Department for Transport

Traffic Advisory Leaflet 1/05

Rumblewave Surfacing

Reading Road North

Introduction

The Highways (Traffic Calming) Regulations 1999 allow local authorities to construct rumble devices. These rumble devices are interpreted as "a part of the carriageway constructed of a material intended to generate noise or vibration in a vehicle passing over it". Technical advice on the construction of rumble devices is contained in Traffic Advisory Leaflet 11/93.

Rumble devices are designed to provide a vibratory and/or audible effect. They are intended to alert drivers to take greater care in advance of a hazard such as a bend or junction, and to help in reducing vehicle speeds. Reliance should not be placed on such traffic calming surfaces alone when seeking speed reduction.

Traditional rumble devices, particularly rumble strips, can generate considerable external noise over a large area. The Department's advice is that that the siting of rumble strips close to residential properties should be avoided.

This leaflet describes a traffic calming surface profile that has been developed as a quieter alternative to conventional rumble strips, and is considered suitable for residential areas. TRL Ltd was commissioned to develop a profile that would create noise and vibration within vehicles passing over it, but not increase noise levels significantly for those outside the vehicles.

January 2005

Traffic Advisory Unit

Development of the surface profile

Two main factors were considered important and led to the selection of a sinusoidal profile:

1. Keeping the height of any profile small, while maximising the transmission of tyre vibration into the vehicle.

2. Reducing tyre vibration to relatively low frequencies, to prevent audible sound being generated.

A series of sinusoidal profiles were laid on the TRL test track, with wavelengths ranging from 0.05m to over 4m. Initial testing indicated that profiles with the shorter wavelengths (less than 0.35m) produced an appreciable increase in exterior noise, whilst the profiles with the longest wavelengths had no appreciable effect on interior noise and vibration. It was therefore decided that the middle range of wavelengths was the most suitable for minimising the noise impact on local residents, while still alerting the driver of the vehicle to the hazard ahead. Subsequent testing indicated that a wave height of more than 4mm was needed to provide an alerting effect that was deemed to be sufficiently noticeable to drivers.

Sinusoidal profiles with wave heights greater than 6-7mm may produce a greater alerting effect to drivers but are likely to generate more external noise. They should not be used on highways without conducting handling trials using a range of vehicles.

Vehicle Handling: Braking, weaving and turning manoeuvres were carried out on the recommended profile at the TRL test track, using a variety of vehicles from two-wheelers to a 17-tonne truck. No loss of control was observed and braking performance was similar to that on a flat surface. There were also no handling problems reported at the pilot sites, although one driver of a mini (original design) did report considerable vibration.

Recommended Profile

A profile with a wave length of 0.35m and a wave height of 6-7mm is recommended (see figure 1). This profile produces the largest increases in interior noise and vibration in a range of vehicle types, and creates little increase in exterior noise levels. This sinusoidal profile does not require special authorisation as the dimensions fall within those allowed under the Highways (Traffic Calming) Regulations 1999, provided that no part of the device is more than 15mm above the surface of the carriageway and there are no vertical upstands exceeding 6mm. At the beginning and end of the traffic calming surfacing, the material should blend as smoothly as possible into the existing road surface and ramps over 1m long are recommended.

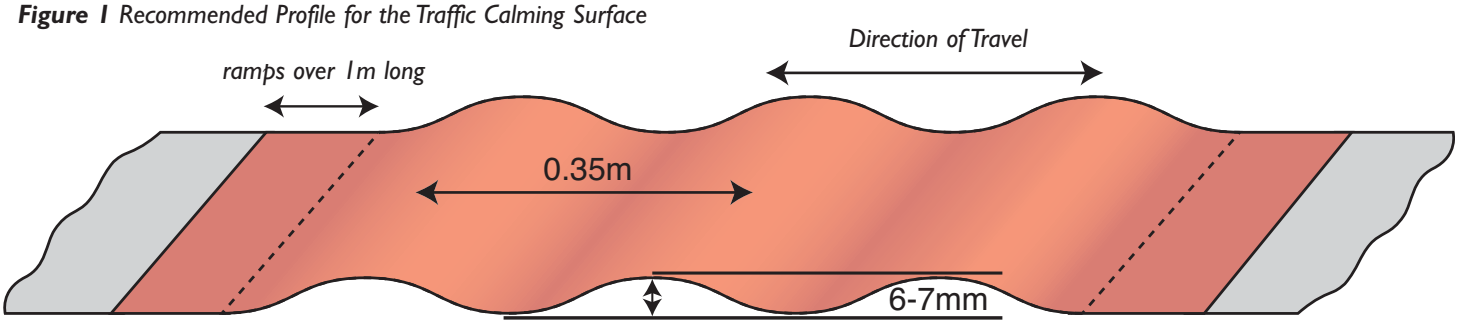
Design Considerations

The choice of the most appropriate layout for the traffic calming surface will, in part, be dependent on local circumstances. The following should therefore only be considered as general advice:

Site supervision: It is important that construction is properly supervised to ensure the correct profile is achieved.

Motorcycle handling trials at TRL

Figure 1 *Recommended Profile for the Traffic Calming Surface*



Note: This diagram is not to scale, the typical number of corrugations in a 22m section would be 57.

Full or Half-width: Although the surface may be constructed over half of the carriageway, it is recommended that it be applied across the full width of the carriageway unless there is central hatching or a physical barrier preventing vehicles crossing to the other side of the road.

Location: Like any traffic calming surface, the rumblewave profile may be used as an alerting feature in advance of hazards such as bends or junctions, when the surfacing should be sited in obvious relationship to the signing of the hazard. It is not recommended for use on the bends themselves, nor at pedestrian crossing points, as the uneven surface could present a trip hazard.

Rumblewave surface treatment has been trialled at a number of sites in Hampshire with 85th percentile speeds between 30 and 45mph; no systematic testing has been carried out at speeds exceeding this. The surfacing is not currently recommended for use in areas where speeds are higher than this. Where there are higher speeds, traffic calming measures should be implemented first to reduce them to below 45mph.

Signing: As with other rumble devices, it is not essential to have warning signs in advance of a rumblewave pad. However, in some cases the local authority may wish to use additional signing to warn the driver of traffic calming features ahead. In this instance diagram 883 in the Traffic Signs Regulations and General Directions (TSRGD) is recommended (see figure 2).

***Figure 2** Warning of the start of traffic calming measures*

Surfacing should be sited in obvious relationship to the signing of the hazard.

NOTE: To avoid distracting attention from speed limit signs, it is recommended that they are not co-located with warning signs.

Length and pattern of surfacing: Rumblewave pads have been laid at seven pilot sites. These included sites with varying reasons for pad implementation and speed limits. The treatments installed have varied in number, length and spacing (see table below). The effect of different dimensions or spacing has not been clearly established.

Rumblewave pilot sites

Site name	Reason for implementation	Vehicle flow	Speed limit	Number of rumblewave sections	Length of rumblewave sections	Spacing of rumblewave sections
Trunk Road, Cove	To alert drivers to a bend on a local distributor road	4200 per day	30mph	1	20m	N/A
Reading Road North, Fleet	Change from 40mph to 30mph speed limit on a semi-urban major approach road	9200 per day	40mph-30mph	1 initially, 1 eight months later	22m	100m
Riders Lane, Havant	Residential estate with low speed limit and no other speed reducing features	1300 per day	20mph	4	12m, 17m, 2 x 22m	56-92m depending on junctions
Rowner Road, Gosport	High flow link road with high pedestrian and cycle flow, accident numbers were high	21500 per day	30mph	9	7 x 12m, 15m, 18m	0-196m depending on junctions, refuges, etc.
Tukes Avenue, Gosport	Residential area with school and shops suffering from rat running traffic. High accidents, especially pedestrian.	4100 per day	30mph	6	2 x 10m, 12m, 15m, 2 x 17m	83-209m depending on junctions
Forest Road, Denmead	Rural road approaching Denmead village, surfacing is situated where the speed limit changes from de-restricted to 40mph	3600 per day	60mph-40mph	2	22m	50m
Gudge Heath Lane, Fareham	Residential properties approximately 10m from road edge, high accident record	9600 per day	30mph	5	8m, 2 x 12m, 2 x 22m	92-245m depending on junctions

Cyclists: Highway authority designers should ensure that a smoother strip of the material, with a less aggressive surface profile, is provided to allow cyclists to pass over the feature with the minimum of discomfort. This strip should be tapered from a profiled to a smooth finish across its width to avoid any vertical upstand.

Cyclists may find the surface uncomfortable

Local authorities may wish to add road markings to guide cyclists to the smoother strip where a cycle lane is not present, as indicated in figure 3 below.

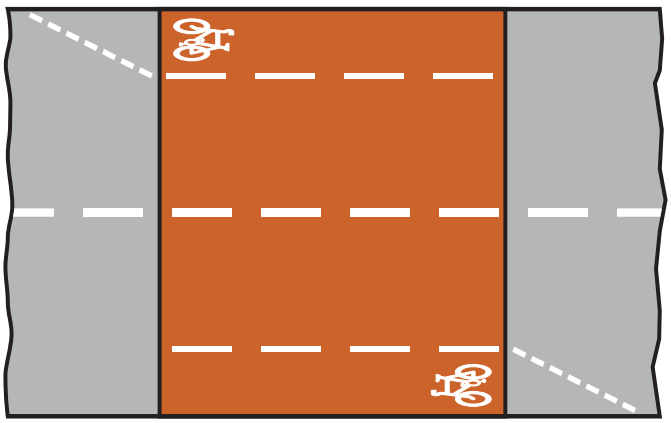


***Figure 3** Guidance of cyclists using diagram 1057 of the TSRGD, width 750mm.*

This would require a special direction if the upright signs (diagram 967) prescribed in the TSRGD were not to be used.

Drainage: As the surfacing is laid over the existing road surface, the road camber should prevent ponding in the corrugations. The smoother strip for cyclists will also allow water to flow along the carriageway.

Vibration: Although rumblewave surfacing has been seen to reduce noise and vibration for local residents compared to other rumble devices, these impacts are not completely eliminated. When considering a rumblewave scheme, factors such as the percentage of HGVs and the type of substrate should be examined, as they are when other vertical deflection measures are implemented (see TAL 10/00).

At some sites where rumblewave devices have been implemented, complaints concerning vibration have been received. TRL investigated this further by taking measurements in four homes where residents had complained of vibrations following the implementation of rumblewave devices, as well as alongside a rumblewave surface on a test track. Maximum vibrations created by heavy vehicles (representative of worse case conditions) were recorded at the trackside. This enabled development of an equation capable of calculating minimum distances that should be allowed between a rumblewave device and the nearest building.

The minimum façade / rumblewave pad separations to avoid vibration disturbance inside homes were then calculated for different ground conditions. These values are listed in the table below. These are for guidance only as there are uncertainties in the way buildings respond to vibration and the exact nature of the ground conditions. However, on most soils at distances in excess of 30m from the kerb there is unlikely to be a significant vibration problem.

Although vibration levels produced by rumblewave pads are well below those that could cause even minor damage there is a perception amongst the general population that if vibrations can be felt they must be having a deleterious effects on the building. For this reason it is advisable to reduce vibration levels below those that are likely to be perceptible by allowing sufficient distance between the rumblewave surfacing and the nearest façade.

Guide values for minimum distances to avoid vibration disturbance

Ground	Minimum distance (m)
Alluvium	105.8
Peat	30.8
London Clay	19.9
Sand/gravel	18.1
Boulder Clay	7.8
Chalk	4.7

Note that the minimum guide distances are based on the distance from the nearest façade to nearest wheel track for heavy vehicles on the rumblewave pad.

The ramps leading to the rumblewave surface can also generate vibrations and these vibrations can become perceptible on upper floors. The longer these ramps the smaller the vibration effect. Ramps less than 1m should be avoided, especially on softer soils.

At one study site at a distance of 14m from a rumblewave device on firm ground (chalk) no perceptible vibration was recorded and it was concluded that the occupant was responding to low frequency noise generated by vehicles passing over the device. A previous social survey reported a small number of complaints concerning increased noise following installation. All these respondents lived within 25m of the device. Therefore, to avoid both noise and vibration problems arising, it is recommended that rumblewave devices should not be placed closer than about 30m from the nearest house foundation. On soft ground such as peat and alluvium and ground of uncertain nature (e.g. infilled ground) greater separation distances will be required.

Benefits

Noise: The recommended surface profile developed by TRL produced significant increases in noise and vibration inside the vehicle and was rated 'noticeable' to 'very noticeable' by car and van drivers. At the pilot locations, recorded external noise levels did not change greatly after the implementation of the surface and appeared to be influenced more by meteorological conditions than by the new surfacing. Subjective assessments by a sample of residents living nearby the surfaces indicated that almost all had experienced limited or no noticeable change in noise or vibration indoors since the installation of the surface. Traffic noise levels were more noticeable when walking past the surfaces, and about one in six of the residents identified an increase in traffic noise when close to the surfaces.

Speed reductions: At all sites the automatic counters recorded overall decreases in mean speed of between 0.2 and 1.9mph. The 85th percentile measurements showed a similar reduction (except at the Forest Road site).

Radar speed measurements of free-flowing vehicles generally showed similar reductions. The one anomaly is the Reading Road North site where radar measurements have shown the average speed dropped by 5mph after the first section was implemented, it rose by 1.7mph over the next seven months, and dropped a further 2.4mph after the installation of the second section. The average speed is now 5.8mph lower than before the installation of section 1 fourteen months previously, although these measurements were taken in damp conditions.

Summary of personal injury accidents (PIAs) at the pilot sites

Site	PIAs in three years prior to pads		PIAs to date after the scheme		
	Number	Annual frequency	Length of time in situ	Number	Annual frequency
Reading Road North, Fleet[1]	13	4.3	33 months	3	1.1
Riders Lane, Havant	2	0.7	24 months	0	0
Rowner Road, Gosport[2]	31	10.3	23 months	8	4.2
Tukes Avenue, Gosport	13	4.3	22 months	6	3.3
Forest Road, Denmead	5	1.3	22 months	1	0.5
Gudge Heath Lane, Fareham	13	4.3	24 months	5	2.5

[1] Included anti-skid surfacing and changes to the signs.
[2] Carriageway resurfacing around pads Sept 2003.

Accident reductions: These figures are encouraging but further monitoring will be required to examine the changes in the frequency of personal injury accidents over a full 3 year 'after' period.

Rumblewave associated with a pedestrian refuge

Site	Mean speeds (in mph) at the pilot sites			85th percentile speeds (in mph) at the pilot sites		
	Automatic speed / flow counters			Automatic speed / flow counters		
	Before mean speed	After mean speed	Difference	Before 85th percentile	After 85th percentile	Difference
Trunk Road, Cove	31.0	30.6	-0.4	36.3	35.8	-0.5
Reading Road North, Fleet	37.1	Section 1 36.3 Section 2 35.7	-0.8 -1.4	42.1	Section 1 41.5 Section 2 41.3	-0.6 -0.8
Riders Lane, Havant	26.8	25.1	-1.7	33.5	32.4	-1.1
Rowner Road, Gosport	29.5	27.6	-1.9	34.7	32.8	-1.9
Tukes Avenue, Gosport	28.5	27.1	-1.4	34.2	32.7	-1.5
Forest Road, Denmead	38.9	38.2	-0.7	44.4	44.8	0.4
Gudge Heath Lane, Fareham	32.1	31.9	-0.2	37.3	36.7	-0.6

Appearance: Construction materials are available in a number of different colours. Whilst contrasting colours such as red may provide an additional alerting effect for the vehicle drivers, neutral colours such as buff or grey may be less intrusive in the local environment, and reduce any negative impact on the local landscape/townscape. This may be of particular relevance in conservation areas. However, light colours will also reduce the contrast of white road markings and make them harder to see at a distance.

Advice and Technical Enquiries:

Traffic Management Division,
Department for Transport,
Zone 3/23 Great Minster House,
76 Marsham Street,
London SW1P 4DR.
Tel. 020 7944 2594
Fax. 020 7944 2469

The Department would be interested to hear from local highway authorities the results of any rumblewave schemes they implement. Please contact the above address.

Colour can be varied to reduce visual impact

References:

Highways Act 1980
Highways (Traffic Calming) Regulations 1999 S.I. 1999 No. 1026
Traffic Advisory Leaflet 7/93 "Traffic Calming Regulations"
Traffic Advisory Leaflet 11/93 "Rumble Devices"
TRL Report 545 "Development of a novel traffic calming surface"
TRL Report PPR020 "Prediction of ground-borne vibration generated by heavy vehicles crossing a rumblewave device".
Traffic Signs Regulations and General Directions 2002 S.I. 2002 No. 3113.

Acknowledgements:

The Department wishes to thank Peter Critchell at Hampshire County Council and John Trusler at Rushmoor Borough Council for their assistance with the pilot schemes; also Steve Loader at Prismo Ltd for his time and effort developing the construction techniques used for the track trials and for the pilot schemes. We also wish to thank Andy Padgham at Kent County Council and Mary Keasley at Waveney District Council for the use of the vibration monitoring results.

Details of Traffic Advisory Leaflets available on the DfT website can be accessed as follows: www.dft.gov.uk
From the DfT homepage, click on Roads and Vehicles, then Traffic and Parking Management and then Traffic Advisory Leaflets.

The Department for Transport sponsors a wide range of research into traffic management issues. The results published in Traffic Advisory Leaflets are applicable to England, Wales and Scotland. Attention is drawn to variations in statutory provisions or administrative practices between the countries.

The Traffic Advisory Unit (TAU) is a multi-disciplinary group working within the Department for Transport. The TAU seeks to promote the most effective traffic management and parking techniques for the benefit, safety and convenience of all road users.

Department for Transport

Requests for unpriced TAU publications to:
Walking and Cycling Unit,
Zone 3/17, Great Minster House
76 Marsham Street, London, SW1P 4DR.
Telephone 020 7944 2478
e-mail: tal@dft.gsi.gov.uk

Scottish Executive

Within Scotland enquiries should be made to:
Scottish Executive, Development
Department, Transport Division 3, Zone 2-F,
Victoria Quay, Edinburgh, EH6 6QQ,
Telephone 0131 244 0847
e-mail: roadsafety2@scotland.gsi.gov.uk

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Within Wales, enquiries should be made to:
Welsh Assembly Government,
Transport Directorate, 2nd Floor, Cathays Park,
Cardiff, CF10 3NQ
Telephone 02920 826947
e-mail: andrew.hemmings@wales.gsi.gov.uk

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Printed in the UK January 2005 on paper comprising 75% post consumer waste and 25% ECF pulp.