721-2.1 GENERAL

Steel Beam Guide Rail (SBGR) is a semi-rigid barrier system which restrains and redirects vehicles by a combination of beam bending (W-shaped steel section), tension, and the lateral restraint provided by the posts (wooden or steel).

Optimum SBGR performance depends on the proper mounting height of the beam. It is essential that this height is maintained for the full service life of the installation.

SBGR can be used for roadside or median applications. The single rail SBGR system is used as a roadside barrier while the double rail SBGR system is used as a median barrier or core-collector separator.

A steel channel section can be added to the single rail SBGR system (steel channel is always provided on double rail SBGR) for the purpose of providing additional stiffness at connections to structures and concrete barriers (to decrease barrier deflection). Although the use of guide rail adjacent to curb and gutter is not desirable, single rail SBGR with channel can be placed adjacent to curb and gutter. Double rail SBGR can only be placed adjacent to mountable curb and gutter.

Refer to the Roadside Safety Manual for further information on SBGR.

721-2.2 REFERENCES

Roadside Safety Manual
Highway Design Bulletin 2004-001
Highway Design Bulletin 2005-001
Highway Design Bulletin 2005-003
Highway Design Bulletin 2006-001
Highway Design Bulletin 2007-004
Highway Design Bulletin 2008-001
Highway Design Bulletin 2011-003
721-2.3 TENDER ITEMS

- Single Rail Steel Beam Guide Rail (variation item)
- Adjust Steel Beam Guide Rail, Wooden Posts
- Adjust Steel Beam Guide Rail, Steel Posts
- Adjust Steel Beam Guide Rail, Steel Posts with Steel Offset Blocks
- Single Rail Steel Beam Guide Rail with Channel (variation item)
- Double Rail Steel Beam Guide Rail (variation item)

721-2.4 SPECIFICATION

The requirements for SBGR are contained in OPSS 721.

721-2.5 SPECIAL PROVISIONS

Refer to chapter ‘E’ of this Manual to review applicable standard special provisions.

721-2.6 STANDARD DRAWINGS

Applicable standard drawings are contained in the 900 series of OPSDs and the 900 series of MTODs.

721-2.7 DESIGN

Steel beam guide rail consists of the following three systems:

1) Single Rail Steel Beam Guide Rail;
2) Single Rail Steel Beam Guide Rail with Channel; and
3) Double Rail Steel Beam Guide Rail.

For warrants in choosing the appropriate length of guide rail refer to the Roadside Safety Manual and the Memorandum: Guide Rail Protection on the Inside of Horizontal Curves & Length of Barrier Protection for Water Hazards (Nov. 18, 2002).

SBGR (with or without channel) shall be installed using either steel posts with routed wooden blocks, steel posts with plastic blocks, or wooden posts with wooden blocks. Installations having a mix of steel and wooden posts in a complete system are not acceptable, with the exception of end terminals, where breakaway wooden posts are required. Extension of an existing wooden post installation with steel posts shall only be allowed when the extension length is greater than 100 m.
The minimum shoulder rounding width for installation of SBGR is 1.0 m.

Each end of the system should be anchored by an appropriate end treatment, terminal system, or structure / concrete barrier connection.

A terminal system shall be installed at the following locations:

1) Approach end on divided highways and one-way ramps;
2) Approach and leaving end on undivided highways and two-way ramps; and
3) Left (median) shoulder on the leaving end on divided highways when the leaving end is located within the clear zone for opposing traffic.


The “Leaving End Treatment” is to be installed on divided highways and one-way ramps. The “Leaving End Treatment” should not be installed on undivided highways or as an approach terminal system. When SBGR is installed on the left (median) shoulder of a divided highway, the “Leaving End Treatment” should not be used when the end of the SBGR is located within the clear zone for opposing traffic. Post 1 of the “Leaving End Treatment” should be located at least 4 m beyond the end of the obstacle being shielded.

The buried leaving end treatment (OPSD 912.233) shall no longer be used for new installations.

The “Treatment at Culverts with Minimal Cover” is to be used to span over top of larger culverts that have less than 1,200 mm of backfill and cover material. At each location where the “Treatment at Culverts with Minimal Cover” is installed, the embankment shall be widened to the minimum dimensions specified on the OPSD, as required. Refer to CDED Section B206-1 – “Earth Excavation (Grading)” and Highway Design Bulletin 2005-003 for more information.

The “Rock Cut Installation” method for both steel and wooden SBGR posts is to be used if solid rock exists within the full standard length of post embedment. Minimum hole diameters as specified on the MTOD shall be provided by the contractor. This installation method is not necessary for SBGR installations in rock fill where solid rock is not expected to be located within the full standard length of post embedment. Refer to Highway Design Bulletin 2006-001 for more information.

The “Steel Beam Installation – Entrances and Intersecting Roadways” is used to specify the construction details of a roadside SBGR system around the radius of an intersecting roadway or entrance. For applicable radii, refer to OPSD 912.531. SBGR installations on radii exceeding that specified on OPSD 912.531 do not require this treatment.
For retrofit of SBGR to existing embankments, ensure that the embankment cross-section is adequate to accommodate the installation with the breakpoint in the rounding located at the backside of the posts and the granular base and subbase at a slope of 3H:1V or flatter. Where embankment widening is necessary, ensure that drainage requirements are properly addressed.

Mounting height tolerances for SBGR are specified in OPSS 721. There are three tender items available for adjustment of SBGR. The purpose of these items is to allow for the adjustment of the mounting height of an existing SBGR installation on wooden or steel posts. Generally, adjustment is necessary at locations where the pavement rehabilitation strategy will raise the existing ground elevation adjacent to an existing guide rail installation. An evaluation of the existing guide rail will provide the designer with an inventory of the type of existing guide rail systems as well as existing mounting height. Existing SBGR installations may consist of the following configurations:

1) Wooden posts with wooden offset blocks:

Although still installed today, these systems were used primarily in the years prior to implementation of SBGR on steel posts in 1995. When adjusting these systems, the posts remain in their current location, but the offset block and rail (and channel, where necessary) are reinstalled at the new mounting height. If the guide rail was installed according to OPSD 912.140, there should be approximately 150 mm of space available for adjustment assuming this is the first adjustment. The evaluation of existing guide rail should determine whether the existing installation can accommodate the proposed change in height.

2) Steel post with steel offset blocks:

Steel post systems have been the most common since they were first implemented in 1995 mainly due to their relative ease of handling and installation. Steel offset blocks were used exclusively with steel post systems from 1995 through 2002 when the standard was revised to specify routed wooden blocks. When they are adjusted, existing steel post systems with steel offset blocks will be retrofitted with routed wooden or plastic offset blocks. This requires the punching of a new hole to accommodate the wooden or plastic offset block.

3) Steel posts with wooden or plastic offset blocks:

From 2003 through the early 2008, steel post systems were installed exclusively with routed wooden offset blocks. In 2008, plastic offset blocks were implemented as an alternative to the routed wooden offset blocks. Since that time, steel post systems with plastic offset blocks have been the most common steel beam system.
Selection of the appropriate tender item for each installation will ensure that the Contractor will address the unique adjustment requirements of each system configuration.

It should be noted that as the top of pavement grade is raised there will be a corresponding steepening of the side slope adjacent to the guide rail. The proposed cross section should be reviewed to ensure that:

1. The breakpoint in rounding occurs behind the back of the SBGR post; and
2. The foreslope immediately behind the SBGR posts is 3H:1V or flatter

Tender items for adjustment include the removal and replacement of existing hardware including bolts, washers, and nuts as well as the installation of new reflectors. For SBGR with steel offset blocks, replacement of the steel offset blocks with plastic or wooden offset blocks is included.

Existing end terminals and treatments should be reviewed when SBGR is being considered for adjustment.

Existing end terminals may consist of Eccentric Loader Terminal (ELT) Systems, Extruder Terminal (ET) Systems, or Sequential Kinking Terminal (SKT) Systems:

1. ELT Systems:
   • Replace ELT installations that are greater than or equal to 5 years in age with a new Steel Beam Energy Attenuating Terminal (SBEAT) System. If the ELT System is located on a horizontal curve with a radius of less than 190m, a new ELT is to be installed;

2. SBEATs:
   • Existing ET and SKT Systems consist of several different variations on wooden and steel posts.
   • Replace ET and SKT System installations on wooden posts with a new SBEAT System.
   • ET and SKT Systems on steel posts that are in good condition may be adjusted.

Existing leaving end treatments consisting of buried leaving end treatments (formerly OPSD 912.233) or upright “fishtail” ends:

1. Buried leaving end treatments are a challenge to adjust and could be replaced with a standard leaving end treatment according to OPSD 912.235. This would require the removal of 16 m of existing SBGR and subsequent installation of 4 m of new SBGR according to OPSD 912.235;

2. Existing upright “fishtail” type end treatments typically have been installed based on the extension requirements for unanchored guide rail in accordance with
Table 3.4.2 in the Roadside Safety Manual. When replacing an upright “fishtail” end treatment with a standard leaving end treatment, ensure that after removal of the unanchored end beyond the hazard that the 4 m of new SBGR in accordance with OPSD 912.235 extends beyond the hazard by 4 m;

3. Where an existing buried end treatment or upright “fishtail” end treatment is on the leaving end of a SBGR installation located on an undivided highway or at a location on a divided highway where the end of the SBGR is located within the clear zone for opposing traffic, the treatment should be considered for replacement with an end terminal.

721-2.8 COMPUTATION

These are Plan Quantity Payment items.

Quantities are computed in metres, and measured horizontally from end to end along the centre line of the installation.

The horizontal length shall include the following when specified:

- End Treatments;
- Treatment at Culverts with Minimal Cover;
- Rock Cut Installations;
- Installation – Entrances and Intersecting Roadways;
- Permanent Transition Installations at Median Hazards;
- Permanent Connections to Concrete Barrier; and
- Structure Connections.

SBGR terminal systems are included in separate tender items to the limits specified on the appropriate OPSD and are not included in the lengths for the tender items detailed above in 721-2.3.

Where guide rail systems overlap in a transition between different types of systems, compute the length of each system under the corresponding guide rail item, as if the other type did not exist. Terminal systems that form parts of transitions shall be counted under the appropriate terminal system tender items.

721-2.9 DOCUMENTATION

Enter SBGR and Adjust SBGR quantities onto the Quantities Miscellaneous sheet for the appropriate tender item, showing station to station and location, left or right of centreline. Provide offsets if required. For Adjust SBGR, note the locations where existing channel is to be reinstalled.
SBGR, Adjust SBGR, end treatments, transitions, structure / concrete barrier connections and anchorage are depicted on the contract drawings with the appropriate OPSD or MTOD number shown adjacent to the symbol.

The SBGR “Leaving End Treatment” is depicted on the contract drawings with the OPSD number shown adjacent to the SBGR symbol. Document the SBGR “Leaving End Treatment” under the standard item, single rail SBGR. Include full payment for this treatment under this item for the equivalent length of single rail SBGR (up to Post 1). Identify locations of this treatment in the Q-sheets, showing both the beginning and end stations, and left or right of centreline and noting in the location and position column “Leaving End Treatment”.

Document the SBGR “Treatment at Culverts with Minimal Cover” under the standard item, single rail SBGR. Include full payment for this treatment under this item for the equivalent length (30 m) of single rail SBGR. Identify locations of this treatment in the Q-sheets, showing both the beginning and end stations, and left or right of centreline and noting in the location and position column “Treatment at Culverts with Minimal Cover”. Show the location of the embankment widening on the contract drawings. Show the dimensions of embankment widening on cross-sections. Payment for grading should be made under the appropriate grading items.

For “Rock Cut Installation”, the length of SBGR installed in rock cut areas shall be listed in a separate column in the Q-sheet with the heading [Rock installation per MTOD 912.131] and stations shall be noted in the location and position column.

For “Steel Beam Installation – Entrances and Intersecting Roadways”, specify the curve radius and angle-of-curve, D. Include the length of rail installation in the tender quantity for the SBGR item. Document the end treatment or terminal system, as applicable, according to the appropriate CDED Chapter B Section.

721-2.9.1 Documentation Accuracy

Record station and quantity entries to the nearest whole metre.

Record offsets when the installation is not according to standard, and then to 0.1 m accuracy. Where SBGR is to be mounted beside curb and gutter, document the appropriate offsets in the contract drawings.