

FLEAT-SP

FLared Energy Absorbing Terminal



Product Manual

FLEAT-SP

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1.0 Introduction

Roads safety barrier systems are designed to shield vehicles from striking a hazard. Steel guardrail systems are the world's most widely specified safety barrier systems and have significantly contributed to improving the safety of our regions roads.

The strength of a steel guardrail system is primarily developed through a combination of the flexural resistance of the rail and the bending resistance of the supporting posts.

In addition, the use of end terminals is an important characteristic in the function of steel guardrail system. Terminals are the specially designed end pieces located at the leading and trailing end of the system.

End terminals are designed to anchor the steel guardrail system and introduce the necessary tensile and flexural strength required for safe vehicle containment and re-direction throughout the length-of-need section.

Some guardrail end terminals also provide the additional feature of reducing the severity of an impact near or at the end of the system.

2.0 The FLEAT-SP

The FLEAT-SP guardrail end terminal is a flared, energy-absorbing end terminal, designed to minimise the severity of impacts occurring at the end of the safety barrier system.

Designed for attachment directly to w-beam guardrail, the FLEAT-SP is one of the world's leading end treatment solutions and is fully compliant to the requirements of NCHRP Report 350.

The FLEAT-SP is available in two configurations. The compact 7.62m TL2 terminal is an economical solution where the posted speed is less than or equal to 70km/h. The standard 11.43m TL3 terminal is acceptable for all posted speeds greater than 70km/h.

The straight flare design feature allows the TL3 FLEAT-SP to be installed at a variable offset from 760mm to 1220mm. The offset of TL2 FLEAT-SP is between 510mm and 810mm. The use of a straight flare reduces the potential for head-on impacts.



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3.0 How the FLEAT-SP Functions

The FLEAT-SP comprises several unique components integral to the performance of the terminal. These include;

- Slotted anchor rail;
- Impact head;
- Bolted hinged posts;
- Steel line posts; and
- Anchor bracket and cable assembly.

During head-on impacts, the FLEAT-SP impact head slides over the w-beam guardrail. The w-beam is sequentially kinked as it moves through the head. The kinking action of the rail absorbs the kinetic energy of the impacting vehicle and brings the vehicle to a controlled stop.

As the impact head slides over the w-beam guardrail, the bolted hinged posts at post locations 1 and 2 yield at ground level. The yielding action of the hinged posts contributes to a soft impact for vehicle occupants.

The use of steel line posts at post locations 3 and beyond provides the FLEAT-SP with the necessary lateral support required for safe vehicle containment and re-direction through the length-of-need section.

4.0 Crash Test Performance

The FLEAT-SP has been crash tested and assessed in accordance with Test Level 3 (TL3) of the National Cooperative Highway Research Program (NCHRP) Report 350.

NCHRP Report 350 is the nominated crash test procedure of *AS/NZS 3845: Road Safety Barrier Systems* and evaluates the structural adequacy of the terminal, vehicle occupant risk and post impact vehicle behaviour.

Crash testing of the FLEAT-SP in accordance with NCHRP Report 350 TL3 was undertaken with an 820kg small car and a 2,000kg pick-up truck travelling at 100km/h.

At the nose of the terminal, these impacts are performed end-on or at angles up to 15°. Along the length-of-need, impacts are performed at 20°.

The FLEAT-SP is also available in a NCHRP Report 350 TL2 configuration. TL2 evaluates vehicle impacts occurring at 70km/h.

The only difference between the TL3 and TL2 configuration of the FLEAT-SP is the length of the terminal. The TL2 configuration of the FLEAT-SP measures 7.62m compared to the TL3 configuration length of 11.43m. The hardware arrangement through the first 7.62m remains the same for both TL3 and TL2 terminals.

The upper speed limit used for the evaluation of terminals in accordance with NCHRP Report 350 TL3 is 100km/h. Whilst there are roads within Australia with posted speeds greater than 100km/h, the FLEAT-SP is acceptable for these high speed locations.

A crash test performed at 100km/h is still considered representative of worst case run-off-road crashes. Extensive evaluation of real-life crash impacts has concluded that, regardless of posted speeds, most impacts with fixed objects occurs at somewhat reduced speeds, likely due to pre-crash application of brakes.

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5.0 Characteristics of Terminals

5.1 Gating Classification

Although the terms “gating” and “non-gating” have traditionally been used to categorise end terminal behaviour, these definitions can be misleading when applied to w-beam guardrail end terminals. The AS/NZS 3845 definitions of “gating” and “non-gating” are as follows;

- **Gating:** terminals that are designed to break away, pivot or hinge, and that allow a vehicle to pass through when impacted at an angle to the end, or at a point upstream of the beginning length-of-need of the safety barrier system.
- **Non-Gating:** terminals that are designed to re-direct and absorb part of the energy of an impacting vehicle at any point along the terminal without allowing it to pass behind the safety barrier system.

All w-beam guardrail end terminals are gating terminals. When struck at or near the nose at an angle of 15° or greater, w-beam guardrail terminals will yield, allowing a vehicle to continue into the area immediately behind and beyond the terminal.

However, a significant performance benefit of the FLEAT-SP is its ability to dissipate kinetic energy during a head-on impact occurring at the nose. This energy-absorbing feature brings the errant vehicle to a controlled stop over a relatively short distance, even at high impact speeds.

The energy-absorbing feature of the FLEAT-SP contrasts with traditional, parabolic flared terminals such as the MELT and BCTA (used in Victoria). These traditional terminals are classified as non-energy absorbing and will allow an un-braked vehicle to travel a significant distance behind the barrier system when struck head-on at high speeds.



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5.2 The Point-of-Need

Since all w-beam guardrail end terminals fall into the gating category, it is important that the terminal point-of-need is identified. This is the location along the terminal that has demonstrated complete containment and re-direction when subjected to a 2,000kg pick-up truck impacting at 20°. When assessed for TL3 conditions, the speed of the impact is performed at 100km/h.

The FLEAT-SP point-of-need is post location 3, a distance of 3.81m downstream from the start of the terminal.

In order to adequately shield a roadside hazard, the beginning length-of-need is required to be calculated for that site. At a minimum, the FLEAT-SP should be installed so that the terminal point-of-need (post 3) aligns with the site beginning-length-of-need. Figure 1 provides an example.

The point-of-need location may vary between terminal types. However, provided the terminal point-of-need and the site beginning-length-of-need are horizontally aligned, the road safety barrier system will provide the same re-directive capabilities, regardless of the terminal selected.

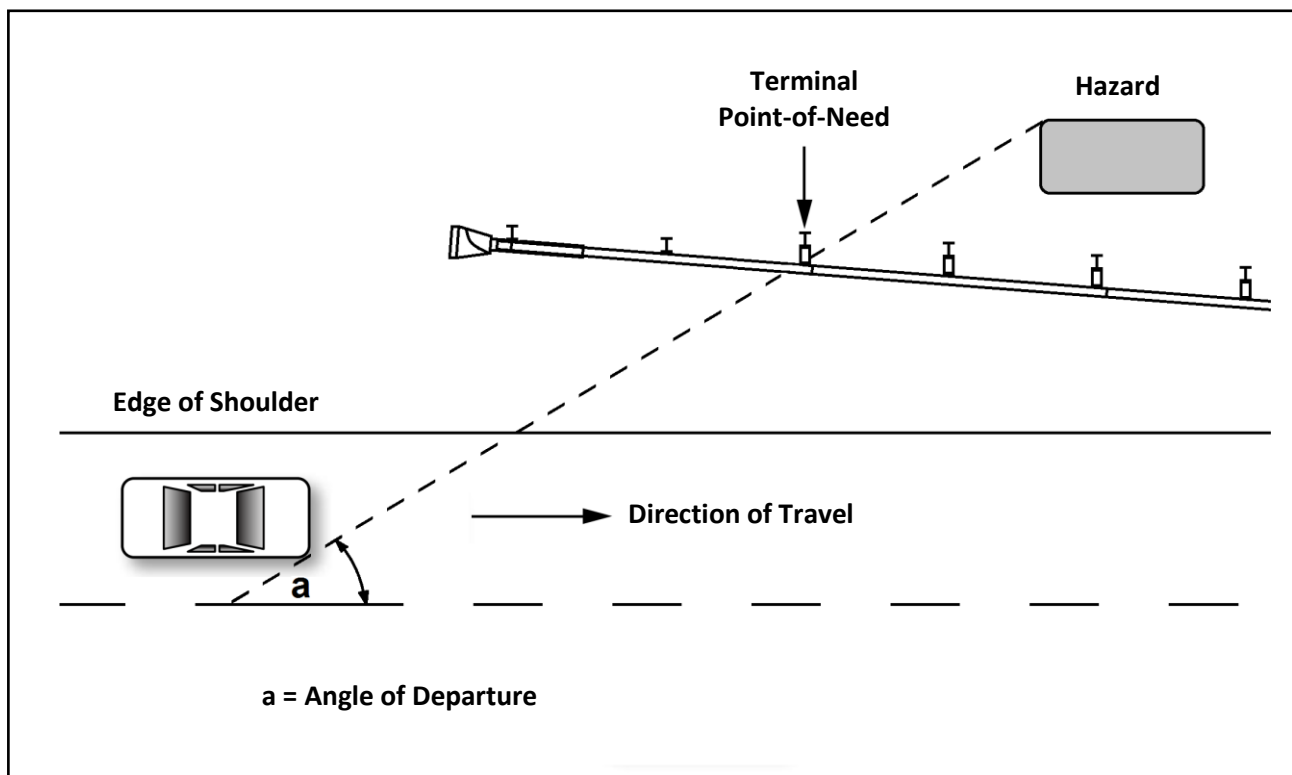


Figure 1: Positioning of Terminal Point-of-Need to Adequately Shield a Roadside Hazard

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5.3 Benefits of a Flared Terminal

A roadside barrier is considered to be flared when it is not parallel to the edge of the travelled way. Motorists are less likely to perceive roadside barriers to be a hazard if the terminal gradually flares away from the approaching traffic.

Introducing a flare allows the barrier to be located further away from the roadway reducing the potential for head-on impacts.

Another significant benefit of installing a flared terminal is reducing the overall length of barrier required to shield a roadside hazard. Over numerous sites, this can provide a significant cost benefit and reduce the time workers spend by the roadside.

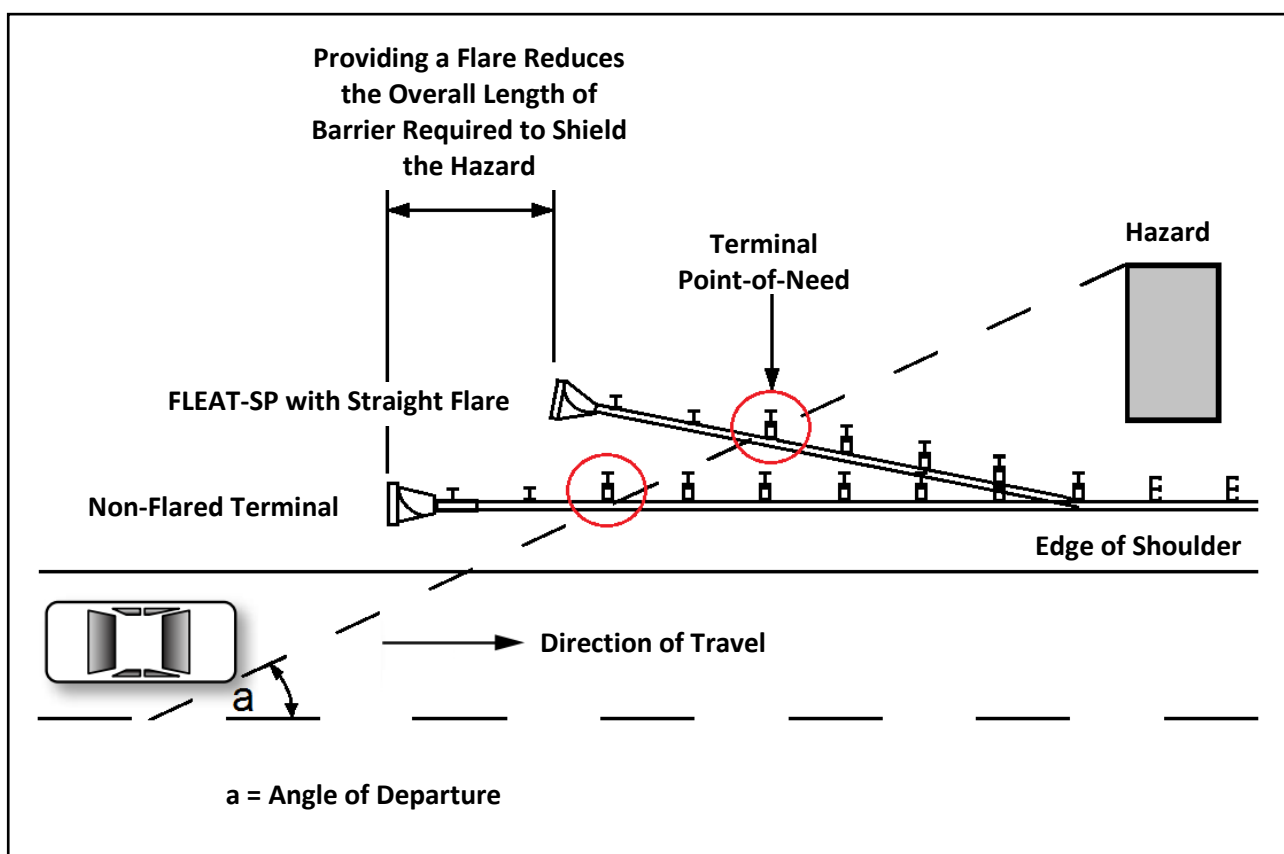


Figure 2: Flaring of the Terminal Reduces the Overall Length of the Barrier

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5.4 Trailing End Protection

The FLEAT-SP is typically installed on the leading end of a guardrail barrier. However, in some instances it is necessary to install a crashworthy terminal on the trailing end. This occurs when the trailing end of a guardrail barrier is located within the clear zone of approaching traffic.

The clear zone is the horizontal width of space available for the safe use of an errant vehicle.

This distance is dependent upon the posted speed and road geometry. Guidelines for determining the clear zone width are contained within state road authority publications.

Please note that in some Australian jurisdictions a crash worthy terminal is required on both the leading and trailing end of a guardrail barrier when installed on an undivided roadway. This is regardless of whether the trailing end is located outside the clear zone of approaching traffic. Please consult with state road authority publications for guidelines.

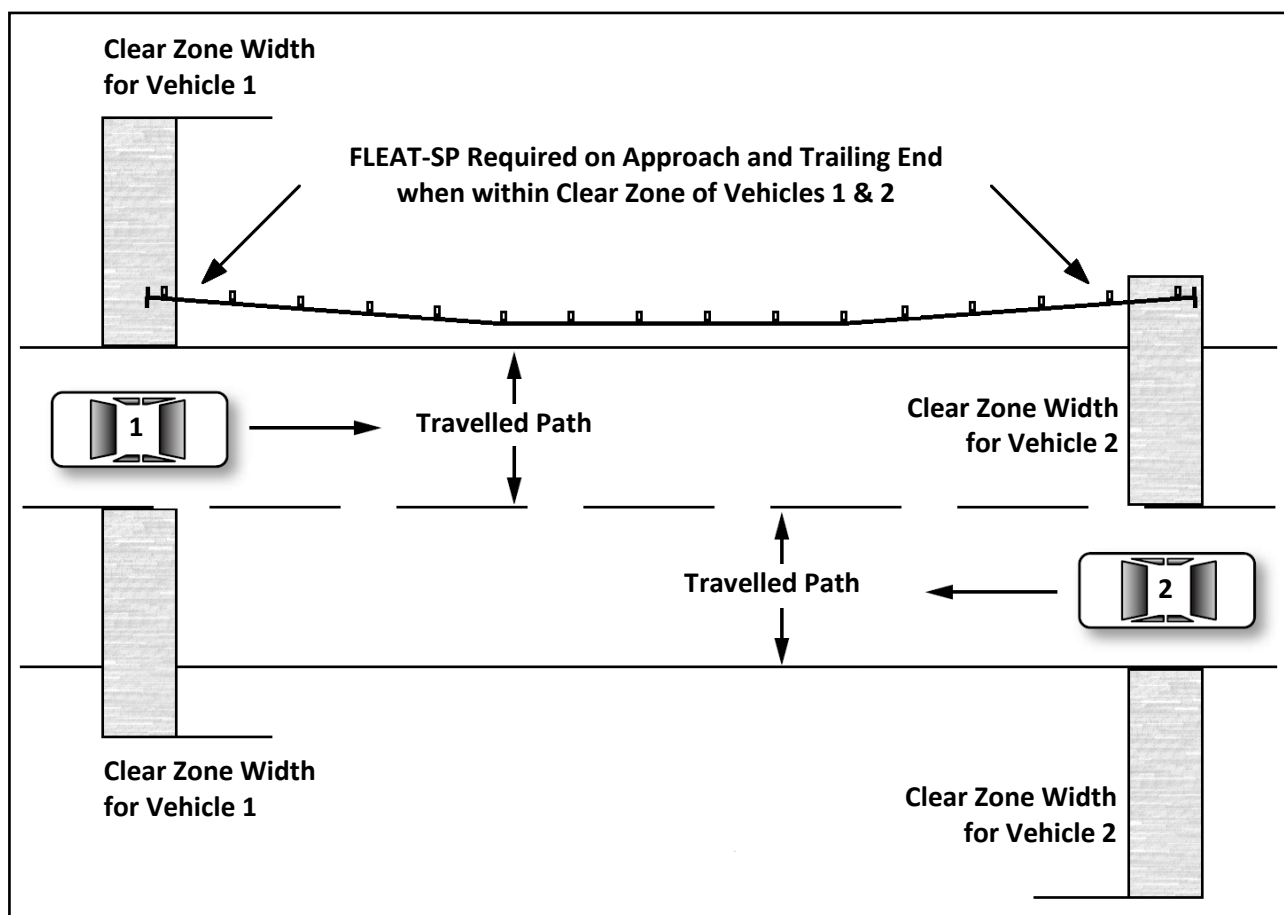


Figure 3: Assessment of Trailing End Protection

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6.0 Set-out

Under crash test conditions, the surfaces immediately in front of and behind terminals are reasonably flat and unobstructed. In the field, conditions vary from site to site and obstructions such as kerbs, services and embankments are encountered.

6.1 Site Grading Requirements

Grading around the area of a guardrail end terminal is an important consideration regardless of the specific terminal type used. The site grading should be considered from three perspectives; advance grading, adjacent grading and run-out grading.

6.1.1 Advance Grading

It is recommended that the area in advance of a terminal be limited to a grading of 10H:1V to ensure that the vehicle's suspension is neither extended nor compressed at the moment of impact. An advantage of the FLEAT-SP is its straight flare construction which is significantly easier to set-out than a parabolic flared terminal such as the MELT or BCTA.

6.1.2 Adjacent Grading

Adjacent grading refers to the surface on which the terminal is installed and the area immediately behind. It is recommended that this area be relatively flat (10H:1V) so that the terrain does not contribute to vehicle behaviour. Where re-direction is expected (beyond the point-of-need), the terminal posts should have 600mm of fill material behind them, providing sufficient lateral support.

For near head-on impacts with the front-right of a vehicle, grading of 10H:1V should extend 1500mm behind the nose of the terminal, minimising the potential for vehicle roll as the terminal is engaged.

6.1.3 Run-Out Grading

Since all w-beam guardrail end terminals are gating, consideration must be given to the area parallel to and behind the safety barrier system. When struck at or near the nose at an angle of 15° or greater, w-beam guardrail end terminals will yield, allowing a vehicle to continue into the area immediately behind and beyond the terminal.

AS/NZS 3845 nominates an area measuring 22.5m long x 6.0m wide measured from the nose of the terminal to be reasonably traversable and free from fixed object hazards. This may be difficult to address, particularly on existing roadways. This is recognised by AS/NZS 3845 which also states that 'if a clear run-out area is not possible, this area should at least be similar in character to adjacent unshielded roadside areas'.

Generally a risk evaluation would conclude that an end terminal installed without the required run-out area could be considered a lower risk than leaving a roadside hazard completely unshielded.

When the desirable run-out area is not available or when there is a high likelihood of a head-on impact with the terminal, the use of an energy-absorbing terminal such as the FLEAT-SP should be the preferred option over non-energy absorbing terminals such as the MELT and BCTA.

The ability of the FLEAT-SP to dissipate energy during head-on impacts and bring an errant vehicle travelling at high-speed to a controlled stop over a short distance reduces the opportunity for an errant vehicle to pass behind the system.

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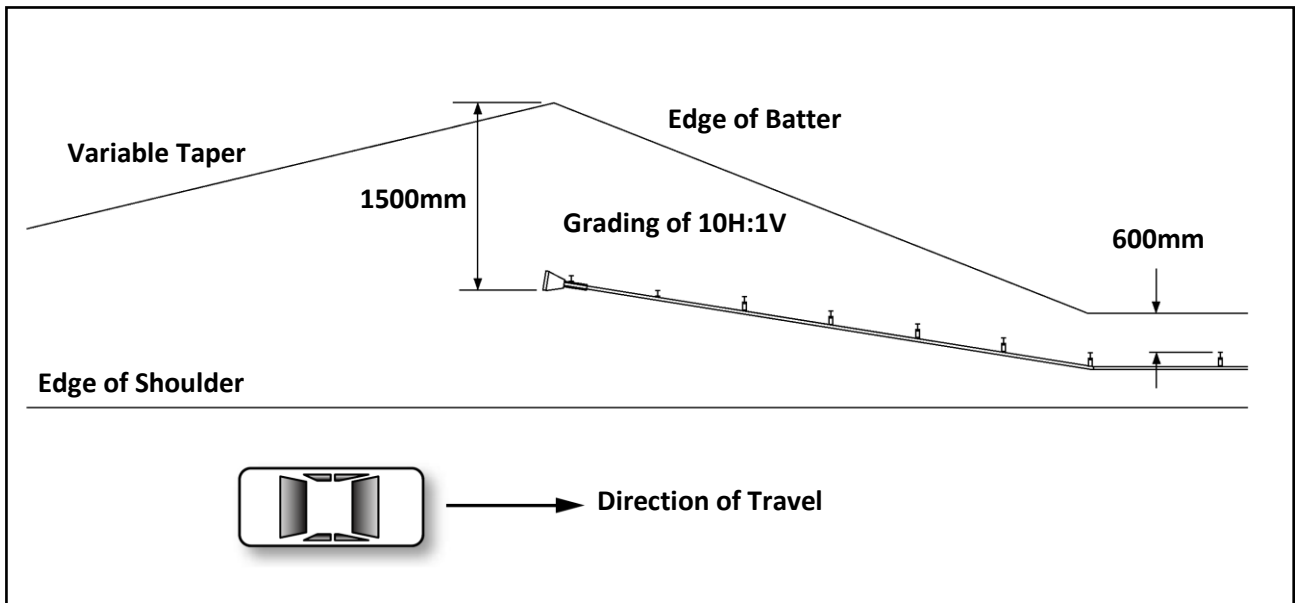


Figure 4: Preferred Grading Arrangement

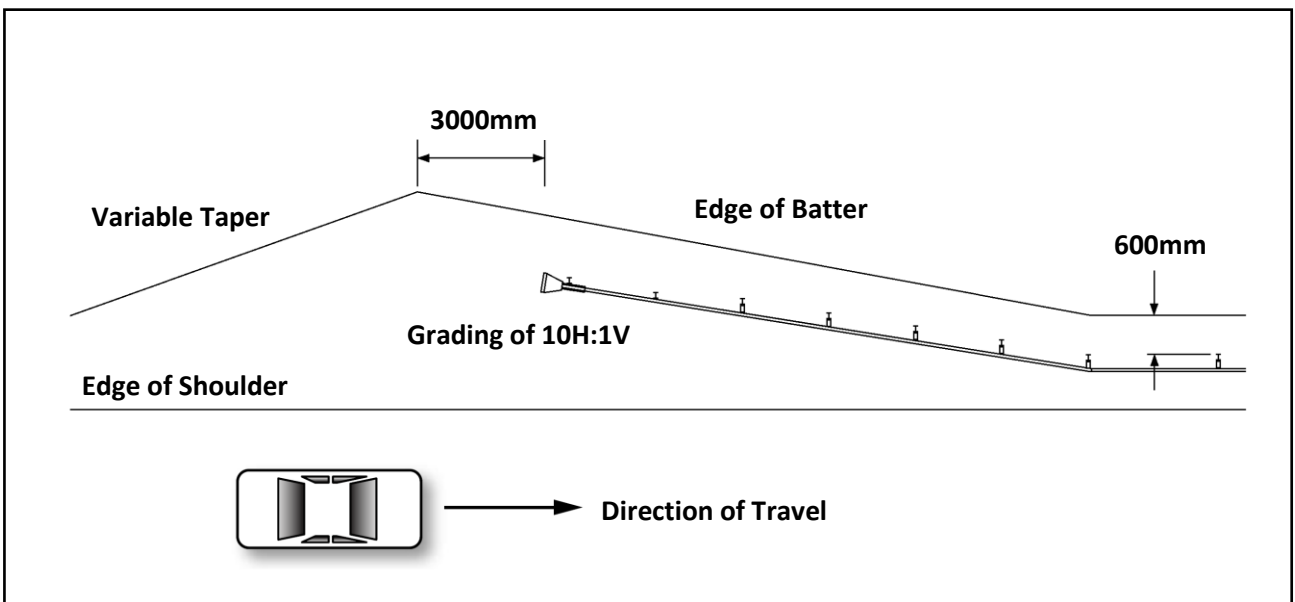


Figure 5: Alternate Grading Arrangement

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6.2 Kerbs

Placing kerbs in front of w-beam guardrail terminals on high-speed roads is not recommended. As an alternative, a shallow gutter in front of the terminal or subsurface grated drainage should be considered.

On lower speed roads that often require a kerb, it is recommended that the location of the kerb be as close as practicable to the face of rail minimising the potential for vehicle launching. If the posted speed is $\geq 80\text{km/h}$ the kerb height should be limited to 100mm.

6.3 Placement in Concrete

The line posts of the FLEAT-SP provide lateral resistance during side-on impacts and are designed to absorb some crash energy through post rotation in the surrounding material prior to fully yielding.

There may be instances when designers prefer the area beneath the safety barrier system to be paved.

Whilst a paved surface has aesthetic appeal, it is important that it does not have an adverse effect on the functionality of the system.

When installed in a paved area, it is recommended that a 'leave-out' area in the pavement be provided that will allow at least 180mm of post deflection at ground line. This 'leave-out' area can be filled with a low-strength concrete mix.

6.4 Other Obstructions & Hazards

During head-on impacts, the FLEAT-SP impact head slides over the w-beam guardrail. It is important that there are no obstructions located or positioned below the impact head, such as vegetation that may hinder the travel of the impact head.

Since the FLEAT-SP functions by sequentially kinking the rail through the impact head, a risk assessment is recommended if pedestrians and/or cyclists will be accessing the area around the terminal.

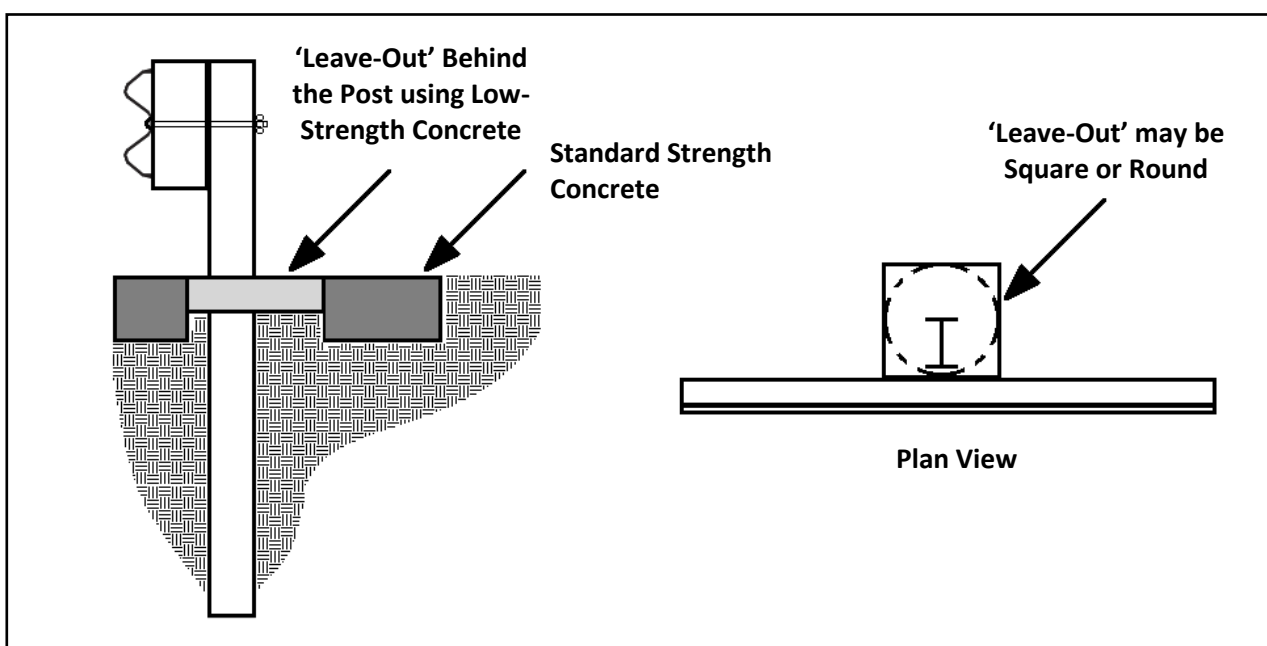


Figure 6: Recommended Post Set-Out for Placement in a Paved Area

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6.5 Variable Flare

The FLEAT-SP is classified as a flared end terminal and is installed gradually tapering away from the roadway.

The flare follows a straight alignment and is not a parabolic flare used for non-energy absorbing terminals such as the MELT and BCTA. This makes the FLEAT-SP an easier to install system.

The FLEAT-SP can be flared to achieve an offset of between 760mm to 1220mm over the TL3 terminal length of 11.43m.

When using a 7.62m TL2 FLEAT-SP, the offset is between 510mm and 810mm.

Positioning the impact head further away from the edge of the travelled way reduces the potential for nuisance impacts.

The flare commences at the splice connection between the FLEAT-SP and the downstream guardrail. The straight flare is achieved by setting back each post and tightening of the bolts.

6.6 Placement on Curves

When the FLEAT-SP is installed at the end of a guardrail system following a curved alignment, the FLEAT-SP must be installed along a straight flare over the length of the terminal.

6.7 Length Between Terminals

The recommended minimum length of a w-beam guardrail barrier is generally 30m (includes the length of the terminals), although this may vary depending upon the design speed. There is no limitation on maximum length of a w-beam guardrail barrier.

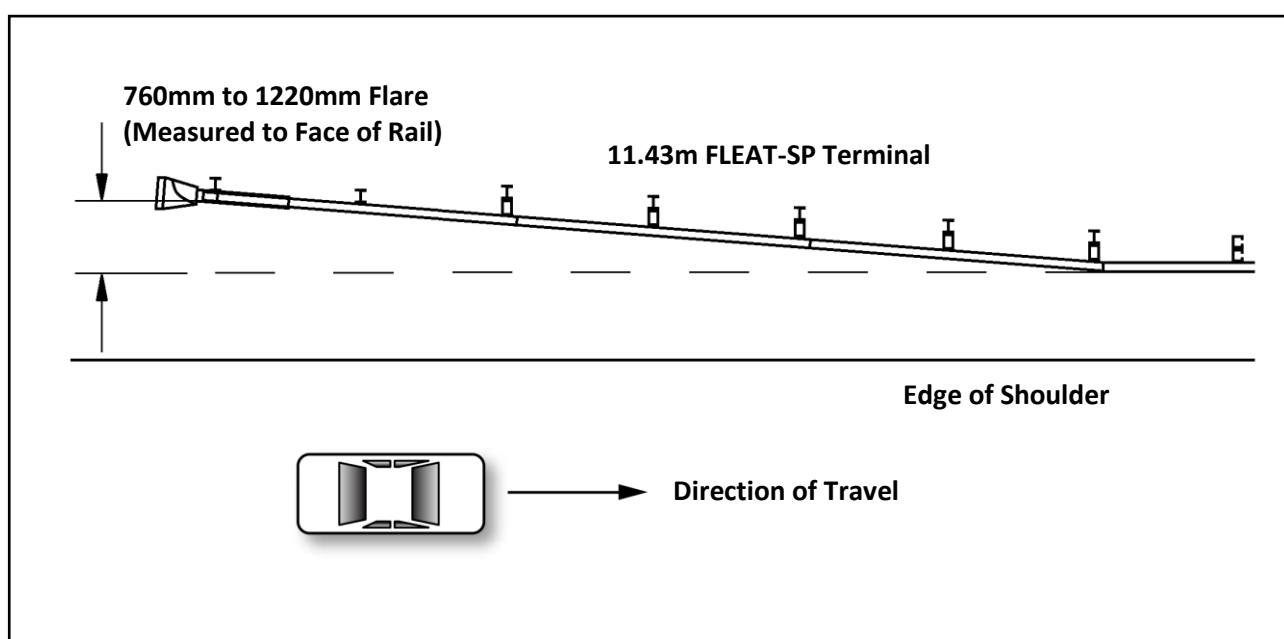


Figure 7: Straight Flare Set-Out

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7.0 Summary

- The FLEAT-SP is fully compliant to NCHRP Report 350. The terminal is available as an 11.43m TL3 compliant system or a 7.62m TL2 compliant system.
- Components used for the assembly of the FLEAT-SP are interchangeable with the SKT-SP with the exception of the impact head. This significantly reduces inventory requirements.
- The specially engineered impact head features high strength steel construction.
- The impact head design improves performance and absorbs the kinetic energy of the impacting vehicle at a more controlled rate. This results in lower ride down deceleration forces.
- The FLEAT-SP can be installed along a variable straight flare of between 760mm and 1220mm over the 11.43m laying length.
- The straight flare feature positions the impact head further away from approaching traffic, minimising the potential for head-on impacts.
- Introducing a flare into the design of the barrier system reduces the overall length of the system required to shield roadside hazards.
- The FLEAT-SP dissipates energy during head-on impacts and brings errant vehicles travelling at high-speeds to a controlled stop over a short distance. This feature reduces the frequency an errant vehicle may pass behind the system.
- Steel components are hot dip galvanised providing durability.

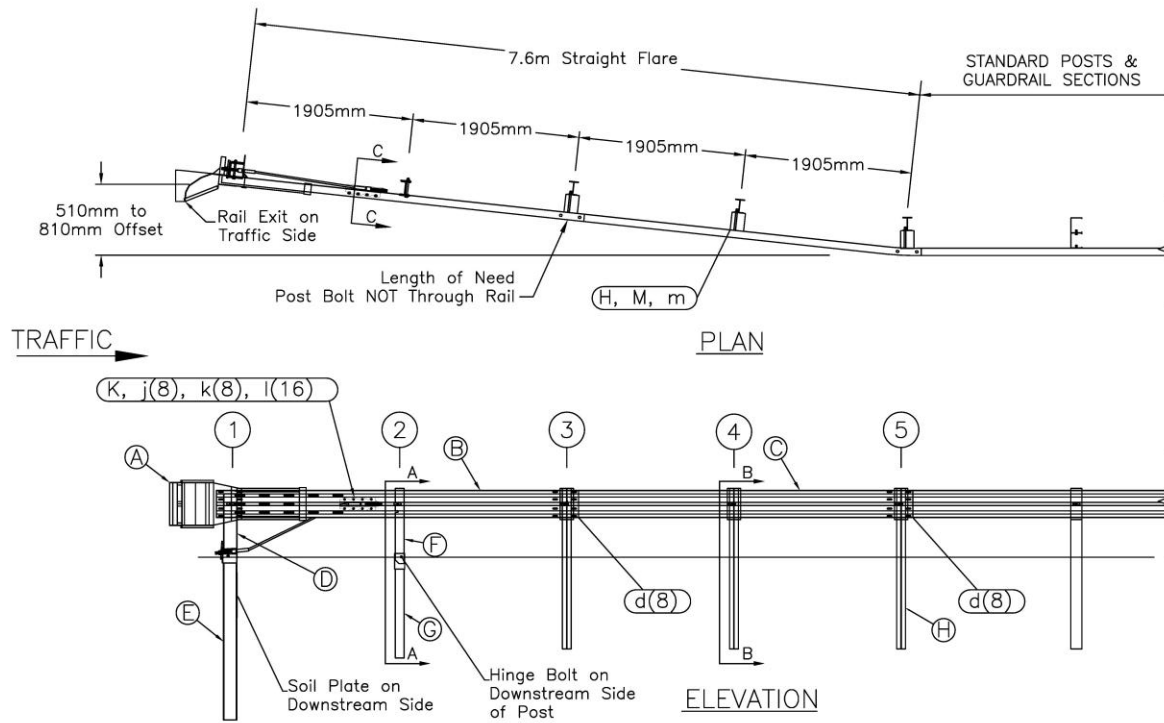


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8.0 Designers Checklist

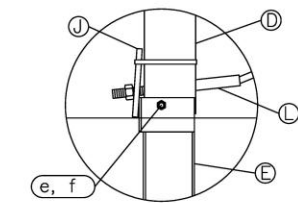
- Determine the design speed and select the most appropriate FLEAT-SP configuration i.e. 7.62m TL2 terminal or 11.43m TL3 terminal.
- Calculate the beginning length-of-need required to shield the roadside hazard.
- Ensure the FLEAT-SP point-of-need is appropriately aligned with the site beginning length-of-need. Refer to example shown in Figure 1.
- Calculate the clear zone width and determine whether a FLEAT-SP is also required on the trailing end. Refer to example shown in Figure 2. Note that some Australian jurisdictions may require a FLEAT-SP on both the leading and trailing end when a barrier system is installed on an undivided roadway. This is regardless of whether the trailing end is located outside the clear zone of approaching traffic.
- Ensure appropriate grading is provided in advance and adjacent to the FLEAT-SP. Refer to examples shown in Figures 4 and 5.
- Provide a suitable run-out area for impacts occurring prior to the terminal point-of-need. As a minimum the area immediately behind the FLEAT-SP should at least be similar in character to adjacent unshielded roadside areas.
- Ensure the FLEAT-SP is set-out on a straight flare of between 760mm and 1220mm over the 11.43m laying length. Refer to Figure 7. If using a 7.62m FLEAT-SP, the set-out of the straight flare is between 510mm and 810mm.
- If the FLEAT-SP is used to terminate a guardrail system following a curved alignment, ensure the set-out of the FLEAT-SP follows a straight flared alignment and does not incorporate the use of curved rails.
- Ensure the guidelines for minimum length between terminals is observed.
- If a paved area is proposed beneath the FLEAT-SP, provide a 'leave-out' behind each post that will allow at least 180mm of post deflection at ground line. Refer to Figure 6.
- On high-speed roads, provide a shallow gutter or subsurface grated drainage as an alternative to a kerb.
- Undertake a risk assessment if pedestrians and/or cyclists will be accessing the area around the terminal.



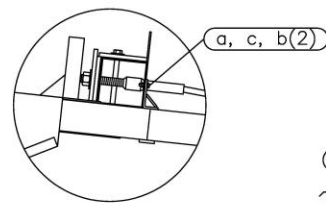
ITEM	QTY	BILL OF MATERIALS	ITEM NO.
A	1	FLEAT IMPACT HEAD	GE-EF-MX-4444-AG
B	1	SLOTTED ANCHOR RAIL	GE-WB-SR-3810-BG
C	1	W-BEAM GUARDRAIL 3810	GR-WB-SR-3810-AG
D	1	TOP POST 1	GE-PG-IS-0650-BG
E	1	BOTTOM POST 1	GE-PG-IS-1900-BG
F	1	TOP POST 2	GE-PG-IS-0700-AG
G	1	BOTTOM POST 2	GE-PG-IS-1100-AG
H	3	STEEL LINE POST	GE-PG-IS-1830-CG
J	1	BEARING PLATE	GE-EF-MX-0011-AG
K	1	ANCHOR CABLE BRACKET	GE-EF-MX-0015-AG
L	1	CABLE ASSEMBLY	GE-EF-MX-2000-AG
M	3	COMPOSITE BLOCK	GE-BL-SS-0310-AS
HARDWARE			
a	2	5/16" x 1" HEX BOLT	GE-FS-56-0001-HG
b	4	5/16" WASHER	GE-FS-56-0000-AG
c	2	5/16" NUT	GE-FS-56-0000-HG
d	17	M16 x 32mm SPLICE BOLT/NUT	GR-FS-16-0016-MG
e	1	M16 x 220mm BOLT/NUT/WASHER	GE-FS-16-0220-HG
f	1	M16 WASHER	GE-FS-16-0000-CG
g	1	M20 x 220mm BOLT/NUT/WASHER	GE-FS-20-0220-HG
h	1	M20 WASHER	GE-FS-20-0000-BG
j	8	1/2" x 1 1/4" ANCHOR BRACKET SHOULDER BOLT	GE-FS-12-0114-HG
k	8	1/2" ANCHOR BRACKET NUT	GE-FS-12-0000-HG
l	16	1/2" ANCHOR BRACKET WASHER	GE-FS-12-0000-AG
m	3	M16 x 255mm POST BOLT/NUT	GE-FS-16-0255-NG

NOTES:

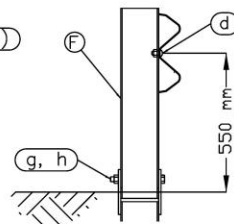
- THE LOWER SECTIONS OF POSTS 1 & 2 SHALL NOT PROTRUDE MORE THAN 100mm ABOVE GROUND.
- THE CABLE ASSEMBLY MUST BE TAUT.



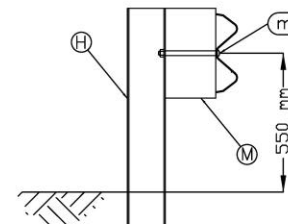
Post #1 Connection Detail



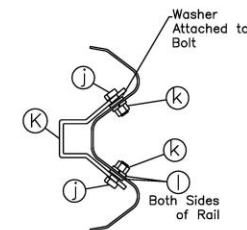
Impact Head Connection Detail



SECTION A-A
Post #2



SECTION B-B
Posts #3 thru #5



SECTION C-C
Anchor Bracket



DRAWING
DESCRIPTION

DRAWING
REFERENCE

NCHRP-350 TL2 FLEAT-SP TERMINAL

K-FLEAT SP TL2

DRAWN BY	AUSTEC DRAFTING	DIMENSIONS	mm
CHECKED	H. WALLACE	SCALE	NTS
APPROVED	T. COLQUHOUN		

REV	DATE	DESCRIPTION	DRAWN	APPRD.	REV	DATE	DESCRIPTION	DRAWN	APPRD.
E	03.09.14	REISSUED FOR APPROVAL	DB	TC					
D	21.05.13	ISSUED FOR APPROVAL	DB	TC					
C	23.04.13	REVISED AND ISSUED FOR REVIEW	DB	TC					
B	14.03.13	INITIAL ISSUE	DB	TC					
A	12.03.13	ISSUED FOR REVIEW	DB	TC					

FLEAT-SP

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