



HIGHWAYS DEPARTMENT

**GUIDANCE NOTES
ON
LOW NOISE ROAD SURFACING**

Research & Development Division

**RD/GN/011C
November 2016**

1. Introduction

- 1.1 Guidance notes RD/GN/011B were issued in July 2001 introducing different types of low noise road surfacing (LNRS) (formerly called noise reducing road surfacing) and their application as mitigation measures on reducing the traffic noise induced by the interaction between road surface and vehicle tyres.
- 1.2 In 2000s, a trial programme on the use of polymer modified friction course (PMFC) as LNRS on local roads was jointly conducted by HyD and EPD. In parallel, EPD engaged overseas expert to review the use of LNRS in Hong Kong and benchmark the experiences in overseas countries. Based on the findings in the trial programme and overseas experiences, the technical application criteria of using PMFC as LNRS on local roads recommended in RD/GN/011B were revised and endorsed by the senior management of HyD and EPD in 2015.
- 1.3 Since 2013, HyD and EPD jointly explored the potentials of “thin surfacing”, essentially in the form of stone mastic asphalt of nominal maximum aggregate size of 6mm, as an alternative LNRS for local roads. Several trial sections have been laid and are being monitored.
- 1.4 This set of guidance notes supersedes RD/GN/011B and updates the technical guidelines on application of PMFC as LNRS and also delineates the latest development of “thin surfacing”.

2. Noise Generated from Traffic

- 2.1 Noise from road traffic has become a very contentious environmental issue. Reducing traffic noise is a subject of understanding the tyre/road/vehicle/noise generation mechanisms and is of an inter-disciplinary nature. The quality of the road surface, tyre design, vehicle system and speeds all have an effect on traffic noise.
- 2.2 Where traffic speeds are lower than 50 km/h, traffic noise is mainly attributable to engine, transmission and exhaust noise, especially from lorries and buses. Where speeds are higher, the major component of traffic noise comes from the tyre/road interaction. This noise comes from, amongst other things, vibration of the tyre wall, compression of air within the contact area of the tyre with the road surface, and the snapping out of the tread blocks as they leave the road surface.
- 2.3 The road surface texture plays a significant role in the tyre/road noise generation mechanism. A rougher surface increases the contact patch, which exacerbates tyre/road noise as the noise is relative to the length of the escape path for the trapped air. At high speed the compression and release of air trapped under the tyre is a significant component of tyre noise. Road surfaces with negative macrottextures (the depth of texture below the road surface) allow air trapped beneath the tyre to escape and hence reduce the amount of noise generated by reducing the air pressures within the contact area. This alleviating effect will be more significant if there is sufficient interconnection between the voids below the running surface.
- 2.4 During wet weather, noise can be generated by traffic as a result of spray generated by moving vehicles. Apart from road safety consideration, provision of an effective path for rapid draining of water from the road surface can reduce the incidence of noise caused by the generation of spray.

3. Low Noise Road Surfacing Materials

3.1 It is worth noting that application of LNRS is just one form of noise mitigation measures and different types of LNRS would have their respective limitations. A holistic approach should be adopted while exploring and designing suitable measures for tackling road traffic noise issues. The primary objective of road maintenance is to maintain the integrity of the road network with particular emphasis on safety and serviceability. Normally, HyD is not expected to carry out any maintenance works solely for restoring the noise reducing performance of LNRS. Any proposed application of LNRS should take this into consideration.

3.2 Polymer Modified Friction Course

Friction course, a porous type of bituminous surfacing, was originally designed to improve skid resistance by virtue of its open texture. Because of the acoustic absorption and rapid drainage properties of the material, it has been revealed by overseas researches that porous friction course can also reduce traffic noise induced by the interaction between road surfaces and vehicles tyres of high speed traffic. Porous friction course, when newly laid, is currently the quietest material with an initial reduction in noise (compared to intact traditional bituminous surfacing) of about 4 to 5dB(A). The noise reduction effect will deteriorate gradually as clogging up of the voids and secondary compression of the surfacing occur over the service life. Furthermore, the interconnected voids allow excellent access to air, so ageing and embrittlement is potentially exacerbated. With an aim to improving its durability, the general use of polymer-modified binder in producing porous friction course, i.e. polymer modified friction course (PMFC), was promulgated in 2007 under HyD Guidance Notes RD/GN/032.

3.2.1 *Previous Trials*

A trial overlay of PMFC on a section of Island Eastern Corridor was conducted in 1987 to study its traffic noise reduction performance. A noise reduction of about 5dB(A) was measured immediately after completion of the overlay. However, the noise reduction effect decreased gradually to 2dB(A) towards the end of life cycle of the friction course, probably due to gradual reduction in porosity by virtue of secondary compression and clogging up of the pores with detritus.

From mid 1990s to early 2000s, the trial of PMFC was further extended to local road sections. Noise monitoring revealed that PMFC on local roads achieved an average of 2.7dB(A) noise reduction initially with a decreasing rate of 0.14dB(A) per year while the durability was greatly affected by the road characteristics and traffic condition. Defects, like reflective cracks, were commonly observed on PMFC overlaid on jointed concrete pavements, especially along isolation joints and expansion joints. On road sections with sharp turning, frequent stop and go, run in/out of carparks, roadside parking spaces and bus stops, premature defects in form of ravelling and potholes were generally found. It has been concluded that free flow traffic is a pre-requisite for PMFC to perform well in both material durability and noise reduction perspectives, while overlay on concrete pavement is likely to cause premature surface distress.

3.2.2 *Application of PMFC on Expressways and High Speed Roads*

Primarily for road safety considerations, PMFC is stipulated as the standard surfacing material for expressways and high speed roads in the territory, with nominal layer thickness of 30mm. Details should be referenced to RD/GN/032.

3.2.3 *Application of PMFC on Local Roads*

Based on technical understanding and overseas experiences coupled with site observations in local trials, 30mm thick PMFC is only advisable on relatively free flow trafficked bituminous local roads. In general, PMFC shall not be considered for local roads with any of the following conditions:

- With vertical gradient larger than 5 %;
- With frequent sharp turning/braking expected (e.g. run-in/out of carpark, busy bus stops);
- With frequent roadside parking (e.g. parking space, designated loading/unloading area, busy street-side commercial or industrial activities etc.);
- Short distance between junction/signalized crossing/zebra crossing and the next stop line (i.e. less than the order of 300 m); or
- On jointed concrete pavement

In applying 30mm thick PMFC on a relatively free flow trafficked road section, the following areas should nonetheless be excluded:

- Braking zone, normally taken as 50 m before the stop line of junction/signalized crossing/ zebra crossing
- Junction area
- Accelerating zone, normally taken as 50 m from the junction/signalized crossing/ zebra crossing

Notwithstanding the above technical application criteria, local experiences and other engineering considerations shall be taken into account in examining proposals to apply PMFC on local road sections. In the event that satisfaction to all the above technical application criteria cannot be fully substantiated and the use of 30mm thick PMFC as LNRS in a new project is proposed, the project proponent should demonstrate to the HyD Regional Office that, amid others, free flow traffic similar to high speed roads will be achieved and frequent resurfacing of PMFC is not required.

3.2.4 *Retrofitting of PMFC on Existing Roads*

For at-grade carriageway and flyover with buried joints, the top 25mm of the existing bituminous surfacing layer or the whole thickness of the existing surfacing if its nominal thickness is less than 50mm, shall be milled off and regulated with 10mm nominal size wearing course material specified in Section 9 of the latest General Specification for Civil Engineering Works. A 30mm thick PMFC shall be added as the uppermost pavement layer.

For flyovers with exposed joints, inlay of bituminous surfacing material shall be adopted. If the nominal thickness of the existing bituminous surfacing material is not less than 100mm, the top 55mm material shall be milled off, regulated with 25mm thick 10mm nominal size wearing course and 30mm thick PMFC. Otherwise, the top 50mm material shall be milled off and laid with 20mm thick 3.35mm nominal size polymer modified cushion course and 30mm thick PMFC. Design requirements for 3.35mm nominal size polymer modified cushion course are included in Table 1.

3.3 Thin Surfacing

“Thin surfacing” refers to a thin layer of non-porous bituminous surfacing (typically 25mm thick) made of relatively fine and gap-graded aggregates (nominal maximum aggregate size of 6mm). An optimised texture, which is smooth enough in minimizing tyre vibration and with small open texture to reduce air pumping, gives the surfacing certain noise reduction potential. Such noise reduction mechanism could be more sustainable than PMFC. In general, its noise reduction ability would be significantly reduced only when substantial surface defects, like raveling and potholes, are developed. Thin surfacing is not applicable to jointed concrete pavement as reflective cracks will propagate along the underlying concrete joints affecting its overall durability.

To evaluate the applicability of “thin surfacing” on local roads in Hong Kong, a trial commenced in 2013 in which several trial sites were selected and laid with polymer modified stone mastic asphalt of 6mm nominal maximum aggregate size (PMSMA6). During the ongoing process of the trials, the performance of the trial sites is being monitored regularly with a view to determine the technical application criteria of PMSMA6 after concluding the trials should the material is found suitable. At this moment, however, promising findings of the trials have yet to be established and such technical application criteria of PMSMA6 are still undetermined.

Other types of PMSMA/SMA are generally not considered as LNRS.

4. **Other Considerations for Applying LNRS**

The following factors should be considered while designing the application of PMFC.

4.1 Additional Loading on Structures

Any overlay will increase the superimposed dead load of an existing structure. Confirmation must be obtained from CHE/B&S that the structure (e.g. flyover, viaduct) can withstand the additional loading. Raising of gully gratings and rodding eye covers in accordance with paragraph 4.2 usually have negligible effect on a structure. However, CHE/B&S should be consulted if it is considered to be relevant.

4.2 Road Pavement Drainage

Gully gratings wholly or partly lying inside the carriageway shall be raised to match with the overlay material using details shown in HyD Standard Drawing H3106A and sketches GN/011/02B & 03B. If the gratings are outside the carriageway, raising of the gratings will not be required. If appropriate, rodding eye covers shall be raised using details shown in drawings GN/011/04B. For at-grade carriageway, raising of kerbs, footways and central dividers due to the application of the overlay will not normally be required. Nonetheless, the flood water may overtop the “lowered” kerb causing flooding to adjacent land or properties. Project proponents should check the flood height in accordance with RD/GN/035 to ensure the flow height will not exceed the kerb height under the ultimate limit state.

For road sections with crossfall less than 2.5% where flood water cannot be effectively drained to roadside gullies, project proponent should examine and address the risk of flooding in PMFC layer.

Furthermore, the existing/raised bridge joint may obstruct surface water draining through the PMFC. Provision of gullies should be considered as ponding may occur at the bridge

joint if there is no gully to collect the rainwater draining along the joint. The design of such drainage system should be responsible by project proponents.

4.3 Reduced Parapet or Kerb Height

The thickness of overlay should be minimised as it reduces the height of upstand of barriers and kerbs. The height of vehicular bridge parapet wall, after overlay, shall comply with the Structures Design Manual for Highways and Railways published by HyD. The required minimum parapet height must still be maintained after overlaying on the adjacent road surface.

4.4 Bridge Joints

LNRS overlaid on concrete surface of the bridge structure with buried joints would be vulnerable to reflective cracking and is therefore not recommended. For raising existing expansion joints, the reference level for the overlay surface should make reference to the future joint level in order to maintain a smooth riding road surface. CHE/B&S should be consulted with the proposed works.

4.5 End Details

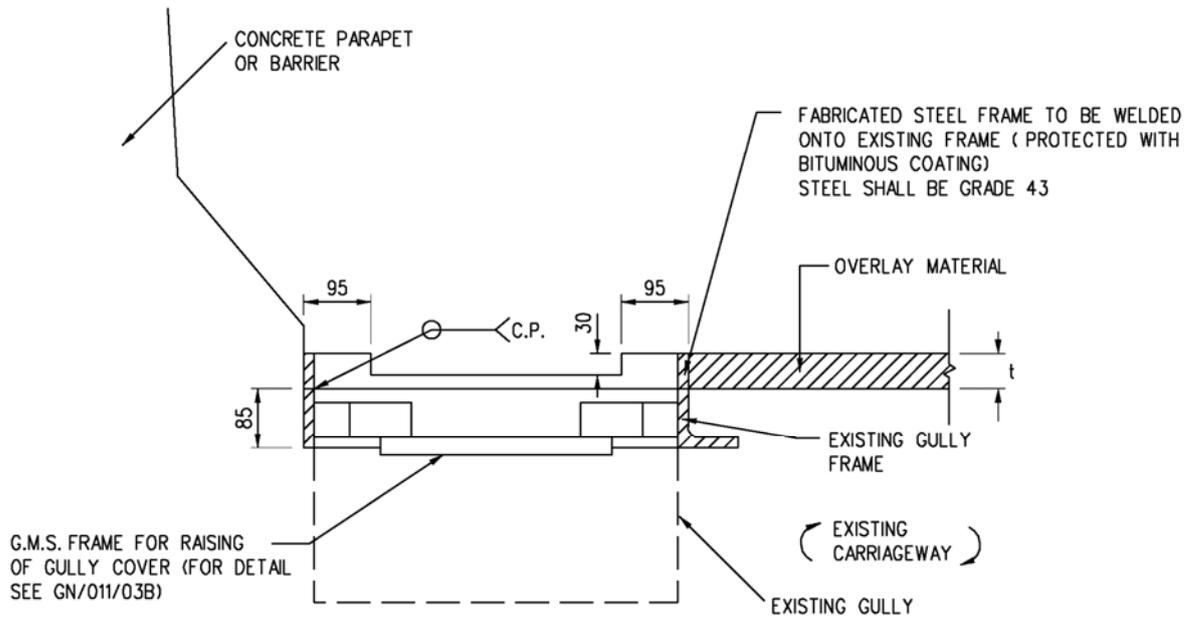
At ends of overlay, detail shown in drawing GN/011/07B should be adopted for flyovers with concrete surfacing. For carriageways with flexible surfacing, the end ramps should be formed by suitable material. It may be necessary to mill off the existing surfacing at the ramps to accommodate the minimum thickness of the new material forming the ramp.

It should be noted that surface water drains through PMFC and flows along the surface of the underlying layer according to the road gradient. The ramp at the end of the overlay will stop the flow at the underlying layer. It is therefore important to stop the downstream end of the overlay at the location of a gully and/or install sufficient gullies at the downstream end of the overlay to avoid the accumulation of surface water which may in turn cause premature deterioration of PMFC.

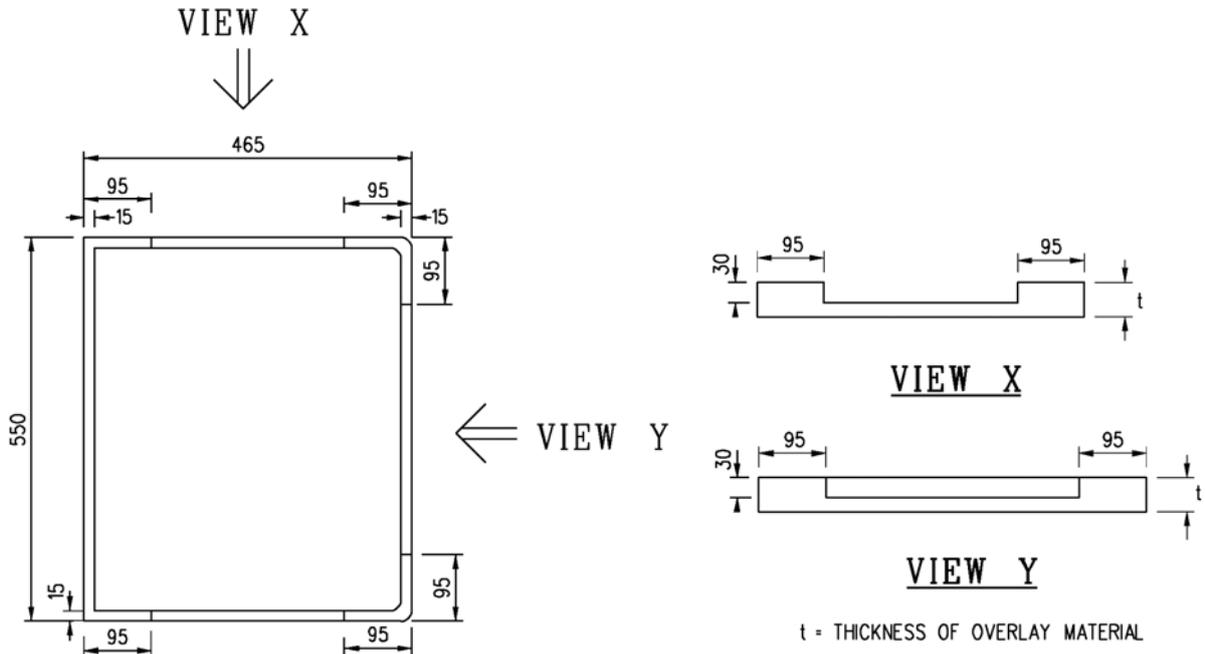
TABLE 1
 POLYMER MODIFIED CUSHION COURSE: -
DESIGN LIMITS FOR PARTICLE SIZE DISTRIBUTION, BITUMEN CONENT AND
 MARSHALL QUOTIENT

Properties		Cushion course
Nominal maximum aggregate size (mm)		3.35
	BS test sieve	Percentage by mass passing
Particle size distribution	6.3 mm	100
	3.35 mm	95 - 100
	1.18 mm	55 - 75
	300 μm	25 - 35
	75 μm	10 - 20
Bitumen content as % of total mass including binder, but excluding polymer	min	9.5
	max	11
Marshall Quotient (kN/mm) = $\frac{\text{Marshall Stability}}{\text{Flow}}$		0.7 - 1.2

Note : The above mix design requirements are for reference only and are subject to change. Engineers may wish to consult the Research and Development Division for obtaining the latest mix design requirements.



DETAILED SECTION OF RAISED GULLY FRAME
(GULLY GRATING TYPE GA1 - 450 SHOWN)

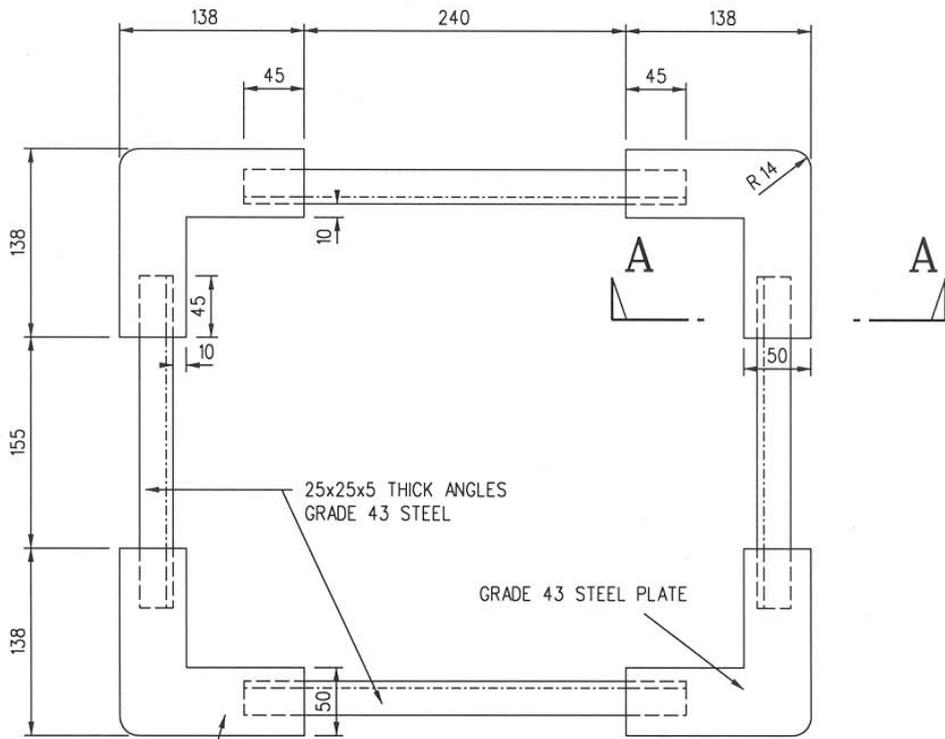


PLAN OF FABRICATED STEEL FRAME

NOTES: DIMENSIONS ARE IN MM

RAISED GULLY FRAME

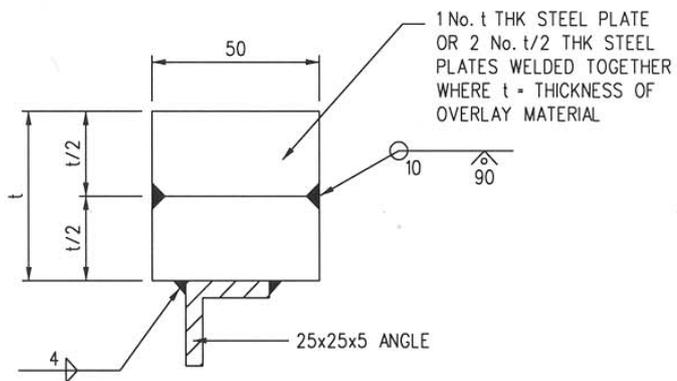
B	Raised gully frame revised		Mar 00
REF.	REVISION	SIGNATURE	DATE
HIGHWAYS DEPARTMENT			
REFERENCE		DRAWING No.	CAD
SCALE		GN/011/02B	
1 : 10			



THE WHOLE FRAME SHALL
BE HOT-DIP GALVANISED
AFTER FABRICATION

PLAN

SCALE 1 : 5



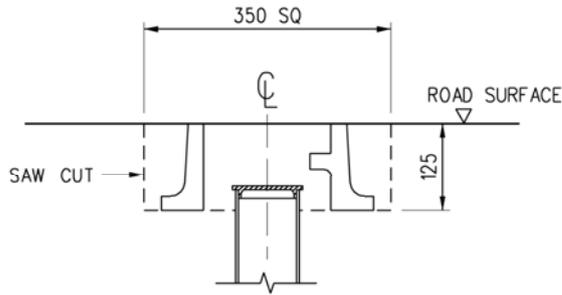
SECTION A - A

SCALE 1 : 2

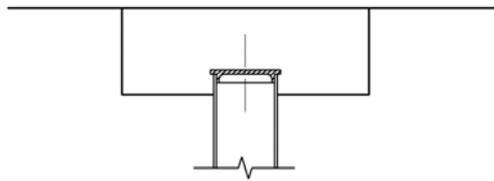
NOTES: DIMENSIONS ARE IN MM

**G.M.S. FRAME FOR
RAISING OF
GULLY GRATING
(TYPE GA1 - 450 SHOWN)**

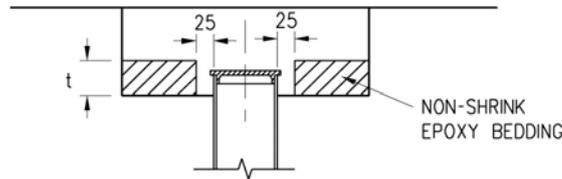
B	General revision		Mar 00
REF.	REVISION	SIGNATURE	DATE
HIGHWAYS DEPARTMENT			
REFERENCE	DRAWING No.	CAD	
SCALE	AS SHOWN	GN/011/03B	



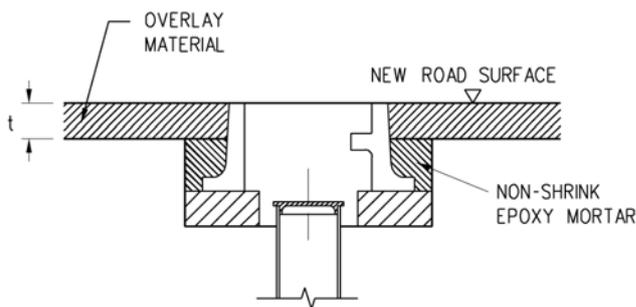
1. SAW CUT TO THE BOTTOM OF THE RODDING EYE COVER (APPROX. 125mm) CARE MUST BE EXERCISED IN SAW CUTTING AND BREAKING UP CONCRETE TO AVOID DAMAGE TO THE REINFORCEMENT AND DOWN PIPE AND TO ENSURE NO MATERIAL FALLS INTO THE RODDING EYE.



2. TAKE OFF THE RODDING EYE COVER BY HAND TRIMMING



3. ADJUST THE LEVEL OF THE COVER WITH NON-SHRINK EPOXY BEDDING



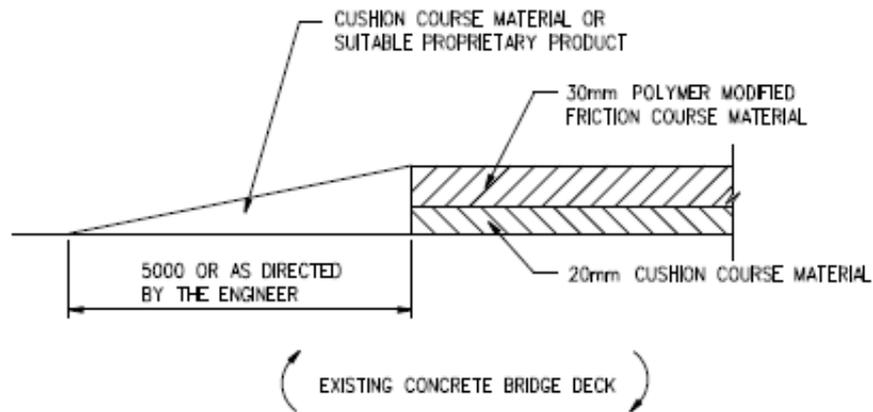
4. INSTALL NEW RODDING EYE COVER TO H3114A & H3115A

t = THICKNESS OF OVERLAY MATERIAL

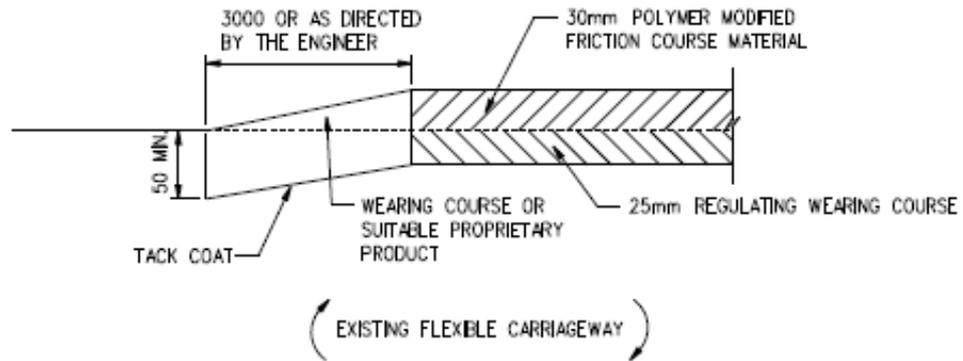
NOTES: DIMENSION ARE IN MM

DETAILS OF RAISING RODDING EYE COVER

B	GENERAL REVISION		MAR 00
REF.	REVISION	SIGNATURE	DATE
HIGHWAYS DEPARTMENT			
REFERENCE		DRAWING No.	CAD
SCALE 1 : 10		GN/011/04B	



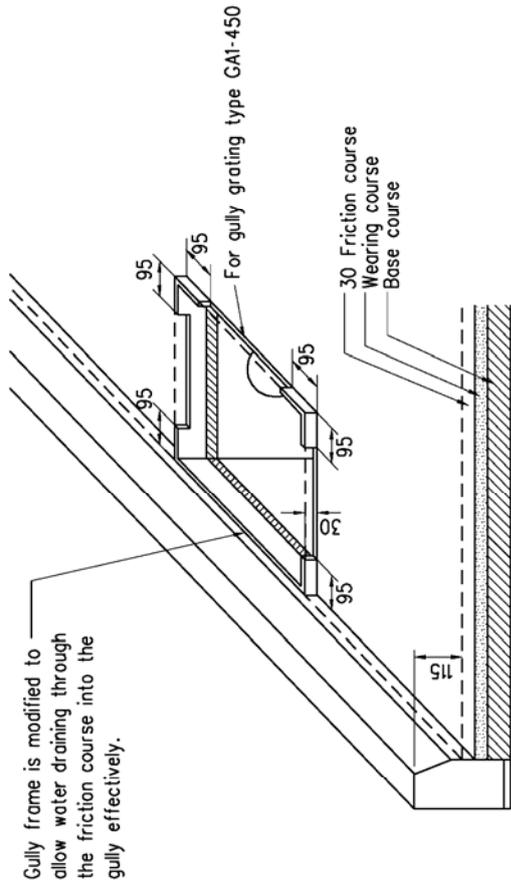
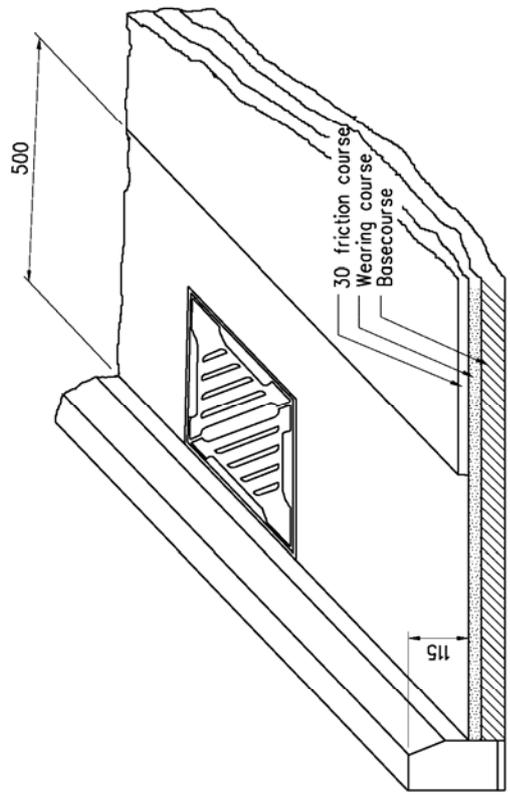
FOR CONCRETE BRIDGE DECK



FOR FLEXIBLE CARRIAGEWAY

DETAILED SECTION
OF STOP ENDS

C	ALLOW FLEXIBILITY TO ADOPT, SUITABLE PROPRIETARY PRODUCT TO FORM RAMP		APR 16
REF.	REVISION	SIGNATURE	DATE
HIGHWAYS DEPARTMENT			
REFERENCE	DRAWING No.	CAD	
SCALE	HOR. 1:100 VERT. 1:5	GN/011/07C	



**CARRIAGEWAY WITH HARD SHOULDER
EQUAL TO OR WIDER THAN 2500MM**

**CARRIAGEWAY WITHOUT HARD SHOULDER
OR WIDTH OF HARD SHOULDER IS LESS THAN 2500MM**

Notes :

1. Dimensions are in millimetres.
2. Kerb overflow weir may be required but is not shown for clarity.

A	Gully frame revised	Mar 00
	Former drg. no. H3003/2 with general revision	June 94
REF.	REVISION	SIGNATURE DATE

**INSTALLATION OF GULLY GRATINGS IN
FLEXIBLE PAVEMENTS WITH FRICTION COURSE**

HIGHWAYS DEPARTMENT	
REFERENCE	DRAWING No. CAD
SCALE	H 3106A
	Diagrammatic