

<b>1132 LEAN MIX CONCRETE SUBBASE</b>
---------------------------------------

**1 GENERAL****1.1 RESPONSIBILITIES****Objectives**

General: Provide lean mix concrete subbase and associated components, as documented.

**Performance**

~~Requirements: [complete/delete]~~

**1.2 CROSS REFERENCES****General**

Requirement: Conform to the following:

- 0136 General requirements (Construction).
- 0152 Schedule of rates – supply projects.
- 0161 Quality (Construction).
- 0167 Integrated management.
- 1101 Control of traffic.
- 1102 Control of erosion and sedimentation.
- 1112 Earthworks (Roadways).
- 1133 Plain and reinforced concrete base.

**1.3 REFERENCED DOCUMENTS****Standards**

General: The following documents are incorporated into this worksection by reference:

*Australian standards*

AS 1012	Methods of testing concrete
AS 1012.1-1993	Sampling of fresh concrete
AS 1012.3.1-1998	Determination of properties related to the consistency of concrete - Slump test
AS 1012.3.3-1998	Determination of properties related to the consistency of concrete - Vebe test
AS 1012.4.2-1999	Determination of air content of freshly mixed concrete - Measuring reduction in air pressure in chamber above concrete
AS 1012.8.1-2000	Method for making and curing concrete - Compression and indirect tensile test specimens
AS 1012.9-1999	Determination of the compressive strength of concrete specimens
AS 1012.13-1992	Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory
AS 1012.14-1991	Method for securing and testing cores from hardened concrete for compressive strength
AS 1141	Methods for sampling and testing aggregates
AS 1141.5-2000	Particle density and water absorption of fine aggregate
AS 1141.6.1-2000	Particle density and water absorption of coarse aggregate - Weighing-in-water method
AS 1141.11.1-2009	Particle size distribution – sieving method
AS 1141.12-1996	Materials finer than 75 µm in aggregates (by washing)
AS 1141.13-2007	Material finer than 2 µm
AS 1141.14-2007	Particle shape, by proportional calliper
AS 1141.18-1996	Crushed particles in coarse aggregate derived from gravel
AS 1141.22 -2008	Wet/dry strength variation
AS 1141.24-1997	Aggregate soundness - Evaluation by exposure to sodium sulfate solution
AS 1141.35-2007	Sugar

AS 1160-1996	Bituminous emulsions for the construction and maintenance of pavements
AS 1289	Methods of testing soils for engineering purposes
AS 1289.3.6.3-2003	Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis using a hydrometer
AS 1289.4.2.1-1997	Determination of the sulfate content of a natural soil and the sulfate content of the groundwater - Normal method
AS 1379-2007	Specification and supply of concrete
AS 1478	Chemical admixtures for concrete, mortar and grout
AS 1478.1-2000	Admixtures for concrete
AS/NZS 1554.3:2008	Structural steel welding – Welding of reinforcing steel
AS 2758	Aggregates and rock for engineering purposes
AS 2758.1-1998	Concrete aggregates
AS 3582	Supplementary cementitious materials for use with portland and blended cement
AS 3582.1-1998	Fly ash
AS 3583	Methods of test for supplementary cementitious materials for use with portland cement
AS 3583.13-1991	Determination of chloride ion content
AS 3600-2009	Concrete structures
AS 3799-1998	Liquid membrane—forming curing compounds for concrete
AS 3972-2010	General purpose and blended cements
AS/NZS 4671: 2001	Steel reinforcing materials
AS/NZS 4680:2006	Hot-dipped galvanized (zinc) coatings on fabricated ferrous articles
SAA HB 155 – 2002	Guide to the use of recycled concrete and masonry materials
<i>Austrroads</i>	
AGPT04C – 2009	Guide to pavement technology part 4C: Materials for concrete road pavements
AGPT04E - 2009	Guide to pavement technology part 4E: Recycled materials
AGPT04G - 2009	Guide to pavement technology part 4G: Geotextiles and geogrids
AGPT04J – 2008	Guide to pavement technology part 4J: Aggregate and source rock
AGPT08-2009	Guide to Pavement Technology Part 8: Pavement construction
<b>Other</b>	
<i>ARRB Group</i>	<i>Specification for Recycled Crushed Glass as an Engineering Material</i>
<i>NSW RMS</i>	<i>QA Roadworks Specification R83 for Jointed Concrete Base</i>

## 1.4 STANDARDS

### General

Standards: To AS 1379, AS 3600, AGPT08 and AGPT04C.

## 1.5 INTERPRETATION

### Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

CRCP: Continuously reinforced concrete.

JRCP: Jointed reinforced concrete.

PCP: Jointed plain concrete.

SFCP: Jointed steel fibre reinforced concrete pavement.

### Definitions

General: For the purposes of this worksection the following definitions apply:

- Lot: A continuous placement of up to 50 m<sup>3</sup> of subbase concrete.

- Nominated mix: Proposed concrete mix after the approval.

## 1.6 HOLD POINTS AND WITNESS POINTS

### Approval

Submissions: To the Superintendent's approval.

**Notice**

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

**HOLD POINTS table**

Clause title/Item	Requirement	Notice for inspection	Release by
<b>PRE-CONSTRUCTION PLANNING</b>			
DESIGN AND CONTROL OF CONCRETE MIX			
Nominated mix	Submit details of concrete mix and materials including NATA certificates and test results	21 working days before ordering concrete	<i>Principal Certifying Authority</i>
Variations to nominated mix and materials	Submit details of any change to nominated mix and materials	21 working days before implementing change	<i>Principal Certifying Authority</i>
<b>EXECUTION</b>			
SITE ESTABLISHMENT			
Subgrade survey	Submit work-as-executed survey of the subgrade.	2 working days before starting	<i>Principal Certifying Authority</i>
TRIAL LEAN MIX CONCRETE SUBBASE			
Construction	Inspection of the trial lean mix concrete subbase	At least 5 working days before starting the subbase works	<i>Principal Certifying Authority</i>
Deficient trial section	Submit methods used in producing deficient work for assessment	1 working day after deficiency identified	<i>Principal Certifying Authority</i>
Non-conforming trial section	Submit changes proposed for construction of new trial section	At least 5 working days before starting the subbase works	<i>Principal Certifying Authority</i>
PRODUCTION, TRANSPORT AND DELIVERY OF CONCRETE			
Concrete production and transport	Submit proposed work methods	21 working days before starting	<i>Principal Certifying Authority</i>
CONCRETE PLACING AND FINISHING			
Equipment and methods	Submit details of proposed equipment, methods and paving plan	21 working days before starting	<i>Principal Certifying Authority</i>
Acceptance criteria for subbase thickness	Submit subbase survey	Within 2 working days of completing concrete works	<i>Principal Certifying Authority</i>
TESTING OF CONCRETE FOR COMPRESSIVE STRENGTH			
Sampling, curing and testing of fresh concrete	Inspection of sampling procedure	Progressive	<i>Principal Certifying Authority</i>
Acceptance criteria	Submit test results	Progressive	<i>Principal Certifying Authority</i>
Acceptance criteria for cored concrete	Submit test results	Progressive	<i>Principal Certifying Authority</i>
REMOVAL AND REPLACEMENT OF SUBBASE			
General	Submit proposed	7 working days before	<i>Principal Certifying Authority</i>

Clause title/Item	Requirement	Notice for inspection	Release by
	method of removal	removal	<i>Authority</i>

**WITNESS POINTS table**

Clause title/Item	Requirement	Notice for inspection
<b>MATERIALS</b>		
CEMENT		
Storage and transport	Test the cement stored for longer than 3 months	Progressive
AGGREGATES		
Storage	Storage and handling to preserve quality of aggregate	Progressive
STEEL REINFORCEMENT		
General	Provide test certificates	Progressive
<b>EXECUTION</b>		
PRODUCTION, TRANSPORT AND DELIVERY OF CONCRETE		
Concrete delivery	Keep record of the delivery information	Progressive
SUBGRADE BEAMS		
General	Provide subgrade beams	7 working days before concrete placement
Excavation	Inspection of subgrade beams excavation profile	2 working days before concrete placement
CONCRETE PLACING AND FINISHING		
Equipment and methods	Give 7 days notice before starting	7 working days
Consistency	Provide consistency test results	Progressive
Ground surface conditions	Provide damp, clean and compacted ground surface	Progressive
Ambient conditions	Protect concrete when cold or hot weather and when it rains	Progressive
Evaporation and moisture loss	Prevent moisture loss when evaporation rate exceeds prescribed limits	Progressive
Paving in general	Provide base slab anchors if required	Progressive
Paving continuity	Provide a construction joint if paving is disrupted	Progressive
Alignment and surface tolerances	Remediation of surfaces above or below level tolerances	Progressive
Acceptance criteria for subbase thickness	Remove insufficiently thick subbase	As directed
JOINTS		
General	Inspection of joints	Progressive
CURING AND DEBONDING		
Application of curing compound	Check application rate with a nominated lot	Progressive
CONCRETE CRACKING		
Non-conforming concrete	Treatment as directed by Superintendent	Progressive

Clause title/Item	Requirement	Notice for inspection
Treatment of spalling	Treatment as directed by Superintendent	Progressive
<b>TESTING OF CONCRETE FOR COMPRESSIVE STRENGTH</b>		
Testing by specimens cut from the work	Cut cores in the presence of the Superintendent	Progressive
Remedial work after coring	Advise proposed method of restoration	Progressive
<b>REMOVAL AND REPLACEMENT OF SUBBASE</b>		
Removal and replacement	Damaged pavement adjacent rejected subbase	As directed

## 2 PRE-CONSTRUCTION PLANNING

### 2.1 ACTIVITY PLAN

#### General

Program: Plan the following activities:

- Provide planning resources to allocate plant and personnel for the contract period.
- Program the work to meet the constraints of **HOLD POINTS** and **WITNESS POINTS**.

### 2.2 DESIGN AND CONTROL OF CONCRETE MIX

#### Nominated mix

General: Before starting the production of the concrete for subbase works, carry out a trial mix to certify the conformance of the proposed concrete mix.

Testing authority: NATA registered laboratory.

Submission requirements:

- Details of all material constituents and test reports to the **MATERIALS** clause and the following:
  - . Cement: Brand and source.
  - . Fly ash: Powerhouse source.
  - . Admixtures: Proprietary source, type, name and dosage recommended by manufacturer.
  - . Aggregates: Source, geological type, moisture condition, proportions and grading for each type and grading for combined aggregate.
  - . Curing compounds: Application rate.
- Concrete mix design.
- Test results and certificates of conformance for the proposed concrete mix:
  - . Standard: To AS 1379.
  - . Acceptance criteria: To **CONCRETE QUALITY REQUIREMENTS**.

Submission type: **HOLD POINT**.

#### Pre-approved mix

Identical mix: To avoid testing the nominated mix, submit results from earlier testing of a mix identical with the nominated mix for approval.

Pre-approval: A mix may be pre-approved under the following conditions:

- If the mix was used in a separate contract within 12 months of the proposed works date.
- If fully approved details have been previously used.
- If the constituent materials and quality remain unchanged from those previously approved.
- If the in-service performance of the concrete incorporating the nominated mix is acceptable.

#### Variations to nominated mix and materials

Approval: Submit details of any changes to the nominated mix, its method of production or source of supply of constituents.

Submission type: **HOLD POINT**.

Non-conformance: Consider any change without approval to a material in the approved mix as a non-conforming material. Concrete containing this material may become non-conforming concrete.

### 3 MATERIALS

#### 3.1 CEMENT

**General**

Standard: To AS 3972.

**Storage and transport**

Storage: Store cement bags under cover and above ground.

Storage time: Re-test cement that has been stored for longer than three months.

Inspection type: **WITNESS POINT**.

Transport: Transport cement in watertight packaging and protect from moisture. Do not use caked or lumpy cement.

#### 3.2 FLYASH

**General**

Standard: To AS 3582.1.

#### 3.3 WATER

**General**

Standard: AS 1379.

Requirement: Clean, free from oil, acid, alkali, organic or vegetable matter.

Limits: Provide water with less than:

- 300 parts per million of chloride ion, determined by AS 3583.13.
- 400 parts per million of sulfate ion, determined by AS 1289.4.2.1.

#### 3.4 ADMIXTURES

**General**

Standard: To AS 1478.1.

Requirement: Provide admixtures free from calcium chloride, calcium formate, or triethanolamine or any other accelerator.

Dosage: Vary the dosage of chemical admixture to account for air temperature and setting time to conform to the manufacturer's recommendations.

Compatibility of admixtures: Provide certificate from the manufacturer for combinations of two or more admixtures.

**Types of admixtures**

Warm season retarder: To control slump within the limits stated in Consistency during the warm season, (October to March inclusive), use a lignin or lignin-based ('ligpol') set-retarding admixture (Type Re or Type WRRe).

Cool season retarder: During the cool season, (April to September inclusive), use only a lignin or lignin based set-retarding admixture containing not more than 6% reducing sugars (Type WRRe conforming to AS 1478.1).

Alkali contribution: For concrete mix with less than 50 kg/m<sup>3</sup> fly ash, the total alkali contribution (measured as Na<sub>2</sub>O) from all admixtures used in any mix must not exceed 0.20 kg/m<sup>3</sup>.

Types: Superplasticisers and high range water reducers (type HR, WR, Re) may be used.

### 3.5 AGGREGATES

#### General

Properties: All aggregate to AS 2758.1, AGPT04J and the following:

- Samples for testing: From dedicated stockpiles or from materials delivered to site.
- Chloride and sulfate ion contents: Less than 0.8 kg/m<sup>3</sup> and 5% respectively.
- Soluble salt content assessment: Maximum 12 months before closing of tenders.

Requirement: Clean, durable materials sourced from natural gravel, crushed stone, air-cooled iron blast furnace slag and sand. Do not use steel-plant slag.

#### Recycled concrete aggregate

Course aggregates from demolition concrete: To the recommendations of SAA HB155 and AGPT04E.

Blending: If blending coarse recycled concrete aggregate with natural aggregates make sure substitution rates are below 30 %.

#### Recycled crushed glass

*Requirement: Meet the recommendations of the ARRB Group in Specifications for Recycled Crushed Glass as an Engineering Material and all other technical criteria for fine aggregate.*

*Blending: Maximum of 30% by mass of the total fine aggregate.*

#### Additional properties for fine aggregate

General: To the **Fine aggregate properties table**.

#### Fine aggregate properties table

Property	Requirement	Test method
Bulk Density	1200 kg/m <sup>3</sup> minimum	AS 1141.4 <sup>(1)</sup>
Water Absorption	5.0% maximum, except slag aggregate: 6.0%	AS 1141.5 and AS 1141.6.1
Material finer than 75 µm	Maximum 10.0 %	AS 1141.12
Material finer than 2 µm	Maximum 1.0 %	AS 1141.13
Soundness	12 % max weighted average loss	AS 1141.24
Organic impurities	Maximum 0.5 %	AS 1289.4.1.1
Sugar content	Less than 1 part in 10,000	AS 1141.35

Notes: <sup>(1)</sup> 'Bulk density' in AS 2758.1 means the same as 'unit mass' in AS 1141.4.

Sodium sulfate soundness: Do not exceed the limits shown in the **Sodium sulfate soundness limits table** as determined by AS 1141.24.

#### Sodium sulfate soundness limits table

Australian Standard Sieve	% Loss by mass
4.75 mm to 2.36 mm	4
2.36 mm to 1.18 mm	6
1.18 mm to 600 µm	8
600 µm to 300 µm	12

Blending: If two or more fine aggregates are blended, apply the above limits to each constituent material.

Grading: Provide fine aggregate and grading determined by AS 1141.11.1 within the limits shown in the **Fine aggregate grading table**.

**Fine aggregate grading table**

Australian Standard sieve	Proportion passing (% of mass of sample)	Deviation from proposed grading (% of mass of sample)
9.50 mm	100	-
4.75 mm	90–100	± 3
2.36 mm	65–95	± 10
1.18 mm	40–80	± 10
600 µm	24–52	± 10
300 µm	8–25	± 5
150 µm	1–8	± 2
75 µm	0–3	-

**Additional properties for coarse aggregate**

General: To the **Coarse aggregate properties table**.

**Coarse aggregate properties table**

Property	Specification limits	Method
Bulk Density	1200 kg/m <sup>3</sup> minimum	AS 1141.4 <sup>(1)</sup>
Water absorption	Slag: 6 % max Other: 5 % max	AS 1141.6.1
Material finer than 75 µm	Maximum 2.0 %	AS 1141.12
Material finer than 2 µm	Maximum 1.0 %	AS 1141.13
Particle shape, 2:1 and 3:1 ratios	Maximum 35 % and 10 %	AS 1141.14
Wet strength	Minimum 50 kN	AS 1141.22
Wet/dry strength variation	Maximum 35 %	AS 1141.22
Soundness - loss in mass	Maximum 9.0%	AS 1141.24
Fractured faces (two or more)	Minimum 80%	AS 1141.18

Notes: <sup>(1)</sup> 'Bulk density' in AS 2758.1 means the same as 'unit mass' in AS 1141.4.

Grading: Provide coarse aggregate with grading determined by AS 1141.11.1 within the limits given in the **Coarse aggregate grading table**.

**Coarse aggregate grading table**

Australian Standard sieve	Proportion passing (% of mass of sample)	Deviation from proposed grading (% of mass of sample)
26.50 mm	100	
19.00 mm	95–100	± 2
13.20 mm	(accepted design mix)	± 5
9.50 mm	25–55	± 5
4.75 mm	0–10	± 3
2.36 mm	0–2	

**Storage**

Storage areas: Locate the storage area to prevent the aggregates becoming intermixed or mixed with foreign materials or segregated.

Inspection type: **WITNESS POINT**.

**3.6 CURING AND SURFACE DEBONDING COMPOUNDS****General**

Standards: AS 3799, AS 1160 and AGPT04C clause 6.



Efficiency index: Minimum 90 % when tested to AS 3799 Appendix B.

#### Curing compounds and debonding

Type	Suitability with bituminous/asphaltic surfacing		Base type
	Wearing surface	No wearing surface	
C5 hydrocarbon resin compound conforming to AS 3799 Class B and with no aromatic hydrocarbon additions. *	Yes	Yes	JRCP
Water borne hydrocarbon resin or styrene butadiene resin (SBR) conforming with AS 3799 Class Z. *		Yes	JRCP
Bitumen emulsion grade CRS/170 conforming to AS 1160. *	Yes	Yes	
White pigmented wax emulsion Class A Type 2. *		Yes	PCP, JRCP, CRCP, SFCP
Debonding bitumen sprayed seal with 7 mm aggregate	Yes	Yes	PCP, JRCP, CRCP

Notes:  
\* For paving in NSW from November to March, use a Type 2 compound which contains a titanium dioxide reflective pigment. At all other times, use a Type 1-D compound.

### 3.7 STEEL REINFORCEMENT

#### General

Standard: To AS/NZS 4671.

Grade, type and size: As shown on the drawings.

Surface condition: Free from loose mill scale, rust, grease, mud, mortar or any other material which would reduce the bond between the reinforcement and the concrete.

Certification: Provide test certificates for the steel reinforcement to AS/NZS 4671.

Activity type: **WITNESS POINT**.

Bar chairs: Plastic bar chairs or plastic tipped wire chairs capable of withstanding a load of 200 kg mass on the chair for one hour at  $23 \pm 5^\circ\text{C}$  without malfunction.

Galvanised bars: Hot dipped to AS/NZS 4680.

### 3.8 CONCRETE QUALITY REQUIREMENTS

#### Compressive strength

Minimum compressive strength:

- At 7 days: 4 MPa.
- At 28 days: 5 MPa.

Maximum compressive strength:

- At 28 days: 15 MPa.
- For drying shrinkage less than  $400 \mu\epsilon$ : 20 MPa.

Testing: To **TESTING OF CONCRETE FOR COMPRESSIVE STRENGTH**.

#### Drying shrinkage

Standard: To AS 1012.13.

Maximum drying shrinkage after 21 days air drying:

- $450 \mu\epsilon$  if maximum aggregate size  $> 20$  mm.
- $550 \mu\epsilon$  if maximum aggregate size  $\leq 20$  mm.

**Consistency**

Standard: To AS 1012.3.1.

Slump range:

- For mechanically placed concrete: 25 mm to 40 mm.
- For hand placed concrete: 50 mm to 65 mm.

Slipform concrete mix: Vebe reading of the trial mix to AS 1012.3.3.

**Air content**

Standard: To AS 1012.4.2.

Maximum air content of fresh concrete:  $5.0 \pm 2.0\%$ .

**Special circumstances**

Approval: If concrete qualities do not conform to the above, provide approval before ordering concrete.

**3.9 CONCRETE FOR SUBGRADE BEAMS****General**

Strength: 32 MPa normal class to conform to AS 1379.

Aggregate size: Maximum nominal size 20 mm.

Slump at the point of placement: 50 to 80 mm.

**3.10 BINDER CONTENT FOR LEAN MIX CONCRETE****General**

Binder content: The hydraulic, cementitious binder content to conform to the following table:

Mix Category	Flyash (kg/m <sup>3</sup> ) <sup>(1)</sup>	Cement (kg/m <sup>3</sup> ) <sup>(1)</sup>	Total binder (kg/m <sup>3</sup> ) <sup>(1)</sup>
Subbase	100 minimum	90 minimum	250 minimum
<sup>(1)</sup> per yielded cubic metre of concrete			

**4 EXECUTION****4.1 PROVISION FOR TRAFFIC****General**

Requirement: Conform to *1101 Control of traffic*.

**4.2 SITE ESTABLISHMENT****Subgrade survey**

Measure the subbase invert levels: If the underlying layer is required to be spray sealed, take levels on the top of the seal and after removal of foreign or loose material such as aggregate.

Method: Report levels to the nearest mm and survey on 5.0 m grid on a plan area.

Requirement: Submit work-as-executed survey of the subgrade to the full extent of the works. Highlight any locations where the actual level is higher than the design levels.

Submission type: **HOLD POINT**.

Non-conforming levels: In the case of non-conforming levels, locally redesign the pavement levels as directed by the Superintendent.

**4.3 TRIAL LEAN MIX CONCRETE SUBBASE****Construction**

Requirement: Before starting the paving works, construct a trial section of lean mix concrete subbase as follows:

- Incorporate the trial section into the subbase works.
- Construct separate trial sections for each subbase type.

- Length:
  - . 50 m to 100 m for mechanical placing.
  - . 15 m to 50 m for manual placement.
- Width: Same as proposed for the work.

Materials and methods: Construct the trial lean mix concrete subbase using the materials, concrete mix, equipment and methods for the entire subbase works.

Inspection: Notify the Superintendent for inspection of the completed trial lean mix concrete subbase.

Approval: Obtain approval of the trial section before starting the remaining works.

Inspection type: **HOLD POINT**.

#### **Deficient trial section**

Assessment: If there are deficiencies in the trial concrete subbase, review the method, equipment, materials and personnel and submit a report.

Submission type: **HOLD POINT**.

#### **Non-conforming trial section**

General: If the trial concrete subbase is not approved, conform to the following:

- Submit changes proposed for construction of the new trial section including the equipment, materials, mix, plant or rate of paving.
- Remove the non-conforming subbase and make good any damage caused by such removal.
- Construct the new trial subbase in conformance with **REMOVAL AND REPLACEMENT OF SUBBASE**.

Inspection type: **HOLD POINT**.

### **4.4 PRODUCTION, TRANSPORT AND DELIVERY OF CONCRETE**

#### **General**

Standard: To AS 1379.

#### **Concrete production and transport**

General: Submit the proposed work methods for the following:

- Handling, storing and batching of materials for concrete.
- Monitoring and measuring the constituent materials for concrete.
- Mixing and transport of concrete.

Submission type: **HOLD POINT**.

#### **Concrete delivery**

Delivery dockets: For each batch of mix, keep record of the following delivery information:

- Supplier name and location.
- Volume of material supplied.
- Product constituents.
- Dispatch time and date.

Inspection type: **WITNESS POINT**.

Delivery time limits: After addition of the cement to the aggregate, concrete to be incorporated into the works within:

- 90 minutes if transported by truck mixer or agitator.
- 60 minutes if transported by non-agitating trucks.

### **4.5 SUBGRADE BEAMS**

#### **General**

Location: Provide below the subbase at expansion joints and isolation joints in the concrete base as shown in the drawings or as directed. Construct subgrade beams before the subbase.

Inspection type: **WITNESS POINT**.

Extent: Full length of joints or as shown on the drawings.

#### **Excavation**

Dimensions and levels: Excavate to the dimensions shown on the drawings. Finish the top surface of the subgrade beam level with the top of the subgrade.

Method: Remove all loose material and trim the vertical faces to neat lines. Re-compact the bottom of the trench as required, to the degree of consolidation of the adjacent undisturbed material.

Inspection type: **WITNESS POINT**.

#### **Concrete**

Minimum compressive strength at 28 days: 32 MPa.

#### **Steel reinforcement**

Conform to the following:

- Reinforcement dimensions and shapes as shown on the drawings.
- Bent to an internal bend radius at least twice the diameter of the bar.
- Do not bend or straighten in a manner that will damage the material.
- Do not use with kinks or bends not shown on the drawings.
- Do not heat for the purpose of bending.

Bar splicing: Fabricate all reinforcement in the lengths indicated on the drawings. Splice to conform to the drawings. Obtain approval for any additional splicing by location and method.

Plan lengths: Conform to the following for length of lapped splices for unhooked bars not shown on the drawings will be as follows:

- Plain bars, Grade 250: 40 bar diameters.
- Deformed bars, Grade 500: 40 bar diameters.
- Hard-drawn wire: 50 bar diameters.
- Reinforcement fabric: Overlap between the outermost wire in each sheet of fabric transverse to the direction of the splice greater than the pitch of the transverse wires plus 25 mm.

Lapped splices: The ends of the bars forming a lapped splice must be welded or securely wired together in at least 2 places. Welding to conform to AS/NZS 1554.3.

On-site bending: Do not use heat for bending of reinforcement.

#### **Construction and protection**

Voids: If any loose material is removed, fill the voids with mortar or concrete and screed to provide a surface flush with the top of the subgrade beam.

Finish: Use a steel float to produce a smooth surface finish, free of any texture.

Protection: Protect from damage by plant, motor vehicles and the paving operation.

Curing: Cure the top surface of the subgrade beam before placing the subbase.

Bond breaker: Apply to the top surface of the subgrade beam, 24 to 72 hours before placing of subbase concrete.

### **4.6 CONCRETE PLACING AND FINISHING**

#### **Equipment and methods**

Proposal: Submit the full details of the equipment and methods proposed for placing and finishing the concrete subbase, together with a paving plan showing proposed paving widths, sequence and estimated daily outputs.

Submission type: **HOLD POINT**.

Notice: Give notice before construction of the subbase on any section of work including the trial subbase.

Inspection type: **WITNESS POINT**.

**Consistency**

Requirement: Supply concrete of a homogeneous, dense and non-segregated mass with low bleeding. If bleed water flows over the slab edge, cease paving until the mix is redesigned and approved.

Concrete edges: Construct edges with no sag or tear.

Consistency check: Perform slump test on each truckload of concrete.

Slump tolerances:

- $\pm 10$  mm for slipformed concrete.
- $\pm 15$  mm for manually placed concrete.

Test results: Provide all consistency test results.

Inspection type: **WITNESS POINT**.

**Ground surface conditions**

General: Provide ground surface for the concrete subbase that is damp, clean and free of loose or foreign matter and compacted.

Inspection type: **WITNESS POINT**.

**Ambient conditions**

Air temperature: If the air temperature in the shade is below 10°C or above 30°C, protect the concrete from cold or hot weather. Provide detailed proposals for protection of concrete in cold or hot weather.

Concrete temperature limits: 5°C to 35°C.

Rain: In case of rain, protect the concrete from rain damage and provide detailed proposals for protection procedures.

Inspection type: **WITNESS POINT**.

Records: Measure and record concrete temperature and wind velocity at the point of concrete placement throughout the course of the work.

Equipment: Provide and maintain all equipment necessary for such measuring and recording.

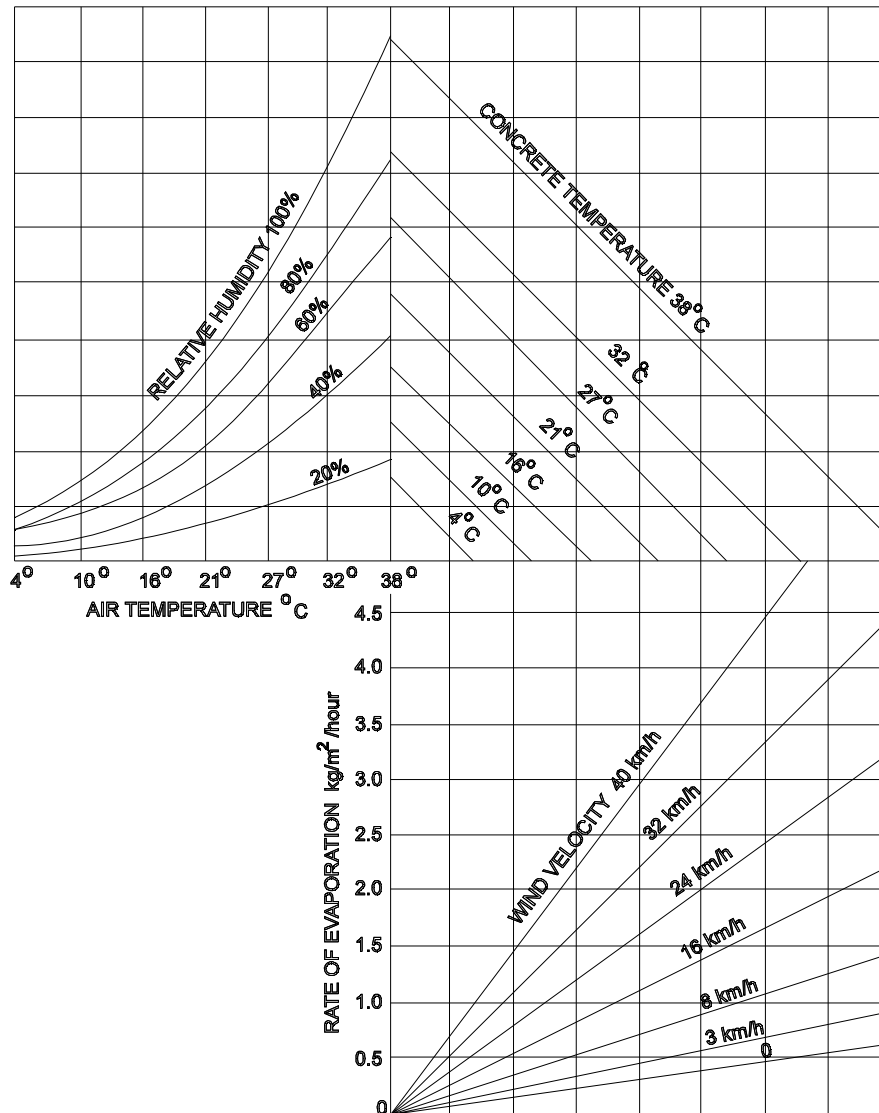
**Evaporation and moisture loss**

Evaporation limit: Take precautionary measures when the value of rate of evaporation, as determined from the **Rate of evaporation graph**, exceeds 0.50 kg/m<sup>2</sup>/hr. Obtain approval for the measures used or cease work.

Inspection type: **WITNESS POINT**.

Evaporation retarder: If an evaporation retarder is used to prevent excessive moisture loss, apply by fine spray after all finishing operations are complete, except minor manual bull-floating. Re-application of evaporation retarder after level floating may be directed as required.

### Rate of evaporation graph



#### Using the Rate of evaporation graph

Information: The graph shows the effects of air temperature, humidity, concrete temperature and wind velocity on the rate of evaporation of water from freshly placed and unprotected concrete.

Example: To determine the evaporation rate from the graph using air temperature at 27°C, relative humidity at 40%, concrete temperature at 27°C and a wind velocity of 26 km/h:

- Enter the graph at the air temperature of 27°C.
- Move vertically to intersect the curve for relative humidity encountered 40%.
- Move horizontally to the respective line for concrete temperature of 27°C.
- Move vertically down to the respective wind velocity curve and interpolate for 26 km/hour.
- Then move horizontally to the left to intersect the scale for the rate of evaporation.
- The rate of evaporation would be 1.6 kg/m<sup>2</sup>/hour in this example.

#### Paving in general

Surface finish:

- Generally: Steel screed or float finish.
- For asphaltic base or concrete base with bitumen seal: Hessian dragged finish.
- For concrete base without bitumen seal: Smooth surface without dimpling, ridges or recesses.

Base slab anchors: During construction of the subbase, make provision for the construction of base slab anchors at the locations shown on the drawings.

Inspection type: **WITNESS POINT**.

**Paving continuity**

Continuity: Make sure the supply of concrete and the concrete paving operation are continuous so that the mechanical paver is not stopped due to lack of concrete.

Disruptions: If disruptions occur in mechanical or hand paving, form a construction joint before restarting the paving operations.

Inspection type: **WITNESS POINT**.

**Mechanical paving**

Paver machine: Conform to the following:

- A self-propelled machine with a gross operating mass of not less than 4 tonnes per lineal metre of paved width.
- Capable of paving at a speed of one metre per minute or less as required to enable the continuous operation of the paver and obtain the required degree of compaction.
- Include an automatic control system with a sensing device to control line and level to the specified tolerances.
- Able to spread the mix uniformly and regulate the flow of mix to the vibrators without segregation of the components.
- Contain internal vibrators capable of compacting the full depth of the concrete.
- Contain an adjustable extrusion screed and/or conforming plate to form the slab profile and produce the required finish on all surfaces.
- Capable of paving in the slab widths or combination of slab widths and slab depths shown on the drawings.

Supporting surface: Provide a supporting surface for the tracks of the paver, curing machine and any other equipment in the paving and curing train to be in a smooth and firm condition.

**Hand placing**

Restriction: Use hand placement only in areas where mechanical placement is not practical. Obtain approval before starting the works.

Formwork: Provide formwork as follows:

- Designed and constructed so that it can be removed without damaging the concrete.
- True to line and grade.
- Braced to support wet concrete.
- Mortar tight.
- Prevents adhesion of concrete to the forms.

Placing in forms: Deliver concrete in agitator trucks and deposit uniformly in the forms without segregation.

Compaction: Compact the concrete by poker vibrators and by two passes only of a hand-guided vibratory screed traversing the full width of the slab on each pass.

Build-up: Prevent any build-up of concrete between the forms and vibratory screed.

Standby vibrators: Require minimum of 1 standby vibrator and  $\frac{1}{4}$  of the vibrator number in use.

Vibrators: Not less than 1 internal vibrators for each 10 m<sup>3</sup> of concrete placed per hour. For paving widths greater than 2.5 m a minimum of 2 vibrators must be used.

Screed: Compact and finish the slab by at least 2 passes of a hand guided vibratory screed traversing the full width of the slab on each pass.

**Alignment and surface tolerances**

Outer edge: Construct outer edges of the subbase to be square to the subgrade and 50 mm wider than the plan position of the base formation with a tolerance of  $\pm 25$  mm.

Longitudinal construction joint: If an edge of a slab is to form a longitudinal construction joint line to conform to **Longitudinal construction joints** for the allowable horizontal alignment tolerances.

Subbase tolerance: +0 mm to -20 mm deviation from the design level.

Finished surface tolerance:  $\pm 5$  mm deviation from a 3 m straight edge.

Remedial works: Remove concrete found to be above level. If concrete is found to be below level tolerance, make it up with base concrete.

Inspection type: **WITNESS POINT**.

**Acceptance criteria for subbase thickness**

Subbase survey: Perform survey level runs after the placement of subbase, taken on a 5 m grid on the plan area. Round off the measurements to the nearest 5 mm.

Subbase thickness determination: Assess the subbase thickness by comparing the subbase survey to **SITE ESTABLISHMENT, Subgrade survey**.

Requirement: Submit work as executed survey of the subbase to the full extent of works.

Highlight locations where the actual level is higher or lower than the design levels.

Submission type: **HOLD POINT**.

Verification of subbase thickness: Cut concrete cores from the pavement edge if directed by the Superintendent.

Accepted tolerance: Accept subbase which is 10 mm or less below the theoretical thickness if represents isolated sections within a lot and such sections comprise less than 5 % of the area of the lot.

Non-conforming thickness: After making due allowance for the tolerances, remove the subbase which is more than 20 mm below the theoretical thickness.

Inspection type: **WITNESS POINT**.

**Protection of work**

Traffic restrictions: Do not allow traffic or construction equipment, other than that associated with testing, on the subbase until the strength of the subbase has reached at least 4.0 MPa.

Damage: Rectify any damage caused to the subbase.

## 4.7 JOINTS

### General

Inspection: Inspect the location and condition of all joints.

Inspection type: **WITNESS POINT**.

### Transverse construction joints

General: Conform to the following:

- Do not scabble.
- Provide only at discontinuities in the placement of concrete determined by paving operations.
- Construct normal to the edge line and as shown on the drawings.
- 10 mm maximum deviation from a 3 m straightedge with due allowances for any planned curvature.
- Make smooth across the joint.

### Longitudinal construction joints

General: Conform to the following:

- Do not scabble.
- Form within 100 mm of the base longitudinal joints or as shown in the drawings.
- 20 mm maximum deviation from the plan or nominated position.
- 10 mm maximum deviation from a 3 m straightedge with due allowances for any planned curvature.
- Make smooth across the joint.



- Make perpendicular to the subgrade surface.

#### 4.8 CURING AND DEBONDING

##### Application of curing compound

Application method: Fine spray immediately following the surface finishing.

Minimum application rate: As stated on the certificate of conformance or at the following rates, whichever rate is the greater.

- Generally: 0.2 litres/m<sup>2</sup>
- Bitumen emulsion: 0.5 litres/m<sup>2</sup> of residual bitumen.
- Hand application: Increase the rates by 25%.

Calculations of application rate: Calculate the amount of curing compound applied to a measured area of a lot nominated by the Superintendent.

Inspection type: **WITNESS POINT**.

Requirement: If the base consists of asphaltic concrete, do not use wax emulsion curing compounds.

Curing period: Maintain the curing membrane intact for seven days after placing the concrete.

Damage: Make good any damage to the curing membrane by hand spraying of the affected areas.

##### Application of bond breaker

Preparation: Immediately before the application of bond breaker, clean the subbase surface of all loose, foreign and deleterious material.

Application rate: Minimum of 0.2 litres/m<sup>2</sup>.

Timing: Apply the bond breaker within the following time frame:

- After the subbase has achieved strength of 4.0 MPa.
- After the subbase level schedules have been completed.
- Within 49 days of placement of the subbase or within 14 days of the achievement of strength conformity, whichever occurs first.
- After the curing compound is applied.
- Minimum 72 hours before placement of the base.

Type of curing compound: If wax emulsion is used, make sure this is the same wax emulsion as used for curing.

#### 4.9 CONCRETE CRACKING

##### Typical subbase cracks

Definition: Full-depth transverse cracks continuous for the full width of the paving run at approximately 3-15 m centres.

Remedial work: Not required.

##### Plastic shrinkage cracks

Definition: Discrete cracks of length less than 300 mm and a depth less than 50 % of the slab thickness that do not intersect a formed edge.

Remedial work: To **Corrective action**.

##### Additional longitudinal and transverse cracks

Definition: Other than typical subbase cracks and plastic shrinkage cracks with cumulative length of cracking in excess of 2 m in any 25 m<sup>2</sup> area of subbase.

Remedial work: To **Corrective action**.

##### Corrective action

Strain alleviating membrane strip: Apply 300 mm minimum width geotextile backed polymer modified bitumen strip over the crack before the placement of the first asphalt base layer or concrete base.

Installation: To manufacturer's recommendations and AGPT04G.

Wax emulsion: Provide double application of wax emulsion for a width of 300 mm along the crack when a concrete base is required.

#### **Non-conforming concrete**

Criteria: Remove and replace subbase if one or more of the following occurs:

- Transverse cracks over 300mm in length at average spacing of less than 2 m over a length of 5 metres.
- Longitudinal cracks for a contiguous length exceeding 5 m.
- Cracks over 300 mm in length within a distance of 1.5 m from a construction joint, isolation joint or free edge.

Inspection type: **WITNESS POINT**.

#### **Treatment of spalling**

Preparation of subbase: Immediately before the treatment, clean the subbase surface of all loose, foreign and deleterious material to the satisfaction of the Superintendent. Wet the area and sprinkle with neat cement.

Inspection type: **WITNESS POINT**.

Treatment method: If the spalled area is greater than 10 mm deep and 15 mm wide infill the area with 6:1 sand/cement mortar and screed the surface flush with the surrounding concrete.

Spalling repair time: Complete treatment no earlier than five working days before the application of the bond breaker.

### **4.10 TESTING OF CONCRETE FOR COMPRESSIVE STRENGTH**

#### **Sampling, curing and testing of fresh concrete**

Method of sampling: AS 1012.1.

Sampling locations: Take samples from the delivery vehicles or from concrete deposited ready for placement.

Minimum frequency of sampling: To AS 1379 and the following:

- At least one sample for the concrete being placed at one time.
- At least one sample for each lot.

Inspection type: **HOLD POINT**.

Moulding: Mould at least two test specimens from each sample to AS 1012.8.1. Supply the number of moulds required for the documented frequency of testing.

Curing: Carry out initial curing on site between 18 to 36 hours. Inspect, cap and mark specimens for identification before sending to testing laboratory.

Transport: Do not transport specimens within 3 hours of being cast.

Testing of specimens: Test each specimen for compressive strength to AS 1012.9.

Test authority: NATA registered laboratory.

Compressive strength of each sample: Average compressive strength of the two specimens taken from the sample and tested at the same age.

Age of specimens: 28 days.

Adjustment due to age: If specimens are tested at more than 28 days after moulding, obtain the equivalent 28 day compressive strength by dividing the test compressive strength by the factor shown in the **Concrete age conversion factors table**. For intermediate ages determine the factor by interpolation.

**Concrete age conversion factors table**

Age of specimen at time of test (days)	Factor
28	1.00
35	1.02
42	1.04
49	1.06
56	1.08
70	1.10
84	1.12
112	1.14
140	1.16
168	1.18
196	1.20
224	1.22
308	1.24
365 or greater	1.25

**Acceptance criteria**

Assessment process of test results: Project assessment to AS 1379.

Reports and records of test results: To AS 1012. Submit test results and keep copies on site.

Submission type: **HOLD POINT**.

Average compressive strength of samples representing the lot: To **CONCRETE QUALITY REQUIREMENTS, Compressive strength**.

Non-conforming concrete: Perform coring test to **Testing by specimens cut from the work**

**Testing by specimens cut from the work**

General: If the subbase concrete strength is non-conforming, request permission to core the in situ subbase for testing of the actual compressive strength representing the particular lot.

Testing authority: NATA registered laboratory nominated by the Contractor.

Specimens' characteristics:

- Shape: Cylindrical cores.
- Preferred dimension of cores: 100 mm diameter.
- Minimum dimension of cores: 75 mm diameter or two and one half times the nominal size of the coarse aggregate, whichever is the greater.
- Tolerance in uncapped state: 5 mm.
- Minimum length: Same as the core diameter.

Frequency of coring: One core for each lot or one core for the area of subbase placed between any two consecutive construction joints, whichever is the lesser. Nominate the lot represented by each core at the time of sampling and record before testing.

Coring procedure: Carry out core cutting in the presence of and at the locations nominated by the Superintendent.

Inspection type: **WITNESS POINT**.

Curing of cores: Despatch cores to arrive at the testing laboratory within 24 hours of the core being cut from the subbase. Start wet curing within 24 hours of the receipt of the cores.

Test method: To AS 1012.14 and the following:

- Adjust the test strength determined for form by a factor to conform to **Core strength factor table**.
- Only use wet conditioning.

**Core strength factor table**

Length/diameter ratio	Correction factor
2.00	1.00
1.75	0.98
1.50	0.96
1.25	0.93
1.00	0.89
Interpolate factors for intermediate form ratios.	

**Remedial work after coring**

Restoration: Advise proposed method of restoration.

Inspection type: **WITNESS POINT**.

**Acceptance criteria for cored concrete**

Equivalent 28 days compressive strength of the specimens cut from work: To

**CONCRETE QUALITY REQUIREMENTS, Compressive strength.**

Test results: Submit the test results for approval.

Submission type: **HOLD POINT**.

Non-conforming concrete: To **REMOVAL AND REPLACEMENT OF SUBBASE.**

**4.11 REMOVAL AND REPLACEMENT OF SUBBASE****General**

Non-conforming subbase: Remove rejected subbase and replace to conform to this clause.

Replace rejected subbase, which extends more than 25 m longitudinally by mechanical means unless the slabs are odd-shaped or mismatched.

Proposed method: Submit details of the proposed methods of carrying out the work that will prevent damage to the adjoining subbase.

Submission type: **HOLD POINT**.

**Subbase sawcuts**

Transverse sawcut:

- Make a transverse sawcut the full depth of the subbase layer at each end of the section of subbase to be removed.
- Make the sawcut normal to the control line.
- Do not over-saw into the adjoining base or underlying sub base.

Longitudinal sawcuts:

- Locate the cut 150–300 mm offset from planned longitudinal contraction joints in the overlying base.
- Do not to extend more than 250 mm past the transverse sawcut at each end of the section to be removed.

Over-sawing: Do not over-saw on any additional internal sawcuts made to aid the removal of the subbase.

**Removal and replacement**

Disposal: Dispose the removed subbase slabs.

Damage to adjoining pavement: Remove and replace any pavement adjacent to the original area of rejected subbase damaged by the operations.

Inspection type: **WITNESS POINT**.

Replacement of bondbreaker: After construction of the replacement subbase, prepare and debond the pavement in conformance with this worksection.

#### 4.12 LIMITS AND TOLERANCES

##### Application

Summary: The limits and tolerances applicable to this worksection are summarised in

##### Summary of limits and tolerances table.

##### Summary of limits and tolerances table

Activity	Limits/Tolerances	Worksection clause/ subclause
<b>Materials for concrete</b>		
Properties for coarse aggregates	To the <b>Coarse aggregate properties table</b>	AGGREGATES, Additional properties for coarse aggregate
Aggregates grading	Deviation from submitted sample not greater than <b>Fine aggregate grading table</b>	AGGREGATES, Additional properties for fine aggregate
<b>Concrete</b>		
Drying Shrinkage at 21 days: -Maximum aggregate size > 20 mm -Maximum aggregate size ≤ 20 mm	maximum 450 µε maximum 500 µε	CONCRETE QUALITY REQUIREMENT S, Drying shrinkage
Consistency	Mechanically placed: 25 mm - 40 mm Hand placed: 50 mm - 65 mm	CONCRETE QUALITY REQUIREMENT S, Consistency
Air content	3% to 7%	CONCRETE QUALITY REQUIREMENT S, Air content
Thickness	Remove concrete if thickness > 20 mm below documented thickness.	CONCRETE PLACING AND FINISHING, Acceptance criteria for subbase thickness
Mixing and transport	After addition of cement to the aggregate incorporate concrete into the work within: -90 minutes where transported by truck mixer or agitator. -60 minutes where transported by non agitating trucks.	PRODUCTION, TRANSPORT AND DELIVERY OF CONCRETE, Concrete delivery
Placing	Protect concrete when the air temperature in the shade is < 10°C or > 30°C.	CONCRETE PLACING AND FINISHING, Ambient conditions
	Protect concrete when the Rate of Evaporation exceeds 0.50 kg/m <sup>2</sup> /h.	CONCRETE PLACING AND FINISHING, Evaporation and moisture loss

Activity	Limits/Tolerances	Worksection clause/ subclause
<b>Alignment and surface tolerances</b>		
Horizontal alignment	Outer edges not to deviate from plan position by more than $\pm 25$ mm.	CONCRETE PLACING AND FINISHING, Alignment and surface tolerances
Vertical alignment - subbase	Level on top surface: + 0 mm to - 20 mm deviation from that shown on the drawings.	
Surface finish	Top surface: $\pm 5$ mm deviation from a 3 m straightedge laid in any direction	
<b>Joints</b>		
Transverse construction joints	$\pm 10$ mm deviation from a 3 m straight edge.	JOINTS, Transverse construction joints
Longitudinal construction joints	- $\pm 20$ mm deviation from the plan or nominated position. - $\pm 10$ mm deviation from a 3 m straight-edge placed along the joint after allowing for any curvature.	JOINTS, Longitudinal construction joints
<b>Bond breaker</b>		
Wax emulsion	Minimum 0.2 l/ m <sup>2</sup> , not earlier than 72 hours before placement of base.	CURING AND DEBONDING, Application of bond breaker

## 5 MEASUREMENT AND PAYMENT

### 5.1 MEASUREMENT

#### General

Payments made to the Schedule of Rates: To *0152 Schedule of rates – supply projects*, this worksection, the drawings and Pay items **1132.1 to 1132.5** inclusive.

Lump Sum prices: Not acceptable.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

#### Methodology

The following methodology will be applied for measurement and payment:

- The cost of all work, materials and equipment is included in the schedule rate for each **Pay item**. Concrete and steel reinforcement for subgrade beams is measured and paid to conform to this worksection. Base slab anchors are measured and paid to conform to *1133 Plain and reinforced concrete base*.

### 5.2 PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
<b>1132.1 Supply and place concrete in subbase</b>	m <sup>3</sup> of concrete in place. Volume calculated from width, length and depth shown on drawings or directed by Superintendent.	All costs associated with all documentation and approvals and the supply and placing of concrete subbase in place including construction joints.
<b>1132.2 Finish and cure subbase</b>	m <sup>2</sup> of subbase. Area calculated from width, length and depth shown on	All costs associated with the finishing and curing of the subbase.

Pay items	Unit of measurement	Schedule rate scope
	drawings or directed by Superintendent. Do not include sides of slabs in area calculation.	
<b>1132.3 Crack treatment by stress alleviating membrane strip (for asphalt base)</b>	Linear metre of strip. Length is actual length measured on site.	All costs associated with the supply and installation of membrane strip.
<b>1132.4 Bond breaker</b>	m <sup>2</sup> of bond breaker. Area based on actual length measured on site and design width shown on drawings. Take no account of tolerances.	All costs associated with the supply and installation of bond breaker.
<b>1132.5 Subgrade beams</b>	m <sup>3</sup> of concrete. Volume determined from width, length, and depth shown on drawings or as directed by Superintendent.	All costs associated with the supply, placing and installation of concrete and reinforcing steel for subgrade beams.