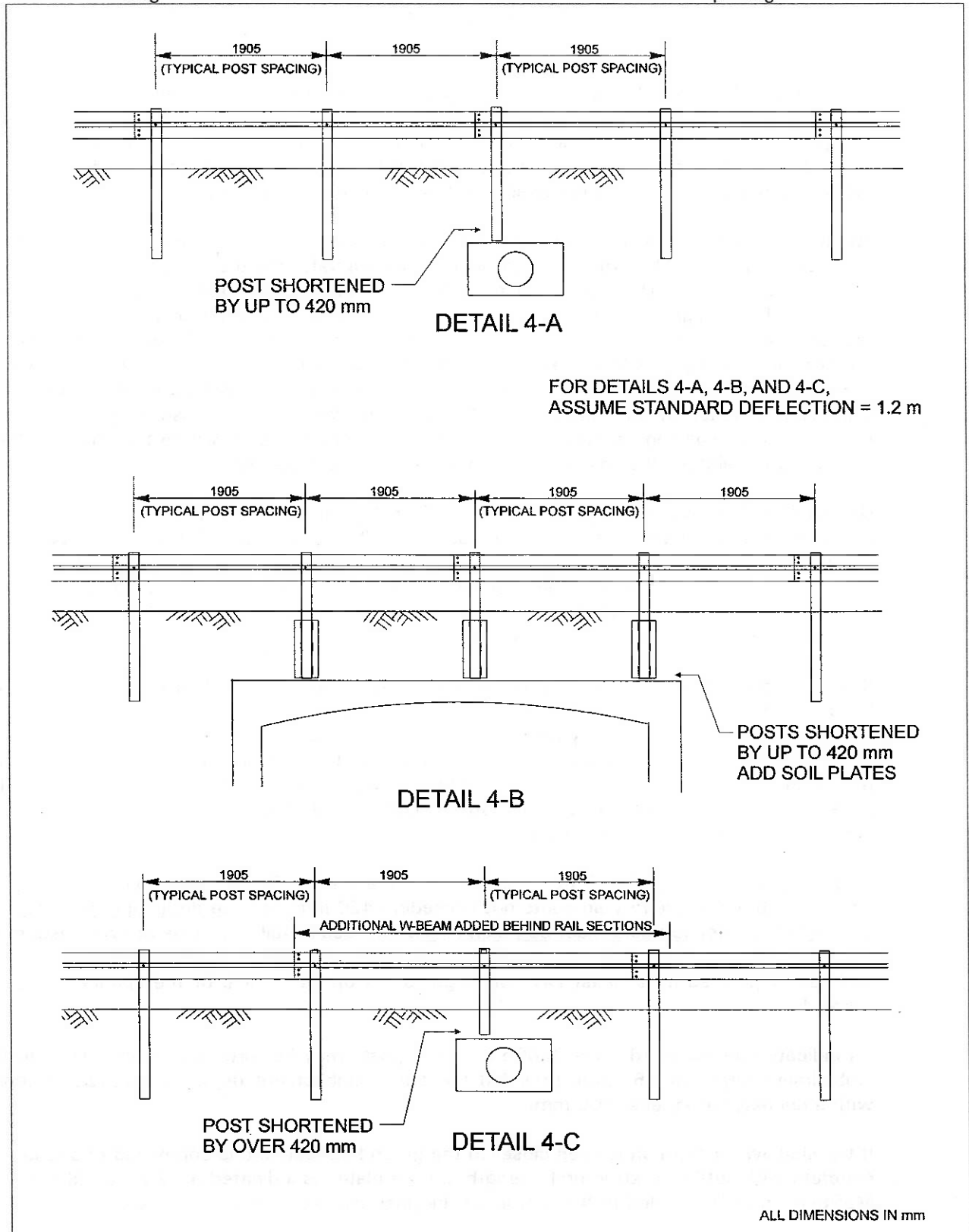
Normal Post Spacing of 0.953 m: In an HPBO run requiring 953 mm post spacings, up to three posts may be shortened by amounts not exceeding 420 mm, but the deflection distance within 3 m of the shortened posts must be taken as 1.2 m. See Detail 4-E. One or two posts may be shortened by more than 420 mm, provided a reinforcing channel is placed behind the rail and its ends are supported by at least two full-length posts on either side of the spanned area. See Detail 4-F.

As indicated on Standard Sheet M606-8, heavy posts may be further shortened to a minimum embedment depth of 450 mm, provided the entire embedment depth is encased in concrete with a diameter of at least 305 mm.

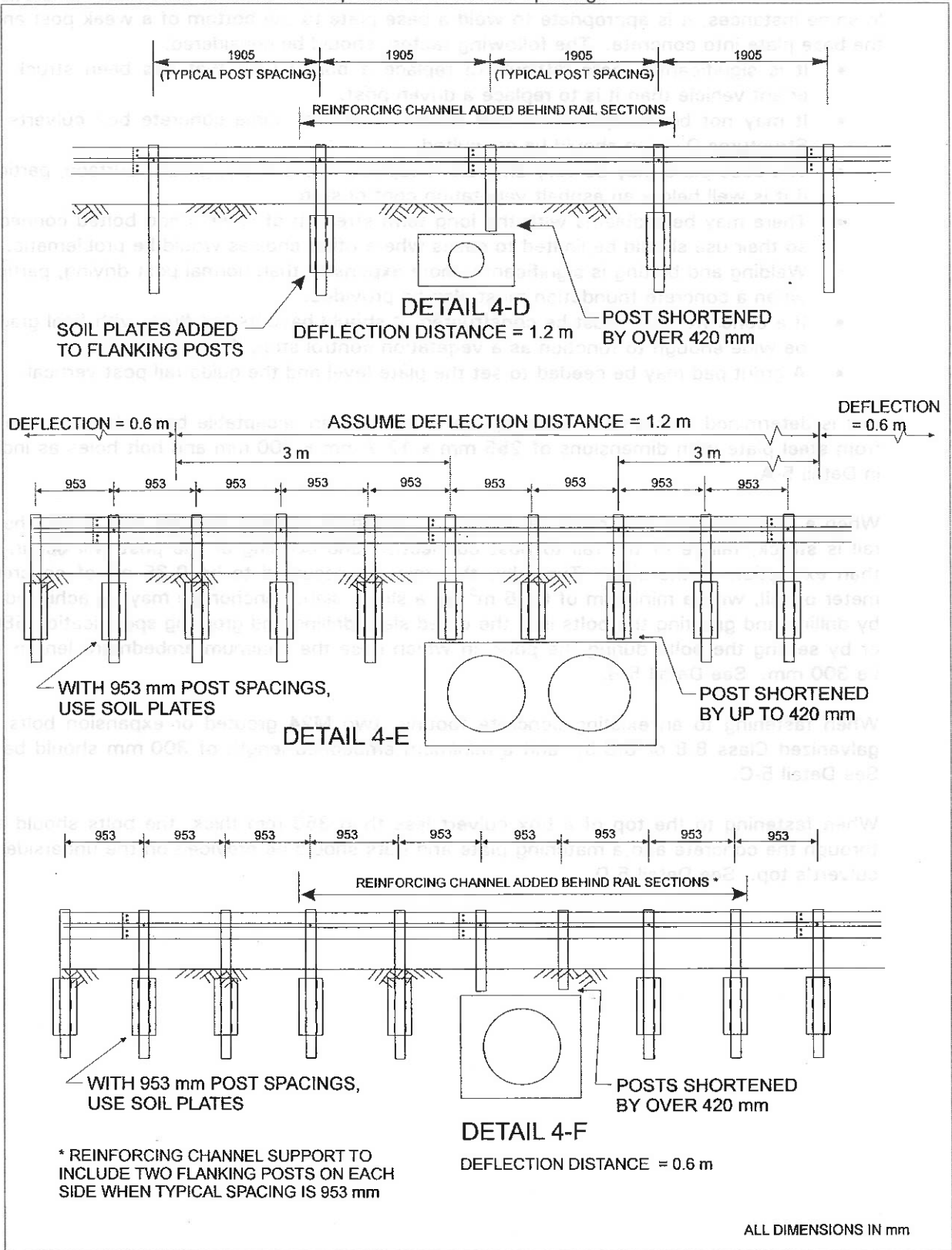
If the shallow obstruction is even closer to the ground surface and is composed of sound concrete with sufficient structural strength, a base plate, as indicated on Standard Sheet M606-10, may be welded to the bottom of the post and bolted to the concrete.

Support of Guide Rail over Shallow Obstructions

Accommodating Shallow Obstructions for HPBO W-Beam with 1.905 m Spacings



Accommodating Shallow Obstructions to Post Driving for HPBO W-Beam with Channel Backup and/or 0.953 m Spacings



E. Base Plates for Weak Post Rail Systems

In some instances, it is appropriate to weld a base plate to the bottom of a weak post and bolt the base plate into concrete. The following factors should be considered:

- It is significantly more difficult to replace a bolted post that has been struck by an errant vehicle than it is to replace a driven post.
- It may not be acceptable to bolt to the "roof" of some concrete box culverts. The Structures Division should be consulted.
- The base plate may be very difficult to replace if it is not at ground surface, particularly if it is well below an asphalt vegetation control strip.
- There may be problems with the long term strength of welded and bolted connections, so their use should be limited to cases where other choices would be problematic.
- Welding and bolting is significantly more expensive than normal post driving, particularly when a concrete foundation must also be provided.
- If a concrete base must be constructed, it should have its top flush with final grade and be wide enough to function as a vegetation control strip, if one is needed.
- A grout pad may be needed to set the plate level and the guide rail post vertical.

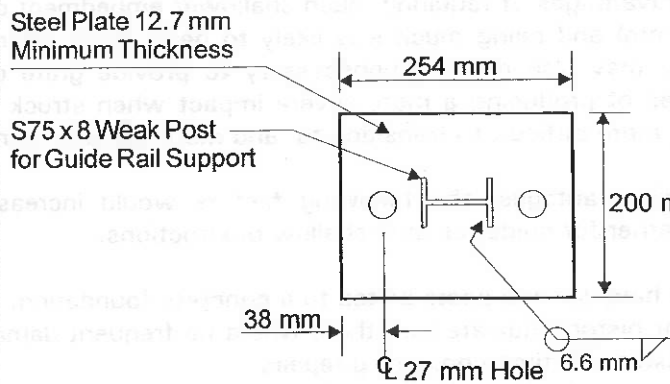
If it is determined that a base plate option is needed, an acceptable base plate may be made from steel plate with dimensions of 255 mm x 12.7 mm x 200 mm and bolt holes as indicated in Detail 5-A.

When a new concrete slab must be poured, it should be massive enough that, when the guide rail is struck, failure of the rail to post connection and bending of the post will occur, rather than extraction of the slab. Typically, this may be assumed to be 0.35 m³ of concrete per meter of rail, with a minimum of 0.56 m³ for a single slab. Anchorage may be achieved either by drilling and grouting the bolts into the cured slab (drilling and grouting specification 586.01), or by setting the bolts during the pour, in which case the minimum embedment length should be 300 mm. See Detail 5-B.

When fastening to an existing concrete footing, two M24 grouted or expansion bolts, F568 galvanized Class 8.8 or 8.8.3, and a minimum embedded length of 300 mm should be used. See Detail 5-C.

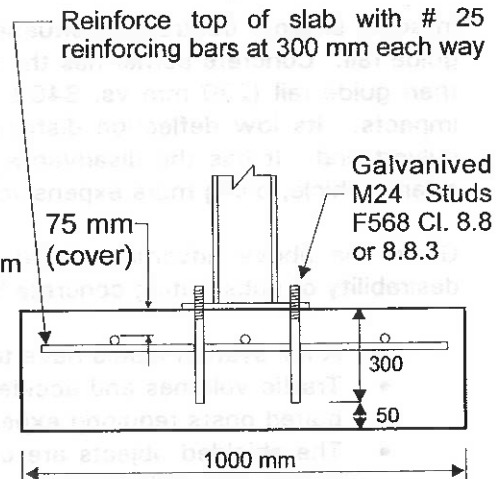
When fastening to the top of a box culvert less than 350 mm thick, the bolts should extend through the concrete and a matching plate and nuts should be provided on the underside of the culvert's top. See Detail 5-D.

Acceptable Base Plate Design and Bolting Options for Weak Post Guide Rail Systems
Detail 5 Acceptable Base Plate Design for Weak Post Guide Rail Systems



DETAIL 5-A

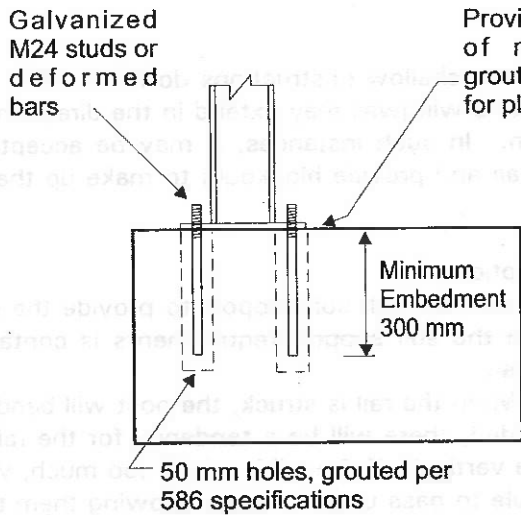
Note: All bolts to receive galvanized heavy hex nuts. Nuts are to be tack welded to plates to prevent loosening by vibration or casual vandalism. Tack weld size should facilitate subsequent nut removal and post replacement.



For stability at impact, minimum foundation slab length to be 1.6 m

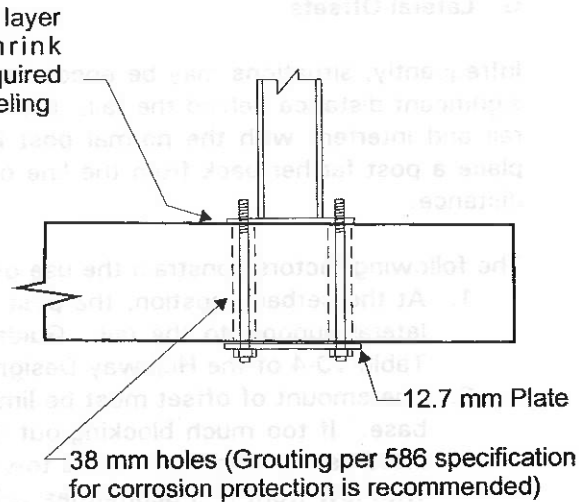
**New Concrete Foundation Slab
Cast at Grade**

DETAIL 5-B



Anchorage to Existing Slab

DETAIL 5-C



Anchorage to Box Culvert Slab

DETAIL 5-D

F. Concrete Barrier

In some shallow obstruction situations, it may be reasonable to substitute concrete barrier for guide rail. Concrete barrier has the advantages of requiring much shallower embedment depths than guide rail (230 mm vs. 840+ mm) and being much less likely to need repair after most impacts. Its low deflection distance may also make it unnecessary to provide grate over a culvert end. It has the disadvantages of producing a more severe impact when struck by an errant vehicle, being more expensive, more difficult to transition to, and more visually obtrusive.

Given the above advantages and disadvantages, the following factors would increase the desirability of substituting concrete barrier for guide rail over shallow obstructions.

- A rail system would have to have several posts bolted to a concrete foundation.
- Traffic volumes and accident history indicate that there would be frequent damage to bolted posts requiring expensive and time consuming repairs.
- The shielded objects are close to the line of the barrier, therefore requiring use of a barrier with little deflection.
- Sufficient level space is available to flare back the ends of a concrete barrier.

If, after evaluation of the above factors, it is judged that a concrete barrier will be used over the shallow obstructions to post driving, then the Pier Protection details shown on Standard Sheet M606-19 may be adapted for that purpose. The normal adaptations would be to use full sections of concrete barrier rather than concrete half sections, and to eliminate the use of backup measures.

G. Lateral Offsets

Infrequently, situations may be encountered where shallow obstructions do not extend for any significant distance behind the rail. For instance, a wingwall may extend in the direction of the rail and interfere with the normal post location. In such instances, it may be acceptable to place a post farther back from the line of the rail and provide blockouts to make up the offset distance.

The following factors constrain the use of this option.

1. At the setback position, the post must have enough soil support to provide the needed lateral support to the rail. Guidance on the soil support requirements is contained in Table 10-4 of the Highway Design Manual.
2. The amount of offset must be limited. When the rail is struck, the post will bend at the base. If too much blocking-out is provided, there will be a tendency for the rail to be lifted as the blockout rotates toward the vertical. If the rail is raised too much, vehicles with low front end geometries will be able to pass under the rail, allowing them to snag on a heavy post system, or to enter the shielded area of a weak post system.
3. Consideration must be given to the interaction between the blockout and the vehicle. Unlike blockouts on HPBO where the stiffness of the system allows the rail to essentially shield the vehicle from the blockout, impacted weak post systems typically separate the rail from the post. When this occurs, the vehicle often strikes the post. If the blockout separates from the post, it could potentially enter the passenger compartment. If the blockout does not separate, it may contribute to snagging of the vehicle. Consequently, the fastening of the blockout to the post must be strong enough to prevent the blockout separating from the post when the post is struck, but

weak enough to allow the blockout to be ripped from the post when the vehicle engages the blockout.

Based on the above considerations, the following limitations should be applied to lateral offsetting.

1. At the setback position, each post must have adequate soil support.
2. If only one post is being set back, its maximum offset should not exceed 500 mm.
3. If more than one post needs to be set back, the maximum offset of any one post should not exceed 305 mm.
4. The maximum length of rail supported by offset posts should not exceed 7.5 m.
5. Blocking out of cable guide rail should be avoided. However, if it is judged necessary, blockouts may be built up from sections of standard box beam, cut to 250 mm lengths. The blockouts should be oriented vertically to prevent the accumulation of debris which could retain water and promote rusting. The blockouts should be drilled to accept the typical three J-bolts on the face that is in contact with the cables. The blockouts should be drilled to permit fastening to the posts using the top and bottom holes normally provided in the posts to receive the J-bolts.
6. The blockouts for weak post W-beam may be made from treated wood or from box beam as above, except that the blockouts should be 360 mm in length. If box beam is used, the blockouts should be joined to each other and the post in the same manner as described above. The connection to the rail should be as shown on Standard Sheet for Corrugated Beam Guide Railing. If treated timber blockouts are used, the width of the blocks should be approximately 140 mm (commercially available 6x6 timbers). A 10 mm deep by 65 mm wide rabbet should be cut in the side that will receive the post. Bolting should be similar to that indicated for standard blockouts for Heavy Post Blocked Out (HPBO) W-Beam. If the offset requires the use of more than one wooden block, the blockouts should be toenailed together with #12 galvanized finishing nails to prevent the blocks from rotating about the single bolt.
7. The blockouts for box beam guide rail may be made from 250 mm lengths of box beam fastened to the posts in the same manner described above for cable guide rail blockouts. However, the holes drilled in the blockout should be positioned to place the top of the blockout flush with the top of the post. The angle used to seat the rail should be connected between the rail and the blockout in a manner similar to that indicated on the standard sheet for Box Beam Guide Rail.
8. If an HPBO system needs to have a post or posts offset farther than the distance provided by the standard blockout, the additional offset may be achieved by incorporating additional standard blockouts and using a longer bolt. To prevent the blockouts from rotating about the bolt, the blocks should be fastened together with either galvanized nails or screws.

H. Payment Considerations

In general, designers specify the required areas of coverage for a run of guide rail and do not address the placement of individual posts. Consequently, it is not reasonable for designers to address potential post driving conflicts with narrow obstructions, since they would have no way of knowing whether the posts would straddle that obstruction or not. The burden is therefore on the contractor to be aware of the observable potential conflicts and to bid accordingly. This responsibility is spelled out in the Standard Specifications, Section 102-04 No Misunderstanding, which states that, "The bidder agrees that its proposed contract prices include all costs arising solely from existing conditions shown, or specified in the contract documents...or readily observable from a site inspection..."

Where potential conflicts with post driving are identified during design, the nature of those conflicts should be indicated in the contract documents, preferably including notes on the plans. This is more important for features that are not readily apparent by a visual inspection of the site, such as buried utilities or footings.

When it is known that special provisions will need to be constructed to support the railing, such as the furnishing of a concrete slab and the bolting of posts to that slab, the details should be provided in the contract plans.

In some instances, obstructions to post driving will be encountered that could not reasonably have been predicted from a reasonable site investigation. Typically, this will be the case with unanticipated boulders or shallow bedrock. In these instances, payment should be determined in accordance with Standard Specification section 109-16, Changed Conditions and Delay Provisions, subsection A, 1, Different Site Conditions, which requires written notification of parties when unanticipated conditions are encountered. The specification further charges the Engineer with investigating the conditions and determining the need for cost or time adjustments and their amount.