HIGHWAYS DEPARTMENT

GUIDANCE NOTES 014D

Permanent Trench Reinstatement

Research & Development Division

RD/GN/014D
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Guidance Notes No. RD/GN/014D - Permanent Trench Reinstatement

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1. Introduction

1.1 The primary objective of this document is to provide guidelines on proper methods of permanent trench reinstatement.

1.2 Current practice in permanent trench reinstatement work has been standardised and is shown on the Highways Department (HyD) Standard Drawings Nos. H1124 to H1131. The Guidance Notes therefore serve as a supplement to explain the requirements aiming at a unified standard for trench reinstatement throughout the whole territory. In essence, Permittees shall reinstate the road affected by their works to its original condition unless otherwise advised by HyD Regional Offices.

1.3 The Guidance Notes shall be read in conjunction with the relevant clauses of the General Specification for Civil Engineering Works, 2006 Edition (Hong Kong Government) (GS), its associated corrigenda, and the current version of HyD Standard Drawings (Drg.) which are available from the Civil Engineering and Development Department's Homepage and Highways Department's Homepage respectively.

1.4 Section 2 of the Guidance Notes spells out the essence of road construction methods, the quality of materials and the standards of workmanship which must be observed when carrying out trench reinstatement.

1.5 Section 3 of the Guidance Notes stipulates the required standard of permanent trench reinstatement as well as the methods to achieve such standard. The sampling and testing of materials are also briefly described.

1.6 The Guidance Notes RD/GN/014D has taken account of the GS and HyD Standard Drawings published since the last version of the Guidance Notes. It supersedes RD/GN/014C.

2. Road Construction

2.1 Road Pavement Structure

Road pavements are made up of an appropriate combination of the following layers :

a) Subgrade (road formation)
The surface of the ground in its final shape after completion of the earthworks and of consolidation, compaction, or stabilisation in situ.

b) Sub-base layer
Assists in load spreading, subsoil drainage, and acts as a temporary road for construction plant.

c) Bituminous roadbase layer/concrete slab/paving slab
The main load-spreading layer.

d) Bituminous surfacing layer
Consists of the base course and wearing course. Base course distributes traffic load over the roadbase and provides a good shape and regular surface on which to lay the relatively thin wearing course. The wearing course is to provide a safe, skid-resistant surface, and to withstand the effects of abrasion and stresses from traffic. On heavily trafficked and stressed bituminous carriageways, stone mastic asphalt (SMA) was introduced as the surfacing layer to replace wearing course due to its superior performance to resist rutting in the Guidance Notes RD/GN/030 issued in December 2001. Polymer modified stone mastic asphalt with 10mm nominal maximum aggregate size (PMSMA10) was introduced subsequently to improve the stability against rutting and shoving. Since the promulgation of RD/GN/038 in April 2012, PMSMA10 has replaced the use of SMA in road network.

e) Friction course layer
Friction course layer is used as the uppermost non-structural layer on roads where the vehicle approaching speed is likely to exceed 70 km/h. It is a water permeable layer and provides a good macrotexture (average texture depth not less than 1.5 mm). To enhance durability, polymer modified friction course is used as a standard surfacing to replace friction course on high speed roads since 2005.

f) Polymer modified cushion course layer
Polymer modified cushion course layer is used as an overlay material on concrete carriageway. It is normally added between the concrete carriageway and the polymer modified friction course layer.

2.2 Tolerance of Thickness and Level of Pavement

2.2.1 The permitted tolerances in level of bituminous or concrete road surface shall be +6 / -6 mm.

2.2.2 The combination of tolerances in levels of various pavement courses shall not result in a reduction in the thickness of the pavement, excluding the sub-base, of more than 15 mm

from the specified thickness nor a reduction in the thickness of the bituminous wearing course or friction course of more than 5 mm from the specified thickness.

2.2.3 The thickness of concrete carriageway slabs shall not be less than the specified thickness minus 10 mm.

2.2.4 The difference in level of the final layer in bituminous works across joints for trench reinstatement shall not exceed 4 mm. The differences in level of the surface of concrete carriageways across joints shall not be more than 3 mm.

2.2.5 The level of covers, frames and other hardware shall not be lower than the surface of carriageway, nor shall it be more than 5 mm higher than the surface of the carriageway. The level of gully gratings shall not be higher than the surface of the carriageway, nor shall it be more than 5 mm lower than the surface of the carriageway.

2.3 Subgrade (Road Formation)

2.3.1 The formation surface shall be :

a) prepared immediately prior to laying the sub-base;

b) formed by trimming and compacting with appropriate mechanical plant;

c) well cleaned and free from mud and slurry; and

d) protected by a polythene sheeting with 300 mm laps set to prevent ingress of moisture or by sealing with bitumen emulsion if it is not immediately covered with sub-base material.

2.4 Sub-base Layer

2.4.1 General

The sub-base layer shall :

a) be constructed by using granular sub-base material or lean concrete;

b) be laid as soon as possible after final stripping to formation level in order to prevent deterioration of the formation, either due to rain which causes the exposed ground to become soggy or due to sunshine which can dry out the surface and cause cracking;

c) be placed and spread evenly before compaction;

d) be well compacted for each layer using appropriate mechanical plant as soon as having been laid; and

e) on completion of compaction be well closed, free from movement under compaction plant and free from compaction planes, ridges, cracks or loose material.

2.4.2 **Granular Sub-base Material**

2.4.2.1 Sub-base material using virgin material shall be crushed rock and shall have the properties as specified in GS Clause 9.02. Recycled sub-base material in lieu of virgin material shall be crushed rock, crushed concrete or clean crushed inert demolition material and shall have the properties as specified in GS Clause 9.03.

2.4.2.2 Each sample of sub-base material using virgin material shall be tested as specified in GS Clause 9.46 to determine the particle size distribution, 10% fines value, maximum dry density, optimum moisture content and plasticity index of the portion passing a 425μm BS test sieve. Each sample of recycled sub-base material in lieu of virgin material shall be tested as specified in GS Clause 9.47 to determine the particle size distribution, 10% fines value, maximum dry density, optimum moisture content, plasticity index of the portion passing a 425μm BS test sieve, CBR value, soundness value, water-soluble sulphate content and percentage of contaminants as defined in Table 9.2 of the GS.

2.4.2.3 Laying and compaction of granular sub-base material shall be in accordance with GS Clause 9.31 for sub-base material using virgin material and GS Clause 9.32 for recycled sub-base material in lieu of virgin material, in particular,

a) moisture content of the material shall not be less than 2%;

b) the compacted thickness of each layer to be laid shall not exceed 225 mm. If the specified final compacted thickness of the sub-base exceeds 225mm, the material shall be laid in two or more layers; the minimum thickness of each layer shall be 100mm and, if the layers are of unequal thickness, the lowest layer shall be the thickest;

c) sub-base material shall be compacted to obtain a relative compaction of at least 95% maximum dry density throughout.

2.4.2.4 The compaction plant shall be operated both longitudinally and transversely. Compaction shall continue until the surface is closed.

2.4.3 **Lean Concrete Sub-base**

2.4.3.1 The making and testing of lean concrete shall comply with the requirements stated in Sections A1.1 to A1.3 of Appendix A1. The 28-day cube strength of lean concrete shall be around 10 MPa.

2.4.3.2 Lean concrete shall be laid and compacted in accordance with Section A1.4 of Appendix A1.

2.5 **Roadbase and Surfacing for Bituminous Carriageways**

2.5.1 **General**

2.5.1.1 Under the current practice, all bituminous materials used in highway works have to be assessed by the Research and Development (R&D) Division of HyD under the

Centralised Mix Design Vetting System. Submission is not required if a design mix already approved by R&D Division is to be adopted. However, bituminous mixes in particular those new or updated mixes which have not been subjected to satisfactory field trials shall not be used. Particulars of all approved bituminous mixes for use in roadbase, base course, wearing course, polymer modified friction course, cushion course and PMSMA10 can be obtained from Highways Department's Homepage.

2.5.1.2 Bituminous material shall be:

a) transported in clean vehicles with smooth trays and sides; and

b) protected from heat loss and contamination by dust or other deleterious material both during transit from the mixer to the laying site, and whilst awaiting tipping by covering it with a heavy canvas or similar covers.

2.5.2 **Laying of Bituminous Material**

2.5.2.1 Before laying bituminous roadbase, a bituminous emulsion tack coat shall be evenly applied to the surface receiving the bituminous material by a spraying machine complying with BS 434:Part 2. Tack shall never be poured. Bituminous materials shall not be laid until the tack coat has cured. Constructional plant and other vehicles shall only run on the tack coat as necessary to lay the bituminous materials.

2.5.2.2 The laying of bituminous materials shall be suspended/avoided in the following circumstances :

a) during periods of heavy rain;

b) when free standing water is present on the surface;

c) when the temperature of the bituminous material falls outside the limits shown in Table 2.1;

Table 2.1 - Temperature Requirements for Bituminous Materials

Type of bituminous material		Roadbase, base course and wearing course	Polymer modified friction course/ cushion course	SMA	PMSMA10
Bituminous mixture temperature at laying (°C)	Min. Max.	- -	To recommend-ation of supplier for bituminous materials	150 180	To recommend-ation of supplier for bituminous materials
Bituminous mixture temperature at start of compaction (°C)	Min.	80[1] - roadbase 85[1] - base course or wearing course		140	

d) when the ambient air temperature is below 8 °C, bituminous wearing course material shall not be laid; and

e) when ambient air temperature is below 10 °C, bituminous friction course material shall not be laid.

2.5.2.3 Surfaces on which bituminous materials are laid shall be clean and free from mud, grit and other deleterious material.

2.5.2.4 Wearing course or friction course laying operations shall only proceed after kerbs, frames, and all other hardware have been set to the correct level.

2.5.2.5 All laying and compacting equipment shall be ready before any bituminous material is laid. Whenever possible, bituminous materials shall be laid using a self-propelled paving machine with screw auger and attached screed capable of giving initial compaction to the material and finishing it to a level suitable for subsequent compaction.

2.5.2.6 Manual laying of bituminous material will only be permitted in the following circumstances :

a) for laying regulating course of irregular shape and varying thickness;

b) in confined locations;

c) adjacent to expansion joints, covers, frames and other hardware; or

d) in reinstatement to trenches.

[1] when roller compaction cannot be used, these minimum temperatures shall be raised by 10°C - 15°C to allow for the longer period required for adequate compaction.

2.5.2.7 Laying of bituminous material by hand shall be done very carefully and the materials shall be distributed uniformly to avoid segregation of the coarse aggregate. Materials shall not be broadcast or spread from shovels as this causes segregation. The material shall be deposited from shovels into small piles and then spread evenly. Any part of the mix that has formed into lumps and does not break down easily shall be discarded.

2.5.3 **Compaction of Bituminous Material**

2.5.3.1 Compaction shall start as soon as possible after the bituminous material has been uniformly laid in place by the paver or by hand. The minimum compaction plant to be used is given in GS Clause 9.36. Normally the following shall be used :

a) a smooth three-wheeled steel-wheeled roller with a mass of between 6 tonnes (t) and 12 t, or a vibratory tandem steel-wheeled roller with an effective mass of between 6 t and 12 t, and a smooth pneumatic-tyred roller with a mass of between 12 t and 25 t, and with not less than seven overlapping wheels which have tyres that are capable of having pressures varying between 300 MPa and 800 MPa, or

b) vibrating plates or rammers which shall only be used for compaction in confined areas and areas adjacent to kerbs, covers, frames and other hardware where the use of a roller is impracticable. In this case, regularity of the surface should be closely checked with a straight-edge.

c) Rollers for compacting SMA/PMSMA10 material shall be either, smooth three wheeled steel rollers with a minimum mass of 10 t, or tandem steel wheeled rollers with a mass of between 6 t and 8 t dead weight. Pneumatic tired-rollers shall not be used. The recommended rolling sequence for tandem rollers is one pass static immediately behind the paver, followed by two to three vibrating passes and then finished off by static passes until all roller marks have been removed.

2.5.3.2 The surface of each layer of bituminous material on completion of compaction shall be :

a) well closed;
b) free from movement under compaction plant;
c) free from roller marks, compaction planes, ridges and cracks; and
d) free from loose material.

2.5.3.3 Where traffic conditions and other constraints permit, 6 hours shall be allowed before constructional plant or other vehicles may use newly laid and compacted bituminous course. Where traffic conditions and other constraints do not permit, the contractor shall so programme his works so as to allow sufficient time for the bituminous courses to be sufficiently cured to withstand traffic loading. In any event, the newly compacted bituminous course shall not be opened to traffic unless the surface temperatures of the bituminous course fall below 50°C. The surface temperatures shall be measured by the infrared type thermometer according to the manufacturer's recommendation or other type of thermometer approved by the Engineer. The use of mercury type thermometer is not allowed.

2.6 Concrete Carriageways

2.6.1 General

2.6.1.1 Concrete for carriageway slabs shall be of Grade 40/20. Ready mixed concrete shall be carried in purposely made agitators operating continuously, or in truck mixer.

2.6.1.2 Polythene sheeting shall be laid on the surface of the sub-base before concreting.

2.6.1.3 If mesh reinforcement is to be used as surface reinforcement, it shall be laid with the main bars parallel to the longer dimension of the reinstatement area. The cover to the reinstatement shall be 60 mm and within the tolerances of +/- 10 mm.

2.6.2 Formwork

Formwork shall be :

a) steel formwork (except for curves or small openings) erected with the gaps carefully sealed to prevent mortar from leaking;

b) securely fixed in position to avoid any movement during concreting;

c) set to the lines and levels within the tolerances of +/-10 mm and +/-3 mm respectively;

d) not loosened or removed until at least 7 hours after completion of concreting; and

e) struck with care to avoid damage to the concrete and to any protruding tie bars or dowel bars.

2.6.3 Placing and Compacting Concrete

The concrete shall :

a) be placed on a clean surface free from standing water;

b) be placed as close as possible in its final position and compacted within 2½hours of the introduction of cement to the concrete mix and within 30 minutes of discharge from agitator or truck mixer;

c) not be allowed a free fall exceeding 2.7m;

d) not be distributed into position by means of vibration;

e) be compacted by internal vibrators to produce a dense homogenous mass;

f) not be compacted by ways of vibrating the reinforcement or formwork;

g) firstly be poured and compacted to the level of the reinforcement (for reinforced concrete slab) which shall then be placed in position; and

h) not be subject to vibration after compaction until 24 hours has elapsed.

2.6.4 **Surface Finish**

2.6.4.1 After compaction, the concrete surface shall be regulated by a regulating machine or a vibrating beam and subsequently by at least two passes of a scraping straight edge with blade length not less than 1.8 m. Wooden floats may be used to tamp or finish small areas. Steel floats or trowels shall not be used.

2.6.4.2 After the surface of the concrete carriageway has been regulated and before the curing compound is applied, the surface, other than the surface of channels and edges of slabs which do not require to be textured, shall be textured by brushing with a wire broom. The surface texture shall be produced by brushing evenly across the slab in one direction at right angles to the longitudinal axis of the carriageway. Brushing shall be carried out after the moisture film has disappeared from the concrete surface and before the initial set is complete.

2.6.4.3 The wire broom shall be at least 450 mm wide and shall have two rows of tufts. The rows shall be 20 mm apart and the tufts in each row shall be at 10 mm centres and in line with the centre of the gaps between the tufts in the other row. The tufts shall contain an average of 14 wires, each of 32 gauge and initially 100 mm long. The broom shall be replaced if any tuft wears down to a length of 90 mm.

2.6.4.4 The texture depth of concrete carriageways shall be determined by sand patch test described in GS Clause 10.57 at least 2 days after the surface texturing has been carried out and before the area is used by constructional plant or other vehicles.

2.6.5 **Curing and Protection**

2.6.5.1 The exposed surfaces of the carriageway slabs shall be cured by treating with an approved curing compound immediately after texturing. Care shall be taken to ensure that full covering is achieved. The edges of a concrete slab shall be treated immediately after the formwork has been removed. Curing compound shall be applied by using an approved low-pressure mechanical sprayer or in accordance with the manufacturer's recommendations.

2.6.5.2 After spraying of the curing compound, the concrete slabs shall be fenced off from all pedestrian and traffic, and protected from rain by a layer of approved protective sheeting for at least 24 hours. The sheeting shall be lapped and securely held in position. Care shall be taken not to damage the curing membrane.

2.6.5.3 Vehicular traffic shall not be permitted on the concrete carriageways until a minimum period of 7 days has elapsed after the completion of concreting or as soon as the concrete has achieved a crushing strength of 25 MPa and until all joint grooves have been sealed or adequately protected.

2.6.6 **Joints**

2.6.6.1 **General**

a) Transverse joints shall be straight and at right angles to the longitudinal axis of the carriageway. Detailed recommendations on panelling design and spacing of joint are given in guidance notes “Panelling Design & Joint Construction of Concrete Slabs” (RD/GN/020) issued by R&D Division of HyD.

b) Dowel bars, tie bars and their sleeves shall be securely fixed in position through holes in the formwork before concreting. The bars shall be parallel to the top surface of the slab and to each other. Bars at transverse joints shall be parallel to the adjacent longitudinal joint or to the longitudinal axis of the carriageway if there is no longitudinal joint or to other lines instructed by HyD.

c) Permanent sealing of joints shall be carried out:

   i) at least 7 days after concreting unless otherwise permitted by HyD;

   ii) immediately after the removal of any dirt or loose material, joint former or temporary sealant or filling materials;

   iii) after the sides of the groove have been thoroughly cleaned and roughened by water jetting, sand blasting or by equivalent methods;

   iv) after the groove has been thoroughly dried; and

   v) with an approved sealant in accordance with the manufacturer's recommendations.

d) A good sealing of joint depends very much on the preparation of the groove. To ensure the sealant adheres firmly on the sides of the groove, primer shall be applied according to the manufacturer’s recommendations. Good adhesion of the joint sealant on the groove also depends on whether the groove is formed to its right dimension and the sides of the groove are clean and dry at the time of application of the sealant.

e) The top sealant shall not protrude from the transverse joint, otherwise it may be damaged by the traffic and can be lost together. The finished surface of the sealant shall be between 4mm and 6mm below the surface of the slab.

2.6.6.2 **Expansion Joints**

a) Details of expansion joints are shown on Drg. H1105.

b) The joint filler together with the sealant groove shall provide complete separation of adjacent slabs.

c) Grooves at expansion joints shall be straight and have parallel sides and be located over the joint filler with such accuracy that the upper surface of the filler is entirely contained within the groove.

d) Any over-sized holes in filler around dowel bar sleeves and any spaces between the filler and the sub-base shall be packed with joint filler material to prevent the intrusion of concrete into the joint.

e) Dowel bars shall be fitted with preformed PVC tight fitting anti-corrosive dowel sleeves.

2.6.6.3 **Contraction Joints**

a) Details of contraction joints are shown on Drg. H1106.

b) Dowels bars shall be fitted with preformed PVC tight fitting anti-corrosive dowel sleeves.

c) Grooves at contraction joints for reinforced slabs may be formed in two stages (Drg. H1109):

i) The initial groove shall be formed by sawing to a width not greater than the final width and to a depth between 1/4 and 1/3 of the thickness of the slab as soon as possible without causing spalling of the edges of the groove and before the development of any crack.

ii) The final sawing of grooves to the full specified width and depth of the groove shall be completed at least 7 days after concreting.

d) The centre lines of the initial and final grooves shall coincide. Initial saw cut shall be omitted when slabs are not cast through the joint.

2.6.6.4 **Longitudinal and Construction Joints**

a) Details of longitudinal and construction joints are shown on Drg. H1107 and H1108 respectively.

b) Dowel or tie bars shall be protected by using preformed PVC tight fitting anti-corrosive dowel sleeves.

c) Groove forming strips of 5 mm width and 25 mm depth shall be securely fixed in position onto the top edge of the adjoining slabs before concreting. Preformed flexible strip sealant may be used as both the groove forming strip and permanent joint sealant.

d) Construction joints shall be formed in concrete carriageway only where approved by HyD or in cases of emergency if concreting is interrupted by adverse weather, plant breakdown or similar circumstances. Construction joints shall not be formed within 2.5 m of an existing or planned expansion or contraction joint.

e) Transverse construction joints shall be formed by either using formwork and cast-in tie bars, or breaking back from an unformed edge and fixing the tie bars and sleeves with epoxy resin grouted in drilled holes.

2.6.6.5 **Isolation Joint**

Isolation joints, as shown on Drg. H1107, are joints across which no dowel bars or tie bars are installed for load transfer. Isolation joints are provided on four sides around manholes or utility pits as given in Drg. H1111 and H1112. Dowel bars should never be provided across the joint between manhole and road slab. Two number 20mm diameter bars shall be provided for each corner of the manhole cover.

2.6.6.6 **Transition Between Concrete and Bituminous Pavements**

A transition slab shall be constructed in accordance with Drg. H1110 at the location where a concrete pavement meets a bituminous pavement.

2.7 Bituminous Footways / Cycletracks

2.7.1 Details of bituminous footways / cycletracks are shown on Drg. H1104.

2.7.2 Bitumen emulsion tack coat shall be sprayed before laying of bituminous surfacing.

2.7.3 The bituminous surfacing layer shall be laid to a standard the same as bituminous carriageways except that manual laying may be employed.

2.7.4 Compaction shall be started before the temperature of the newly laid material falls below 100 °C and shall continue until all roller marks have been removed.

2.8 Concrete Footways / Cycletracks / Run-in

2.8.1 Details of concrete footways / cycletracks are shown on Drg. H1104. Details of concrete run-in are given on Drg. H1113 and H1114.

2.8.2 A polythene sheet shall be laid on the surface of the sub-base before concreting.

2.8.3 Concrete footways shall be laid in bays not exceeding 20 m^2 with a maximum joint spacing of 5 m.

2.8.4 Footway joints shall be open joints of 3 mm - 6 mm wide and 20 mm deep.

2.8.5 The concrete surface shall be brushed finish in the same manner as for concrete carriageway.

2.8.6 The exposed concrete surfaces shall be cured by treating it with an approved curing compound immediately after texturing.

2.9 **Paving Block Carriageways / Footways / Run-in**

2.9.1 Details of carriageways / footways / run-in of paving block construction are shown on Drg. H1103, H5101, H5102, H5114, H5125 - H5127, H5133 – H5137.

2.9.2 Precast units shall be carefully handled and stored to avoid damage to corners.

2.9.3 All boundary kerbs and other edging strips or restraints shall be laid and set sound before paving operation commences.

2.9.4 Sand for bedding precast units shall have the particle size distribution stated in Table 2.2. The sand shall have a moisture content exceeding 4 % and not exceeding 8 % at the time of the laying.

2.9.5 Sand for filling joints between precast units shall have the particle size distribution stated in Table 2.2. The sand shall have a moisture content of less than 0.5 % at the time of filling joints.

2.9.6 A layer of sand shall be laid and shall be screeded and tamped to a uniform depth over the complete width of the area to be paved. The quantity of sand shall be sufficient to permit screeding to waste and to achieve a tamped thickness which exceeds 20 mm and does not exceed 30 mm.

2.9.7 The sand layer shall not be disturbed by additional compaction, foot-marks or other damage after the layer has been screeded and tamped to the required level and before the units are laid. Sand shall not be screeded and tamped more than 1 m in advance of the units which have been laid.

Table 2.2 - Particle Size Distribution of Sand for Paving Blocks

BS test sieve	Sand for bedding precast units	Sand for filling joints between precast units
	% by mass passing	% by mass passing
10 mm	100	100
5 mm	85-100	100
2.36 mm	65-100	100
1.18 mm	40-98	90 - 100
600 μm	25-72	60 - 90
300 μm	10-35	30 - 60
150 μm	0-15	15 - 30
75 μm	0-10	5 -10

2.9.8 Paving slabs shall be laid on the prepared sand layer immediately after screeding and tamping in such a manner that the sand is not disturbed. Paving slabs shall be adjusted to form uniform joints between 2 mm and 3 mm wide and shall be bedded into the final position using a wooden mallet or a plate vibrator fitted with a rubber base-pad.

2.9.9 The uses and the requirements of cement/sand bedding shall be in accordance with Drg. H1103, H5125, H5126 and H5133 – H5137.

2.9.10 Final levelling of the slabs shall be carried out as soon as possible after bedding and before changes in the moisture content of the prepared sand layer occur.

2.9.11 Where necessary, slabs/blocks shall be accurately cut with a portable bench saw, hand power disc, hydraulic splitter, or other device producing a cut edge visually comparable to that of an uncut slab/block, free from chips and true to line.

2.9.12 Where it is not possible to cut units to fit neatly around an obstruction, the obstruction shall be surrounded with colour matched concrete box-out slab in advance of paving and the paving units cut to fit along edges of concrete.

2.9.13 A colour matched cement mortar shall be available on site during laying operations to allow the filling-in, to the full depth of the precast unit, of narrow sections between units and adjacent kerbs, edgings, covers, frames and other hardware not readily assessed or unsuitable for cutting units to fit.

2.9.14 After the units have been bedded, sand for filling the joints shall be spread over the surface of the units and brushed into the joints in such a manner that all joints are completely filled.

2.9.15 Paved areas shall be further compacted by at least two passes of a plate compactor fitted with a rubber base-pad after filling the joints to ensure that the joints are completely filled. Sand shall be added as required and compacted into the joints.

2.9.16 Carriageways and paved areas to which vehicles will have access shall be compacted by at least ten evenly-spaced passes of a pneumatic-tyred roller having a gross weight of between 10 t and 12 t. Sand shall be added as required and brushed and compacted into the joints.

2.9.17 Excess sand shall be removed after completion of compaction. Damaged units shall be immediately removed and replaced.

2.9.18 On completion, the level of paved areas constructed using paving slabs or interlocking blocks shall be within 3 mm of the specified level. The difference in level between any two adjacent slabs shall not exceed 2 mm.

3. Trench Reinstatement

3.1 General

3.1.1 The standard and requirements of road construction set out in Section 2 also apply to trench reinstatement.

3.1.2 Trench reinstatement involves the following steps :

a) determine extent of reinstatement;
b) saw cut along reinstatement limits;
c) excavate and remove margin area and areas of loose materials;
d) prepare road formation;
e) put back a sub-base layer;
f) put back roadbase and surfacing layers / concrete slab / paving slab; and
g) put back a polymer modified friction course layer, polymer modified cushion course layer, SMA[2] or PMSMA10 by a specialist contractor if it originally exists.

3.1.3 Special care shall be taken to compact materials near the edges of the trench.

3.1.4 All joints affected shall be reinstated to the original type and alignment.

3.1.5 The trench shall be reinstated with the same material and thickness as the existing construction except as otherwise explicitly specified in the Guidance Notes or advised by HyD.

3.1.6 The reinstatement of any surface shall be completed so that the edges of the reinstatement are flush with the adjacent surfaces and the reinstatement shall not show any significant surface depression nor surface crowning in between.

3.1.7 All street furniture, road markings, road studs and landscaping works, removed during the course of works, shall be reinstated immediately following the completion of the works to the original positions in accordance with the relevant GS Clauses and the HyD Standard Drawings.

3.1.8 Any existing staircase affected shall be reinstated to the original material, dimensions, lines, levels, details and with the same associated street furniture such as railing unless otherwise advised by HyD Regional Offices.

3.2 Extent of Reinstatement

3.2.1 General

3.2.1.1 The extent of reinstatement work shall be determined and marked clearly on site by the staff of HyD / utility responsible for permanent reinstatement.

3.2.1.2 In determining the extent of the reinstatement area, the location of the trench relative to the boundary and the joints of the pavement, and the damage caused to the road structure

[2] PMSMA10 is recommended as the reinstatement material when SMA is present.

due to the trenching work shall be taken into account. Any cracking within the adjacent road slab resulting from the excavation operation shall require the relevant area of the slab to be removed and included within the area to be reinstated. The limit of the reinstatement must lie in an area of firm pavement.

3.2.1.3 Damaged pavement and weakened roadbase, sub-base and subgrade shall be removed before the preparation of the road formation.

3.2.1.4 Except for pavements of paving slab / block construction, the boundary of the reinstatement area shall be saw-cut. The cut shall be straight and vertical, and deep enough to prevent any spalling at edges or cracking of the pavement. The minimum depth of saw-cutting for different types of pavements are given in Table 3.1.

Table 3.1 -Minimum Depth of Saw-cut Required for Different Types of Pavements

Type of pavement	Minimum depth of saw-cut
Bituminous Carriageway : friction course bituminous surfacing	 30 mm 40 mm
Concrete Carriageway	75 mm
Concrete Run-in	75 mm
Bituminous Footway & Cycletrack	20 mm
Concrete Footway	20 mm

3.2.1.5 A minimum lapping between interface layers at the edges of the reinstatement area as shown in Table 3.2 shall be provided :

Table 3.2 -Minimum Lapping between Interface Layers of Pavement

	Interface layers	Minimum lapping
Carriageway	concrete slab / sub-base	150 mm
	bituminous surfacing / road base	150 mm
	friction course / bituminous surfacing	150 mm
Footway, cycletrack & run-in	concrete slab / sub-base	75 mm
	bituminous surfacing / sub-base	150 mm

3.2.2 **Extent for Bituminous Carriageway, Footway and Cycletrack Reinstatement**

3.2.2.1 The limits of reinstatement in bituminous carriageways, footway and cycletrack shall be determined in accordance with Drg. H1130.

3.2.2.2 The reinstatement area shall be located at a minimum clearance of 450 mm from an edge (kerb line, building line or an adjoining concrete pavement). If the minimum clearance cannot be kept, the reinstatement area shall extend to the edge.

3.2.2.3 The width of the reinstatement area shall be sufficient for the operation of a roller for the compaction of bituminous road courses in carriageways.

3.2.2.4 Stepped or L-shaped reinstatement area is not permitted unless the length of each step along the length of the carriageway, footway or cycletrack is not less than 20 metres except at location of joints, manholes or junction boxes. The offset of each step shall not be less than 300 mm.

3.2.2.5 Chamfers at the corners are permitted for trenches going round road junctions.

3.2.2.6 For the following categories of road, the reinstatement area shall extend transversely to the full width of the traffic lane affected :

a) carriageways constructed within the last five years;
b) carriageways re-surfaced within the last one year; and
c) footway or cycletrack constructed within the last one year.

3.2.2.7 The extra reinstatement area to be provided to satisfy the minimum clearance limit in Section 3.2.2.2 and full width reinstatement in Section 3.2.2.6 may be confined to the wearing course provided that the lower courses have not been damaged. The reinstatement within such area can be done by cold milling and resurfacing the wearing course. The specifications of cold milling and resurfacing work are available on request from HyD Regional Office.

3.2.3 **Extent for Concrete Carriageway Reinstatement**

3.2.3.1 The limits of reinstatement in concrete carriageways shall be determined in accordance with Drg. H1125.

3.2.3.2 The reinstatement area shall be located at a minimum clearance of 900 mm from a longitudinal joint or an edge and of 1500 mm from a transverse joint. If the minimum clearance cannot be kept, the reinstatement area shall extend to the edge / longitudinal joint / transverse joint. In case the end of the trench straddles across a transverse joint, the reinstatement area shall extend at least 1500 mm from the transverse joint to ensure a minimum slab size.

3.2.3.3 The reinstatement area shall essentially be rectangular on plan with the sides either parallel or perpendicular to the longitudinal axis of the carriageway.

3.2.3.4 The width of the reinstatement area shall be sufficient to enable drilling of horizontal holes for dowel bars/tie bars and subject to a minimum width of 900 mm.

3.2.3.5 Stepped or L-shaped reinstatement area within a slab panel is generally not permitted. However, for a long trench with a branching arm at the end, an additional contraction joint(s) may be added to divide the reinstatement area into two rectangular areas. Similar arrangement can be made for branching arms at the middle of a long trench.

3.2.3.6 For concrete slab constructed/ reconstructed within the previous five years, the reinstatement area shall extend to the full width of the slab panel. The minimum clearance of the reinstatement area from a transverse joint shall be 3m otherwise the area shall extent to the joint. However, HyD may also require the reinstatement area be extended to the full length of the slab panel after having taken into account the location of the trench within the panel, the degree of damage to the subgrade, and the additional joints created.

3.2.4 Extent for Concrete Footway and Run-in Reinstatement

3.2.4.1 The limits of reinstatement in concrete footway and run-in shall be determined in accordance with Drg. H1128.

3.2.4.2 The reinstatement area shall be located at a minimum clearance of 300 mm from an edge or a transverse joint. If the minimum clearance cannot be kept, the reinstatement area shall extend to the edge or transverse joint. In case the end of the trench straddles across a transverse joint, the reinstatement area shall extend at least 300 mm from the transverse joint.

3.2.4.3 The width of the reinstatement area shall be 300 mm minimum.

3.2.4.4 Stepped or L-shaped reinstatement area within a slab panel or within a run-in is not permitted except as stated otherwise in Drg. H1128.

3.2.4.5 Chamfers at the corners are permitted for trenches going round street corners.

3.2.4.6 For footway or run-in constructed within the last one year, the reinstatement area shall extend to the full width of the slab panel or full width of the run-in.

3.2.5 Extent for Paving Slab/ Block Reinstatement

3.2.5.1 The limits of reinstatement in pavements of paving slab/ block construction shall be determined in accordance with Drg. H1131.

3.2.5.2 All paving slabs/ blocks within a distance from the trench of at least 300 mm or twice the largest lateral dimension of the paving slabs/blocks, or disturbed/loosened as result of the trench works shall be taken up and relaid together with the other slabs/ blocks removed for the trenching works. If necessary, further slabs/blocks should be lifted and reinstated to the edge of the paved area in order to achieve satisfactory finish.

3.3 Backfilling

3.3.1 Backfilling Materials

3.3.1.1 The backfilling materials shall not contain any of the following:

a) broken concrete, bricks and bituminous materials;

b) material susceptible to volume change, including marine mud, soil with a liquid limit exceeding 65% or a plasticity index exceeding 35%, swelling clays and collapsible soils;

c) peat, vegetable, timber, organic, soluble or perishable material;

d) dangerous or toxic material or material susceptible to combustion; and

e) metal, rubber, plastic or synthetic material.

3.3.1.2 Backfilling material shall not exceed 75 mm maximum particle size.

3.3.1.3 Earthworks materials, which are suitable for backfilling purpose, after excavation shall be kept free from water and shall be protected from damage due to water and from exposure to weather conditions which may affect the materials.

3.3.1.4 Apart from the backfilling materials as stipulated in Sections 3.3.1.1 to 3.3.1.3 above, Appendix A3 of this document stipulates the application criteria and performance requirements of controlled low-strength foamed concrete as an alternative backfilling material for backfilling utilities trenches without power cables.

3.3.2 Compaction of Backfilling Materials

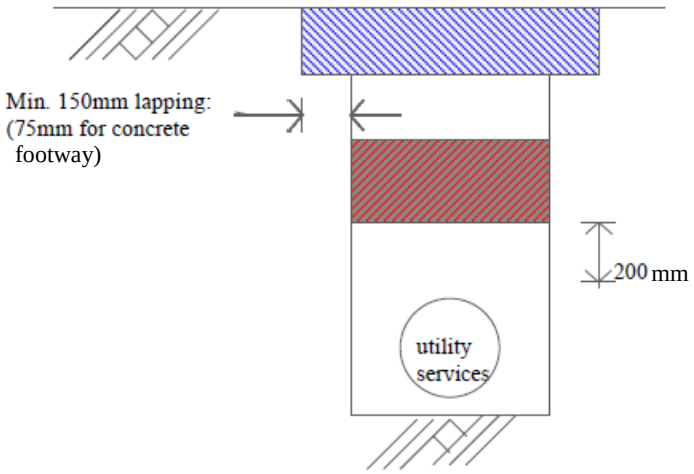
3.3.2.1 Except as stated in Section 3.3.1.4 above and Section 3.3.2.4 below, the excavation shall be backfilled in compacted layers not exceeding 150 mm thick. Each layer of backfilling materials shall be compacted with a power rammer, vibratory plate or vibratory roller. Except as stipulated in Section 3.3.2.4, the relative compaction of the compacted backfill, either in term of the in-situ dry density and maximum dry density or in term of in-situ bulk density and maximum converted bulk density, determined in accordance with the GS Clauses 6.74 to 6.83, shall not be less than 98% for levels within 200 mm below bottom of sub-base nor 95% for other levels of backfill (Figure 3.1).

3.3.2.2 Backfilling materials shall be at optimum moisture content during compaction. The tolerance on the optimum moisture content percentage shall be +/-3%, provided that the backfilling material is still capable of being compacted in accordance with the required relative compaction.

3.3.2.3 Suitable backfill materials may be carefully placed by hand and compacted in accordance with the specifications of the road opening party up to the levels of :

- 150 mm above the crown of the utility ducts, cables or pipes;
- 150 mm above the roof of the chambers, junction boxes or other installations; or

- 300mm above the crown of water pipes.



Pavement courses	*Material*	*Layer Thickness for compaction*	*Moisture content*	*Relative compaction required*
surfacing/ concrete slab	bituminous material / concrete	for wearing course, see Table 3.4		no bituminous material cores shall have air void content > 10% / there shall be no honeycombing in concrete.
road base[3]	bituminous material			no cores shall have air void content > 10%.
sub-base	granular sub-base or lean concrete[4]	225 mm max. 200 mm max.	>2% -	> 95% max. dry density > 95% theoretical dry density with zero air content
backfill	suitable backfilling material (see Section 3.3.1)	150 mm max.[5]	tolerance ±3% of optimum moisture content	>98%[5] for level within 200mm below sub-base; > 95%[6] for other levels

Figure 3.1 – Compaction of Pavement Courses for Trench Reinstatement

[3] for bituminous carriageway only
[4] lean concrete can only be used in concrete carriageways. The sub-base material to be used shall conform with the existing construction.
[5] except that backfilling material around water, sewage and drainage pipe shall be deposited and compacted in layers not exceeding 100mm thick to a level of 300mm above the top of the pipe
[6] except that backfilling material within 300mm above the top of sewer and drainage pipe shall be compacted to a relative compaction of at least 85% throughout.

3.3.2.4 Fill material around water, sewage and drainage pipes shall be deposited in layers not exceeding 100mm thick to a level of 300mm above the top of the pipe and compacted by hand-rammers or manually operated power equipment. Fill material within 300 mm above the top of sewer and drainage pipes shall be compacted to obtain a relative compaction of at least 85% throughout.

3.4 Sub-base Reinstatement

3.4.1 The sub-base to be put back shall be of granular sub-base material or lean concrete as shown in Table 3.3. However, lean concrete shall be used only where the existing construction is of the same material. The material to be used for concrete carriageway shall conform with the existing construction. The thickness of sub-base shall be the same as the adjoining pavement but subject to a minimum value.

Table 3.3 - Minimum Thickness of Sub-base Reinstatement

Type of pavement	Sub-base material	Minimum thickness of reinstatement
Bituminous Carriageway	granular sub-base	150 mm
Concrete Carriageway	granular sub-base; or lean concrete	150 mm 150 mm
Concrete or Paving Block Footway	granular sub-base	75 mm
Bituminous Footway or Cycletrack	granular sub-base; or bituminous sub-base	75 mm 75mm
Run-in	granular sub-base	150 mm

3.5 Bituminous Carriageway, Footway and Cycletrack Reinstatement

3.5.1 Details of bituminous carriageway, footway and cycletrack reinstatement are shown on Drg. H1129. Bituminous materials shall be laid and compacted in accordance with Section 2.5.

3.5.2 Joints with existing surface shall be adequately compacted with the transverse joints being compacted first followed by the longitudinal joints.

3.5.3 For bituminous carriageway, the roadbase to be put back shall be of the same thickness as the adjoining pavement but subject to a minimum of 200 mm. The bituminous surfacing layer shall be 105 mm thick which consists of 65 mm base course and 40 mm wearing course.

3.5.4 For bituminous footway and cycletrack, no roadbase is required but the bituminous surfacing to be put back shall be of the same thickness as the adjoining pavement but subject to a minimum of 25 mm.

3.5.5 Wearing course material may be laid in place of the base course material or roadbase in trench reinstatement provided that the laying thickness of individual layer is within the range shown in Table 3.4.

Table 3.4 - Nominal Single Layer Thickness for Laying Wearing Course

Material	Minimum thickness	Maximum thickness
Wearing course (10 mm nominal size)	20 mm	35 mm
Wearing course (20 mm nominal size)	40 mm	50 mm

3.5.6 Where an existing friction course layer is present, a friction course layer of the same thickness shall be put back. Permanent reinstatement of sections requiring polymer modified friction course, polymer modified cushion course, SMA or PMSMA10 shall be carried out, by a contractor in the Specialist List for Supply of Bituminous Pavement Materials and Construction of Special Bituminous Surfacing, in accordance with HyD's requirements. The Specialist List is available for reference on request from the R&D Division of HyD.

3.5.7 Sampling and Testing in Bituminous Pavement Works

3.5.7.1 If required by HyD, surface regularity of the final surface of minor bituminous works shall be determined as stated in GS Clause 10.55. There shall be no irregularity exceeding 10 mm in both the longitudinal and transverse directions. An irregularity means that the gap between the surface of the carriageway, and a 3 m straight-edge placed on the surface of the carriageway, exceeds the specified amount.

3.5.7.2 Unless otherwise required by HyD, the sampling and testing requirements (i.e. particle size distribution, bitumen content and Rice's specific gravity of each batch of the bituminous materials) as stipulated in the GS can be waived but the supplier's routine quality control test records relevant to the works shall be submitted to HyD.

3.5.7.3 If required by HyD, bituminous material cores shall be taken from each layer of bituminous material other than friction course in accordance with the GS. Each bituminous material core shall be measured to determine compacted layer thickness of the bituminous material and tested to determine the air void content. The test results shall be sent to relevant HyD Regional Office within 14 days of tests. No cores shall have an air void content exceeding 10.0%. The compacted layer thickness shall comply with Section 2.2.2.

3.5.7.4 If required by HyD, tests for texture depth and permeability shall be carried out on the final surface of friction course at positions as agreed by HyD. The average texture depth of friction course shall not be less than 1.5 mm and not more than one of the tests for texture depth shall give a result of less than 1.2 mm. Unless otherwise agreed by HyD, the rate of testing for texture depth and permeability shall be 2 tests each for area of less than 100 m^2 and 4 tests each for area of 100 - 200 m^2.

3.6 Concrete Carriageway Reinstatement

3.6.1 Details of concrete carriageway reinstatement are shown on Drg. H1124. The concrete road slab to be put back shall be of Grade 40/20 concrete. The thickness shall be the same as the adjoining pavement.

3.6.2 Type C503 long mesh reinforcement shall be used as surface reinforcement. However, if the existing mesh reinforcement is heavier than type C503, then the existing type shall be used.

3.6.3 Mild steel dowel bars of diameter 25 mm shall be provided on all sides of the reinstatement area except it abuts a transverse joint, longitudinal joint or kerb.

3.6.4 The placing, compacting, surface finishing and subsequent curing of the concrete shall be in accordance with Section 2.6.

3.6.5 Joints Reinstatement

a) The joint reinstatement details are shown on Drg. H1126.

b) Existing dowel bars and tie bars, which are in good condition, may remain in place but the old concrete around the bars shall be carefully removed before concreting.

c) Any existing dowel bars and tie bars displaced, bent or damaged shall be cut along the face of the joint and replaced. A replacement bar shall be of the same diameter and shall be installed at a distance of 75 mm from the original bar.

d) The holes drilled for the installation of replacement bars shall be parallel to the road surface.

e) Epoxy resin shall be used for fixing replacement bars in the existing road slab.

f) Old joint sealant, groove forming strip and joint filler shall be removed and replaced.

g) Preformed PVC tight fitting dowel sleeves or anti-corrosive sleeves shall be used for replacement bars as appropriate.

h) The details of joint construction shall be in accordance with Section 2.6.6.

3.6.6 Sampling and Testing of Concrete

3.6.6.1 Testing to determine the workability and compressive strength of concrete in concrete carriageways shall be as stipulated in GS Clauses 16.52 to 16.62, except the following :

a) the average slump value of the two specimens taken from one sample of concrete shall not exceed the approved slump value by more than 10 mm;

b) one sample of concrete shall be provided from each 25 m^3 or 25 batches of concrete or from the amount of concrete produced each day, whichever is less.

3.6.6.2 For hardened concrete slabs being suspected defective, HyD may require that cores be cut for investigating the followings :

a) the thickness of the slab ;
b) for signs of segregation ;
c) positions of crack inducers, reinforcement, dowel bars and tie bars ;
d) degree of compaction ; and
e) the compressive strength of the hardened concrete.

3.7 Concrete Footway / Run-in Reinstatement

3.7.1 Details of concrete footway and run-in reinstatement are shown on Drg. H1127 and H1128. The concrete slab to be put back shall be of Grade 30/20 concrete for footway and Grade 40/20 for run-in. The thickness shall be the same as the adjoining footway/run-in but subject to a minimum of 75 mm for footway and a minimum of 150 mm for run-in.

3.7.2 All footway joints affected shall be reinstated to the original type and alignment. Other reinstatement details shall be in accordance with Section 2.8.

3.8 Paving Slab/Block Reinstatement

3.8.1 Details of paving slab/block reinstatement are shown on Drg. H1131, H5101, H5102 and H5114. Precast paving slabs/blocks in footways shall be made of Grade 30 concrete, whereas precast concrete interlocking blocks in carriageway or areas to which vehicles will have access shall be made of Grade 45 concrete.

3.8.2 Paving blocks shall be laid to the standard stated in Section 2.9.

3.8.3 Where trench excavation work is required through the pavement, the paving slabs / blocks shall be extracted by hand.

3.8.4 Unbroken slabs / blocks, once loosened, shall be lifted and carefully handled, thoroughly cleaned to remove all sand and other detritus clinging to their sides, and stacked to avoid damage to corners, ready to be re-laid as for new works. Damaged or defective units shall not be reused.

3.8.5 The paving slabs / blocks to be put back shall be of the same thickness as the adjoining pavement subject to a minimum of 60mm in footway and 80mm in carriageway/run-in.

3.8.6 The paving slabs / blocks shall be relaid according to the original pattern and original type of bedding, including the provision of geogrid, if any.

3.8.7 Masonry steps affected by trenches shall be taken up in whole pieces with extreme care and properly stacked on site for re-use. Any damaged masonry step resulting from trench work shall be replaced at the cost of the road opening party. The road opening party is

required to reinstate masonry steps to original position immediately upon completion of trench work.

3.9 Common Defects in Trench Reinstatement

3.9.1 Examples of common defects and the corresponding suggested preventive measures in trench reinstatement are shown in Appendix A2.

A1. **Lean Concrete Sub-base**

A1.1 Lean concrete shall be made and constructed in accordance with the following:

a) The aggregate shall consist of either coarse and fine aggregate batched separately or an all-in aggregate, having a nominal maximum size not exceeding 40 mm nor less than 20 mm.

b) The overall grading of the aggregate shall be within the limits shown in Table A1.1 and additionally the grading of the aggregate passing the BS 5 mm sieve shall be within Zone 2 or Zone 3 of BS 882, subject to the following sub-clause.

c) If the grading of the aggregate passing the BS 5 mm sieve is within Zone 1 or Zone 4 of BS 882, HyD may approve the use of the aggregate and permit the proportion passing the BS 5 mm sieve for a Zone 1 material to exceed by 5 per cent or for a Zone 4 material to fall below by 5 per cent the figures given in Table A1.1, provided that trial mixes and a trial area constructed with the plant to be used in the work show that a mix can be obtained which can be satisfactorily compacted.

Table A1.1 - Range of Grading of Aggregate for Lean Concrete Sub-base

BS test sieve	% by mass passing	
	40 mm nominal max. size	20 mm nominal max. size
75 mm	100	-
37.5 mm	95 – 100	100
20 mm	45 – 80	80 – 100
5 mm	30 – 40	35 – 45
600 μm	8 – 30	10 – 35
150 μm	0 - 6	0 - 6

d) If the grading of the aggregate passing the BS 5 mm sieve is within Zone 1 or Zone 4 of BS 882, HyD may approve the use of the aggregate provided that trial mixes and a trial area constructed with the plant to be used in the work show that a mix can be obtained which can be satisfactorily compacted. For the trial the contractor shall use the materials, mix proportions, mixing, laying compaction plant and construction procedure that he proposes for the main work.

e) The ratio by weight of cement to aggregate, expressed in terms of its saturated surface dry condition, shall be sufficient to produce the required average crushing strengths to the requirement of this clause. The ratio of cement to aggregate by weight shall not, however, be more than 1:15 nor less than 1:20 except with the approval of HyD.

f) The material shall be mixed in accordance with the requirements stipulated in Section 16 of the GS.

A1.2 **Testing of Lean Concrete Sub-base**

a) Lean concrete sub-base shall be tested for strength and density.

b) The strength of lean concrete sub-base shall be determined by compression tests on test cubes. The cubes shall be of 150 mm size and made in pairs at intervals, each pair being from a separate batch of concrete. One cube of each pair shall be tested at 7 days and the other at 28 days. At the start of the work, 3 pairs of cubes shall be made to test the cube strength for each 800 m^2 of base or part thereof laid each day. When the first 30 results of 7-day tests are available and provided that these meet the requirements in the Section A1.3(a) & A1.3(b), and for so long as HyD is satisfied with the quality of the mix, he may reduce the number of cubes required to 3 pairs each 1600 m^2 or part thereof of base laid each day.

c) The results of the cube test shall be treated as successive groups of 3 and the average strength and range, i.e., the highest minus the lowest value, shall be calculated for each group.

d) The making, curing and testing of all cubes shall be in accordance with the methods described in Construction Standard CS1, except that the cubes shall be compacted by means of an electric or pneumatic hammer. The hammer shall have a square or rectangular foot having an area between 0.01 and 0.015 m^2 and sufficient pressure shall be used directly on each of the three layers of material filled into the mould to result in the material being compacted to refusal.

e) At the start of the work and until such time as HyD may order a reduction in the number of density tests required, three determinations shall be made of the dry density of the compacted base for each 800 m^2 or part thereof of base laid each day. The method specified in BS 1377 shall be used so that they are representative of the full depth of the base. To ensure accuracy, these tests shall be made only after a period of 4 hours has elapsed since the completion of the compaction and preferably within 24 hours. When the first 30 tests have been made and provided that these meet the density requirement in Section A1.3(c) and for so long as HyD is satisfied with the standard of compaction, he may reduce the number of density tests to 3 determinations for each 1600 m^2 or part thereof base laid each day.

f) The results of the density tests shall be treated as successive groups of three and the average density shall be calculated for each group.

A1.3 Compliance Criteria

a) The average 28-day strengths of groups of three cubes of lean concrete determined in Section A1.2 shall be such that not more than one in any consecutive five such averages is less than 9.6 MPa or more than 12 MPa (or within other range as advised by HyD[7]). If, however, the overall average of any consecutive five groups of three cubes (i.e. fifteen cubes strengths) falls below 11 MPa at 28 days, or if the average range of five consecutive groups exceeds 50 % of the overall average strength of the fifteen cubes, HyD may require the use of different materials or mix proportions.

b) Furthermore, in order to ensure a high probability at an early stage that the above requirements will be met, the average 7-day strengths of groups of three cubes determined in accordance with Section A1.2 shall be not less than 6.7 MPa or more than 9.3 MPa (or within other range as advised by HyD[7]) and if more than one of the 7-day average strengths of groups of three cubes in any consecutive five such averages falls below 6.7 MPa the cement content shall be increased and if above 9.3 MPa the cement content shall be reduced, both to such a value as may be approved by HyD and the making of cubes shall be continued at the same rate as at the start of the work until the results show that a satisfactory material is being produced.

c) The average dry density obtained from groups of three determinations of the compacted lean concrete carried out in accordance with Section A1.2 shall be not less than 95 % of the theoretical dry density with zero air content. If more than one average density in any consecutive five such averages fails to meet this requirement HyD may require the Contractor to make good by removing the layer represented by the low densities and replacing it with further material to the requirements of this clause.

A1.4 Laying and Compaction of Lean concrete sub-base

a) The lean concrete shall be transported, laid and cured in accordance with the requirements stipulated in Section 16 of the GS. Compaction shall be carried out by means of a vibrating roller which applies a static load of more than 1.76 kN/100 mm width of vibrating roll or by a vibratory compactor with a static pressure under the base plate of more than 20.7 kPa. The recommended minimum No. of passes for different equipment are given in Table A1.2.

b) Where required by HyD the vibrating roller shall be operated both longitudinally and transversely and subsequently the surface finished by rolling without vibration. Compaction shall be continued until the surface is closed and the density of the compacted base meets the requirements for density in Section A1.3(c). The maximum period of time between mixing of the materials and completion of compaction of any given material shall be 2 hours.

[7] Reference can be made to Table 3 of "Cement Stabilized Materials" by R.I.T. Williams of University of Surrey, Guildford, UK.

Table A1.2 -Compaction Requirements for Lean Concrete Sub-base

Type of compaction plant	Category	No. of passes for		
		layer < 100 mm	layer < 150 mm	layer < 200 mm
Vibratory roller	Static force per 100 mm width (kN)			
	1.76 - 2.30	4	6	10
	2.31 - 2.80	3	5	9
	2.81 - 3.50	3	5	8
	3.51 - 4.20	2	4	7
	4.21 - 4.90	2	4	6
Vibrating plate compactor	Static pressure under base plate (kPa)			
	> 20.7 (kPa)	3	6	10

c) Any layer of compacted lean concrete not covered by another pavement course within 2 hours shall be cured for a period of not less than 7 days or until being covered by the next pavement layer. Curing shall be achieved by one of the following methods:

i) covering with a polythene sheeting adequately secured from being blow off the surface with joints overlapped at least 300 mm to prohibit egress of moisture;

ii) spraying bituminous priming coat to the final surface of sub-base layer at the rate between 0.9 L/m^2 and 1.1 L/m^2; or

iii) spraying with curing compound at the rate according to the manufacturer's recommendation.

Table A2.1 – Common Defects in Trench Reinstatement

Type of defects in trench reinstatement	Some of probable causes	Suggested preventive measures	Photo Ref.
Subsidence/ surface depression	● Consolidation of isolated areas of soft or poorly compacted subgrade ● Loss of sub-base support	● Mud or swelling clays, etc. shall not be used as backfilling material ● (Section 3.3.1.1); ● Excavated materials that are to be re-used should be protected from wetting or excessive drying during storage; ● Excavations should be protected as far as reasonably practical from the ingress of water, and water running into them should be drained or pumped away; ● Backfilling material shall, at the time of compaction, be at an appropriate moisture content between +/-3% of the value; ● Compaction equipment should be operated and maintained in accordance with manufacturer's instructions[8]; ● Compaction should cover the entire pavement surface[9]; ● Maximum compaction layer thickness and minimum relative compaction requirements should be followed (Figure 3.1); ● All voids around utility services should be filled with suitable backfilling materials; ● The minimum lapping at the edges of the reinstatement area should be provided before placing concrete slab or road surfacing (Table 3.2);	Plate 1
Road marking and street furniture not properly reinstated			Plate 5

[8] All vibrating compacting plant must be checked regularly and adjusted as required in order to ensure that the manufacturer's recommended operating frequency is maintained throughout the working life of the plant.

[9] Where the excavation width is more than 50mm greater than the roll or plate width of compaction equipment (i.e. the side clearance between the compacting surface and the wall the excavation exceeds 25mm per side) two or more traverses of the compaction equipment will be required to ensure coverage of the entire surface and all will be deemed to constitute a single compactive pass.

Table A2.1 – Common Defects in Trench Reinstatement

Type of defects in trench reinstatement	Some of probable causes	Suggested preventive measures	Photo Ref.
Block Cracks on concrete slabs around drawpit / manhole covers	• Insufficient concrete slab thickness;	• The minimum thickness of the slab should be constructed (150mm for run-in, 75mm for footway, or the same thickness as the adjoining concrete carriageway slab);	Plate 3
Box-out spalling - cracks developed across slab emanating from manholes	• No proper box-out slab around manholes or utility pits; Settlement of an improperly set frame;	• Box-out road slab for manholes on concrete carriageway should be constructed in accordance with Drg. H1111 and Drg. H1112; the minimum clearance from isolation joints should be maintained and corner steel bars should be placed to control cracking;	Plate 2
Rocking drawpit / manhole covers	• Cover or frame of drawpit not properly constructed	• The level of the sides of the frame should be checked so that the covers will not rock when initially placed in position, nor develop a rock with wear;	
Saw cutting was not carried out			Plate 4

Common Defects in Trench Reinstatement

Plate 1:
Subsidence of reinstated trench.

Plate 2:
No proper boxing out of road slab was constructed around manhole covers (see Drg. H1111).

Plate 3:
Block cracks were found on concrete slabs around drawpits.

Plate 4:
Saw cutting was not carried out.

Plate 5:
Road marking has not been properly reinstated.

A3.1 Controlled Low-strength Foamed Concrete for Backfilling Utilities Trenches - Application Criteria and Performance Requirements

a) This document sets out the application criteria and performance requirements of controlled low-strength foamed concrete (hereinafter referred to as "Foam Concrete") which may be considered for use as an alternative backfilling material in lieu of the conventional backfilling materials in backfilling utilities trenches without power cables under public roads maintained by HyD. The application of Foam Concrete as an alternative backfilling material will provide a solution to overcome some difficult underground situations, such as trenches with congested utilities, where backfilling or compaction of the conventional backfilling materials cannot be conducted satisfactorily and thus causing unsatisfactory permanent reinstatement of the pavement above.

b) The Permittee of an excavation permit ("XP") may propose to use Foam Concrete as an alternative backfilling material to backfill their excavated utilities trenches. The acceptance of Foam Concrete as an alternative backfilling material shall be subject to agreement by all the concerned utilities undertakings ("UUs") (i.e. the UUs with existing installations exposed within the trench and will be embedded by Foam Concrete during the backfilling) and to the satisfaction of respective maintenance section of HyD Regional Office. The Permittee shall be responsible for seeking written agreement from all concerned UUs and HyD. The Permittee shall also be responsible for seeking advice and agreement by LCSD if the use of Foam Concrete for backfilling would affect nearby trees.

c) In view of the low thermal conductivity of Foam Concrete as compared with soil, it must not be used to surround or apply on top of the existing underground power cables. Permittees using Foam Concrete to surround or apply on top of the existing underground power cables shall be held responsible for any cable failure or damage arising therefrom.

d) As Foam Concrete may flow into damaged pipes or ducts within the utilities trench, the Permittee shall check to ensure that all ducts and pipes to be embedded with Foam Concrete are in good conditions. In case of doubt, the Permittee shall consult the concerned UUs and seek their consent prior to application of Foam Concrete for backfilling a utilities trench with existing installations by others. Cracks/holes in existing utilities ducts/pipes should be sealed by appropriate materials/means (subject to agreement by the owners of the utilities ducts/pipes) before placing of Foam Concrete.

e) In general, Foam Concrete proposed for trench backfilling shall be a mixture of by-product materials, fine aggregates, admixtures or additives, water and a small amount of Portland cement, which usually has a high flowability and controlled low-strength that allows easy re-excavation, yet is strong enough for backfilling needs and support of the pavement above. The potential advantages associated with the use of Foam Concrete include: less on-site labour and equipment requirements (due to its flowable nature and easy placement with no vibration needed); and fast construction speed (from order, delivery of materials to clean up).

f) Foam Concrete may be ordered from concrete suppliers with capability to produce Foam Concrete meeting the acceptance criteria as given in Table A3.1 below and it shall be produced at their mixing plant. Mixing the Foam Concrete using pre-

packed materials on site is in general not allowed, unless the Permittee demonstrates that the use of ready mixed Foam Concrete is impractical due to site constraints or otherwise as approved by HyD. The Permittee shall, prior to placing the Foam Concrete, submit the necessary documents and justification to the Research and Development (R&D) Division of HyD to demonstrate that the proposed concrete supplier possesses the capability to produce Foam Concrete meeting the acceptance criteria. The test procedures and general acceptance criteria as given in Table A3.1 below shall be referred to in selecting the suitable Foam Concrete mix for backfilling.

g) The bottom of the trench to be backfilled with Foam Concrete shall be in relatively dry condition.

h) Foam Concrete shall not be used in locations of steep gradients. As the high flowability and self-leveling properties of Foam Concrete will lose quickly, workers can level up the surface sometime after placing of Foam Concrete on sloping surface.

i) Depending on the setting properties of the proposed Foam Concrete, the Permittee shall allow a sufficient period of temporary occupation of the site to allow the Foam Concrete to set and to achieve sufficient initial strength to take the loading of the footway/carriageway pavement or surfacing materials above, and the subsequent traffic/pedestrian loading.

j) Floating of light weight cables/pipes should be avoided by ensuring appropriate ties/weighs are attached to the concerned utilities during the placing of Foam Concrete.

k) Samples/Cubes of the proposed Foam Concrete shall be collected from the site and tested. Similar to other concrete mixes, sufficient number of concrete cube samples shall be prepared at the time of casting for subsequent testing to check against the compressive strength requirements, and the concrete supplier is required to ensure the mixes comply the specified requirements and bear the responsibility if found otherwise.

l) Due to the low compressive strength of Foam Concrete, it should be noted that traditional uniaxial compression machine with 50kN loading capacity is normally not suitable for testing such material with compressive strength less than 1 MPa. The Permittee shall perform appropriate tests to determine the suitability of load application on Foam Concrete after the backfilling to confirm that adequate strength is achieved prior to placing the pavement or surfacing materials above.

m) As Foam Concrete may not reach its initial set and provide sufficient load bearing capacity in the first several hours after placement, it will be a hazard in term of drowning. The Permittee shall ensure that the backfilled trench is properly fenced off before setting of Foam Concrete and subsequent application of the pavement or surfacing materials above.

n) If Foam Concrete is used for backfilling utilities trenches, details including the test results of the proposed Foam Concrete, written agreement by the concerned UUs, LCSD (if any) and respective maintenance section of HyD Regional Office, list of the utilities embedded by Foam Concrete, record photographs and the area of application (including length, width and depth of the trench) shall be submitted to HyD for recording in the Excavation Permit Management System (“XPMS”) and

future reference by other XP applicants.

o) If the 28 days compressive strength of the proposed Foam Concrete is subsequently found to be exceeding 1 MPa, the Permittee shall be required to propose rectification measures and to demonstrate that the hardened non-compliant Foam Concrete can still be excavated with hand tools without sharp edges to the satisfaction of HyD especially if other UUs' existing installations are embedded by the non-compliant Foam Concrete. It is deemed not necessary to remove such hardened non-compliant Foam Concrete immediately since the embedded installations may also be damaged when the Foam Concrete is really too hard to break. However, HyD may require the Permittee to remove the non-compliant Foam Concrete with appropriate agreed method (e.g. using hand tools), backfill the trench with conventional backfilling materials and then reinstate the pavement/surface above.

A3.2 Procedures relating to use of Foam Concrete as alternative backfilling material

a) If Foam Concrete other than general fill is proposed for backfilling utilities trenches without power cables, the Permittee shall submit support documents to HyD showing that agreement was sought from respective maintenance section of HyD Regional Office, LCSD (if any) and all the concerned UUs with existing installation to be embedded by the proposed alternative backfilling materials. The support documents shall be uploaded to the XPMS before placing the Foam Concrete on site.

b) The proposed Foam Concrete shall be manufactured with materials conforming to the General Specification for Civil Engineering Works (GS). Particulars of the Foam Concrete including sources, mix constituents, test reports satisfying the acceptance criteria as shown in Table A3.1 and plan showing the extent (including length, width and depth of the trench) of Foam Concrete application shall be submitted for vetting and approval at least 14 days before it is placed on site. Details of the testing standards for Foam Concrete are shown in the Table A3.2.

c) Upon delivery of the Foam Concrete to site, test of density, flowability (ASTM D6103) and hardening time of the low-strength foam concrete shall be conducted. At least four 150 mm Foam Concrete cubes shall be made from each batch, with two number for the 3 days and two number for 28 days compressive strength testing. For Foam Concrete placed at trench for footpath or carriageway, drop ball test (ASTM D6024) should be performed to demonstrate that the hardened Foam Concrete is ready for load application prior to applying the pavement or surfacing materials above. Test report of the Foam Concrete including density, flowability, time to reach penetration resistance with final set and compressive strength shall be conducted to demonstrate that the specified acceptance criteria are satisfied.

d) On submission of a Completion Notice, the Permittee shall submit to the HyD the original copy or certified true copy of the test certificate/report according to the Conditions of XP. In summary, if Foam Concrete is applied as an alternative backfilling material, the following additional information shall also be submitted:

- record photographs of the site testing and trench before and after backfilling using the Foam Concrete;
- the original or certified true copy of the test certificate/report of Foam Concrete proving that the performance of the specified acceptance criteria are met; and

- As-built plan of the area of application where the Foam Concrete is applied including length, width and depth in both pdf and shp format.

Table A3.1 - Test Procedures and Acceptance Criteria for Controlled Low-strength Foamed Concrete

No.	Test	Testing Standard	Acceptance Criteria
1.	Density	Wet density measured on site or in the plant	800 to 1800 kg/m^3
2.	Flowability	ASTM D 6103	Slump flow spread (without segregation) $\geq$200 mm
3.	Hardening Time	CS1: 2010, followed BS EN 13294	Time from completion of mixing to reach penetration resistance with final set (3.5 N/mm^2), preferably within 8 hours but not longer than 24 hours
4.	Initial Strength	ASTM D6024	If no surface water and no indentation with diameter larger than 75 mm is observed after the ball-drop test, the hardened Foam Concrete is considered ready for load application.
5.	Compressive Strength	CS1: 2010 – determination of compressive strength	Unconfined compressive strength $\leq$1 MPa at 28 days; and not less than 0.3 MPa before application of the surfacing materials

Table A3.2 - Testing Standards for Controlled Low-strength Foamed Concrete

ASTM C 6103	Flow Consistency of Controlled Low Strength Material
ASTM D 6024	Test Method of Ball Drop on Controlled Low Strength Material to Determine Suitability for Load Application

HyD Standard Drawings (an extract):

H1103	Paving Units Typical Construction Details
H1104	Details of Footway and Cycle-way
H1105	Details of Expansion Joint in Concrete Carriageway
H1106	Details of Contraction Joint in Concrete Carriageway
H1107	Details of Longitudinal Joint and Isolation Joint in Concrete Carriageway
H1109	Details of Joint Groove for Transverse Joints
H1110	Typical Transition between Concrete and Flexible Pavements
H1111 - H1112	Details of Concrete Road Slab Around Manholes or Utility Pits
H1124 - H1131	Permanent Reinstatement of Pavement
H5101 - H5102	Concrete Paving Blocks
H5114	Precast Concrete Paving Units - Dimension, Colour & Bonding Pattern
H5125 - H5127	Paving Units
H5133 – H5135	Paving Units - Run-In Details
H5136	Laying Paving Units with Geogrid
H5137	Permanent Reinstatement of Pavement - Laying Paving Units with Geogrid