

SPECIFICATION 406

ROCK PROTECTION

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SPECIFICATION 406
ROCK PROTECTION
REVISION REGISTER

Date	Clause Number	Description of Revision	Authorised By
20/09/2017	Table 406.1	Added Half Tonne	A/SWE
12/12/2016	Whole Document	Reformatting	SCO
28/11/2016	Table 406.1	Renaming of Rock Class	SWE
03/03/2009	Table 406.1	Column 4 removed "Minimum" from the title.	SWE
01/08/2006	Whole document	Complete revision of Issue No 3 to new format	MCP

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SPECIFICATION 406

ROCK PROTECTION

GENERAL

406.01 SCOPE

1. The work under this specification consists of the supply and construction of all types of rock protection linings and rock pitching.

406.02 REFERENCES

1. Australian Standards, MAIN ROADS Western Australia Standards and MAIN ROADS Western Australia Test Methods are referred to in abbreviated form (e.g. AS 1234, MRS 67-08-43 or WA 123). For convenience, the full titles are given below:

Australian Standards

AS 1141.22	Methods for Sampling and Testing Aggregates: Method 22: Wet/Dry Strength Variation
AS 1726	Geotechnical Site Investigations
AS 2758.4	Aggregates and Rock for Engineering Purposes Part 4: Aggregates for gabions baskets and wire mattresses
AS 3704	Geotextiles – Glossary of Terms
AS 3705	Geotextiles – Identification, Marking and General Data
AS 3706	Geotextiles – Method of Tests

Other Standards & Publications

AUSTROADS Waterway Design, A Guide to the Hydraulic Design of
Bridges, Culverts and Floodways. Publication No. AP-23/94
AUSTROADS Guide to Geotextiles. Publication No. AP-3/90

MAIN ROADS Specifications

Specification 302 EARTHWORKS

406.03 – 406.05 NOT USED

PRODUCTS AND MATERIALS

406.06 SOURCE ROCK

1. Source rock for rock protection and rock pitching shall consist of clean, sound, durable, hard rock. Rock used shall be fresh to slightly weathered and of very high to extremely high strength, as defined in AS 1726. Rock that is laminated, fractured, porous or otherwise physically weak is unacceptable. Flat slab-like rock pieces, with the breadth or thickness less than one third its length, should be avoided due to poor interlocking and easy dislodgement by flow where not grouted.

Properties

2. Limestone (calcarenite) used for rock pitching shall be moderately strong to strong, with reference to the Clark and Walker Classification System for cementation and strength.

Rock Pitching

- Unconfined Compressive Strength (UCS) shall not be less than 12.5 MPa, and
- Calcium Carbonate Content (CaCO₃) shall not be less than 80% in accordance with Test Method WA 915.1.

3. Rock for use in bridgeworks shall be to the details shown on the Bridgeworks Drawings. For roadworks and drainage works, rock shall conform to the details given in Table 406.1.

Rock Type and Size

4. **Prior to delivery to site, the Contractor shall certify to the Superintendent that the rock conforms to the specified requirements for its intended use. Test results shall be reported on NATA endorsed documents.**

HOLD POINT

TABLE 406.1 Rock Protection and Rock Pitching (General Requirements)

Rock Class	Rock Size (m) *	Approximate Rock Mass (kg)	Percentage of Rock Larger than Rock Size in the Second Column	Typical Use (Examples Only)
Facing (Type B)	0.40	100	0	Culvert Outlets
	0.30	35	50	
	0.15	2.5	90	
Light	0.55	250	0	Floodway Batters
	0.40	100	50	
	0.20	10	90	
Quarter Tonne	0.75	500	0	Floodway Batters
	0.55	250	50	
	0.30	35	90	
Half Tonne	0.90	1000	0	Floodway Batters
	0.70	450	50	
	0.40	100	90	
One Tonne	1.15	2000	0	Floodway Batters
	0.90	1000	50	
	0.55	250	90	
Two Tonne	1.45	4000	0	Floodway Batters
	1.15	2000	50	
	0.75	500	90	
150 Rock Pitching	0.15 x 0.15 x 0.15		100	Landscaped Slopes (Typically Limestone)
400 Rock Pitching	0.40 x 0.40 x 0.20		60	Landscaped Slopes (Typically Limestone)

* Assuming a specific gravity of 2.65 and spherical shape for Facing, Light, Quarter Tonne, Half Tonne, One Tonne and Two Tonne.

406.07 ROCK FILL FOR GABIONS AND MATTRESSES

1. Rock fill for gabions and mattresses shall be produced or derived from dense, hard, durable and clean rock in accordance with AS 2758.4. It shall be resistant to weathering actions of air and water and shall be free from cracks and other structural defects.

Rock Type

2. Rock used for rock fill shall be fresh to slightly weathered and of very high to extremely high strength, as defined in AS 1726. The rock fill shall be clean, angular, and durable and of uniform quality, free from dust, clay, dirt and other deleterious material and free from an excess of flat or laminate pieces. For gabions the minimum rock size shall be 100mm and the maximum rock size shall be 250mm. For mattresses the minimum rock size shall be 75mm and the maximum rock size shall be two-thirds the thickness of the mattress, or 250mm, whichever is the lesser. The rock supplied shall have a range of sizes and a degree of angularity to ensure mechanical interlocking between rocks.

Properties

3. When determined in accordance with AS 1141.22, the aggregate wet strength shall not be less than 100kN and the wet/dry strength variation shall not exceed 35%. The rock may be crushed so as to produce the aggregate suitable to test by AS 1141.22.

4. **Prior to delivery to site, the Contractor shall certify to the Superintendent that the rock fill conforms to the specified requirements for its intended use. Test results shall be reported on NATA endorsed documents.**

**HOLD
POINT**

406.08 ROCK SUPPLY BY PRINCIPAL

1. Where some or all the rock protection requirements are supplied by the Principal, details are provided at Annexure 406A. The Contractor shall supply any additional rock that is required for the works.

**Annexure
406A**

406.09 GEOTEXTILE LINING

1. The geotextile for rock protection shall be a non-woven fabric consisting of long chain synthetic polymer fibres, composed of at least 95% by mass of polyester or polyolefins (polypropylene, polyethylene), bonded by needle punching, heat or chemical bonding processes or combinations thereof. Bonded fibres must be capable of retaining their relative position in the geotextile. The polymer fibres shall be rot proof, chemically stable and have low water absorbency. The geotextile shall have a high ultraviolet resistance such that when tested in accordance with AS 3706.11 shall have retained strength of at least 50% after 672 hours of test exposure. The geotextile shall be free of any flaws or defects that may adversely affect the mechanical or physical properties of the fabric.

Geotextile

2. Each roll of geotextile shall be provided with a suitable covering to protect the fabric against moisture and ultraviolet radiation, and marked in conformance with AS 3705.

Supply

3. Prior to installation, the geotextile rolls shall be stored on site under a protective cover and supported off the ground. The Contractor shall take appropriate measures to protect the geotextile from damage. This includes adhering to any other recommendations on method of storage set by the supplier/manufacturer.

Storage

4. Prior to the use of geotextile, the Contractor shall submit to the Superintendent product certificates of compliance from the supplier, showing that the geotextile complies with all the requirements of this specification for intended use. Test results shall be reported on NATA endorsed documents.

**HOLD
POINT**

5. The Contractor shall also certify that the geotextile delivered to site meets the Specification requirements. Sampling, conditioning and statistical analysis of results for each batch of geotextile shall be carried out in accordance with AS3706.1. Sampling frequency shall be in accordance with Appendix A of AS 3706.1. The conformance testing shall include determining the mean weight (mass per unit area) of the geotextile, in accordance with AS 3706.1.

**Sampling
and Testing**

406.09.01 GEOTEXTILE FOR ROCK PROTECTION

1. The Equivalent Opening Size (EOS) of the geotextile shall be less than 200 µm, mean value determined in accordance with AS 3706.7. The Geotextile Strength Rating (G) shall be greater than 4500, as defined in AUSTRROADS "Guide to Geotextiles" where $G = (L \cdot h_{50})^{0.5}$. L (in Newtons) is the characteristic value of burst strength (CBR Plunger Method) for the batch tested determined in accordance with AS 3706.1 and AS 3706.4. h_{50} (in mm) is the characteristic puncture resistance (Drop Cone Method) value for the batch tested determined in accordance with AS 3706.1 and AS 3706.5. The characteristic values of L and h_{50} shall be calculated as the mean value less 0.83 standard deviation. If appropriate, the minimum G rating may be reduced to 2000 where the nominal maximum particle size of the rock is no greater than 200 mm.

**EOS and G
Rating**

406.09 02 GEOTEXTILES FOR GABIONS AND MATTRESSES

1. All gabions and mattresses shall be laid on geotextile filter lining as per the Drawings.

2. The Equivalent Opening Size (EOS) of the geotextile shall be less than 200 µm, mean value determined in accordance with AS 3706.7. The Geotextile Strength Rating (G) shall be greater than 2000, as defined in AUSTRROADS "Guide to Geotextiles" where $G = (L \cdot h_{50})^{0.5}$. L (in Newtons) is the characteristic value of burst strength (CBR Plunger Method) for the batch tested determined in accordance with AS 3706.1 and AS 3706.4. h_{50} (in mm) is the characteristic puncture resistance (Drop Cone Method) value for the batch tested determined in accordance with AS 3706.1 and AS 3706.5. The characteristic values of L and h_{50} shall be calculated as the mean value less 0.83 standard deviation.

**EOS and G
Rating**

406.10 GABIONS

1. Details of gabions shall be as shown on the Drawings.

- | | |
|--|---|
| <p>2. The gabions supplied by the Contractor shall be flexible, woven, galvanised PVC coated steel wire mesh boxes to the overall dimensions as specified on the Drawings. Alternative equivalent or improved methods of corrosion protection such as Zinc-Aluminium alloy and polyethylene coatings are acceptable.</p> | <p>Corrosion Protection</p> |
| <p>3. Gabions shall have a hexagonal mesh with nominal size of 80mm x 100 mm. The minimum steel core wire diameter for the mesh shall be 2.7 mm.</p> | <p>Mesh Size and Wire Diameter</p> |
| <p>4. Each gabion shall be divided by diaphragms into cells whose length shall not be greater than the width of the gabion plus 100 millimetres.</p> | <p>Cells</p> |
| <p>5. Prior to use, the Contractor shall submit to the Superintendent product certificates of compliance from the supplier, showing that the gabions, selvages and lacing wire comply with all the requirements of this specification for its intended use.</p> | <p>HOLD POINT</p> |

406.11 MATTRESSES

- | | |
|---|---|
| <p>1. Details of rock mattresses shall be as shown on the Drawings.</p> | |
| <p>2. The mattresses supplied by the Contractor shall be flexible, woven, galvanised PVC coated steel wire mesh boxes to the overall dimensions as specified on the Drawings. Alternative equivalent or improved methods of corrosion protection such as Zinc-Aluminium alloy and polyethylene coatings are acceptable.</p> | <p>Corrosion Protection</p> |
| <p>3. Mattresses shall have a hexagonal mesh with nominal size of 60mm x 80mm. The minimum steel core wire diameter for the mesh shall be 2.0mm for mattresses with less than 350mm depth and 2.4mm for 350 to 550mm depth.</p> | <p>Mesh Size and Wire Diameter</p> |
| <p>4. Each mattress shall be divided by diaphragms into cells across the width of the unit and at not more than 1m centres or as shown on the Drawings.</p> | <p>Cells</p> |
| <p>5. Prior to use, the Contractor shall submit to the Superintendent product certificates of compliance from the supplier, showing that the mattresses, selvages and lacing wire comply with all the requirements of this specification for its intended use.</p> | <p>HOLD POINT</p> |

406.12 SELVEDGES

- | | |
|--|-----------------------------|
| <p>1. All edges of the gabions, mattresses, diaphragms and end panels shall be selvaged with a continuous wire, thicker than the corresponding wire of the gabion, mattress or diaphragm, to give the mesh rigidity when subjected to tension.</p> | <p>Edge Selvedge</p> |
|--|-----------------------------|

- | | | |
|----|---|----------------------|
| 2. | The selvaging must be such that the mesh will not unravel. In addition, the strength of the connection between the galvanised selvedge wire and the mesh shall be equal to or greater than the breaking strength of the mesh. | Properties |
| 3. | The minimum steel core wire diameter shall be 3.4mm for gabions, 2.4mm for mattresses less than 350mm depth and 3.0mm for mattresses between 350 to 550mm depth. | Wire Diameter |

406.13 LACING/TYING AND CONNECTING WIRE

- | | | |
|----|---|----------------------|
| 1. | Lacing/tying and connecting wire must be supplied with the gabions and mattresses to perform all the wiring operations required for the construction of the gabions or mattresses on site. | Lacing |
| 2. | The minimum steel core wire diameter, for lacing/tying and connecting either gabions or mattresses, shall be 2.2mm. | Wire Diameter |
| 3. | Where the selvedge has to be fastened to the cut ends of the mesh, its diameter shall be 3.4mm, and it shall be attached by binding the cut ends of the mesh about it so that a force of not less than 8 330N applied in the same plane as the mesh, at a point on the selvedge of a mesh sample of length 1 000mm, is required to separate it from the mesh. | Fastening |

406.14 – 406.25 NOT USED

CONSTRUCTION

406.26 GEOTEXTILE LINING

- | | | |
|----|---|---------------------------|
| 1. | The correct geotextile filter lining shall be supplied to suit unconfined rock protection, or for use with gabions and mattresses. | Lining Types |
| 2. | The period between initial laying out and complete cover of the geotextile with rock embankment protection, gabions or mattresses shall not exceed 14 days. Where possible and practical, geotextile shall be placed just ahead of associated advancing construction work and covered by relevant construction materials or suitable protective sheeting within 48 hours of being placed. | Exposure |
| 3. | Any geotextile allowed to remain exposed to sunlight for a period greater than 14 days shall be removed and replaced at no cost to the Principal. | Prolonged Exposure |
| 4. | The geotextile shall be laid in full roll widths as supplied with the length of the fabric laid in the direction of stream flow. Adjacent strips shall be overlapped a minimum of 500mm. | Laying and Overlap |

5. The Contractor shall take every reasonable care to ensure that the geotextile is not damaged during installation and cover placement operations. The laid geotextile shall be subjected only to pedestrian traffic. **Care**

6. Any geotextile torn shall be replaced or patched by the laying over of an additional piece of geotextile extending a minimum of 1m from the extremities of the tear. The fabric shall be held down by rocks or other suitable means to prevent movements before placement of the rock embankment protection, gabions or mattresses. **Repair**

406.27 ROCK PROTECTION

1. Rock protection shall be supplied to the specified classes of rock, and shall comprise hard, clean rock spalls or cobbles obtained from the excavation of a uniform type and colour and grading as specified in Clause 406.06, placed to the dimensions, shape and extent shown on the Drawings. **Class of Rock**

2. Excavation for any required trenching for the placement of rock protection shall be constructed to the line, level and dimensions shown on the Drawings. Surplus, oversize and unsuitable material from excavations shall be disposed of in accordance with Specification 302 EARTHWORKS. **Excavation**

3. The rock spalls shall be firmly placed into position to the required lines and levels with a minimum of voids and shaped to suit the drain grades or batter slopes to the following tolerances and compacted with at least 4 passes of a crawler tractor of mass not less than 11 tonnes: **Placement**

- (a) Batter slopes shall be smoothly shaped to a uniform plane; **Tolerances**
- (b) The dimensions of the rock layer shall not be less than that shown in the Drawings. Local surface irregularities of the finished surface shall not vary from the prevailing batter slope by more than +100mm or -50mm measured at right angles to the slope except for culvert outlet protection which shall not vary by more than +0mm or -100mm;
- (c) On floodways, no rock shall project above the shoulder and pavement level.

4. Rock protection shall present a generally uniform finish with flat surfaces of larger individual spalls, facing uppermost, comprising the finished surface and thoroughly keyed to the adjoining rocks. **Finish**

5. Care shall be taken during placement to prevent sand filling voids between the rocks. **Voids**

- | | | |
|----|--|-------------------|
| 6. | Where grouted rock protection is specified, individual rock spalls shall be placed on a mortar bed and voids between spalls filled with mortar, as detailed in the Drawings. The size of the voids shall not exceed 50mm in any direction. | Mortar |
| 7. | Mortar for grouting shall comprise a 3:1 mix of builder's sand and ordinary Portland cement, with all sand being from the same source. | Mortar Mix |

406.28 ROCK PITCHING

406.28.01 SAMPLE PANELS

- | | | |
|----|---|-------------------|
| 1. | Prior to the commencement of rock pitching, the Contractor shall prepare a sample panel of each type of rock pitching required in the Works, each at least 1.5m high x 2m long, for the Superintendent's approval. | HOLD POINT |
| 2. | The samples shall display rock colour, texture, grain, surface treatment, rock size and jointing detail. The sample shall remain until the completion of stonework in the Works. | Display |
| 3. | The standard of construction approved for the samples shall be maintained throughout the Works. | Standard |

406.28.02 CONSTRUCTION

- | | | |
|----|--|--------------------------|
| 1. | The finished rockwork on sloping rock pitching shall present a uniform surface matching adjacent slopes. The finished surface shall be thoroughly cleaned of all excess mortar and other debris. | Sloping Rockwork |
| 2. | Transitions from pitched batter slopes to pitched level surface shall be in the form of a smooth vertical curve to both top and toe conforming to the dimensions and form as indicated on the Drawings. | Slope Transition |
| 3. | Unless otherwise shown on the Drawings, the rocks shall be set level and flush for a lateral distance of 1.0m when located adjacent to other paving materials such as kerbs, paths and manholes. | Paving Transition |
| 4. | Rocks at the top and toe of batter slopes shall be securely underpinned with mortar to prevent any vertical movement. No mortar shall be visible after adjacent finished levels have been restored. Voids shall be filled with mortar from the bottom to within 10mm of the exposed face of the rock. | Mortar Work |
| 5. | Mortar shall comprise a 3:1 mix of builder's sand and ordinary Portland cement, with all sand being from the same source. Where limestone is used for rock pitching, mortar shall comprise a 3:1:1 mix of builder's sand, builders lime, and ordinary Portland cement, with all sand being from the same source. | Mortar Mix |

406.29 INSTALLATION OF GABIONS AND MATTRESSES

1. The assembly and erection of the gabions and mattresses shall conform to the following and the manufacturer's recommendations. Prior to assembly, the wire mesh of the gabion or mattress shall be opened out flat on the ground and stretched as much as possible to remove all kinks and bends, and checked to make sure that all creases are in the correct positions for forming the box. **Assembly**
2. The gabion or mattress shall be assembled individually by lifting the side and end panels into vertical position to form a rectangular box, ensuring that the tops of all four sides are level. **Panels**
3. The four corners of the gabion or mattress box shall be wired together with lengths of lacing wire supplied. Starting at the top, the end of the wire shall be secured by twisting it around the selvages and through each mesh in turn using alternate single and double loops. The wire at the bottom shall be secured with the lacing wire turned to the inside of the box on completion. The diaphragm panels shall also be secured in a similar fashion. **Lacing**
4. The assembled empty gabion or mattress boxes shall be positioned in the structure. The end or side from which work is expected to proceed shall be secured either to completed work or by stakes driven into the ground at the corners. These stakes must be secure and reach at least to the top of the gabion or mattress. **Staking**
5. For gabions, the opposite end or side of the box shall be stretched using crowbars or a small winch and secured top and bottom by stakes placed at the corners, fixed at the bottom and tied back at the top. Lacing to adjacent boxes and filling shall be carried out whilst gabion boxes are under tension. **Gabion Stretching**
6. For mattresses, movement of the rockfill inside the cells, either due to gravity or flowing current, should be kept to a minimum. Mattresses on slopes shall be placed such that the long dimension lies up and down the slope i.e. internal diaphragms at right angles to the direction of the slope. In watercourses, the long dimension of the mattress should be aligned with the direction of flow i.e. internal diaphragms at right angles to the direction of flow. The boxes shall be wired together along all adjoining edges and at diaphragm points. **Mattress Alignment**
7. The gabion boxes shall be filled one third full and horizontal interval bracing inserted (approximately 0.30m apart) to prevent excessive bulging and distortion of the completed structure. This procedure shall be repeated when the box is two thirds full. For both gabions and mattresses, final filling shall be to a level 25 to 50mm above their tops to allow for subsequent settlement. **Filling**

8. Closing and lacing down of lids for both gabions and mattresses shall proceed as soon as practicable after filling operations. The lids shall be stretched tight over the filling with suitably design closing tools and laced securely through each mesh along all edges, ends and diaphragms. The ends of all lacing wires shall be turned into the box on completion of all lacing operations.

Final Lacing

406.30 – 406.80 NOT USED

AS BUILT AND HANDOVER REQUIREMENTS

406.81 – 406.90 NOT USED

CONTRACT SPECIFIC REQUIREMENTS

406.91 – 406.99 NOT USED

SPECIFICATION 406 GUIDANCE NOTES

DELETE THESE GUIDANCE NOTES FROM FINAL DOCUMENT AFTER USING FOR REFERENCE

All edits to downloaded TDP documents shall be tracked (most word processing software allows this to be done automatically). Deletions shall be struck through e.g. ~~example~~. Insertions shall be in italics e.g. *example*. If **all** information relating to a clause is deleted then the clause number should be retained and the words "**NOT USED**" should be inserted.

The proposed documents with tracked changes shall be submitted to the Project Manager for review, prior to printing the final batch of documents. When this final printing is carried out, the tracked changes option is to be **turned off**.

The Custodian of this specification is the Senior Waterways Engineer.

1. ANNEXURE 406A – SUPPLY OF ROCK BY PRINCIPAL

1.1 Insert details into Table where some or all the rock requirement is being supplied by the Principal.

1.2 If not applicable, delete table and insert "NOT APPLICABLE FOR THIS CONTRACT".

SPECIFICATION AMENDMENT CHECKLIST

Specification Name: No: **406** Revision No: _____ Title: **ROCK PROTECTION**

Project Manager: Name: _____ Signature: _____ Date: _____

Checked By: Name: _____ Signature: _____ Date: _____

Contract No: _____ Contract Description: _____

ITEM	DESCRIPTION	SIGN OFF
<i>Note: All changes/amendments must be shown in Tracked Change mode until approved.</i>		
1.	Project Manager has reviewed Specification and identified Additions and Amendments.	
2.	CONTRACT SPECIFIC REQUIREMENTS addressed? – Contract specific materials/products/clauses added? (Refer Specification Guidance Notes for guidance).	
3.	Any unlisted Materials/Products proposed and approved by the Project Manager? – if “Yes” provide details at 15.	
4.	Standard Clauses amended? – MUST SEEK approval from MCP.	
5.	Clause deletions shown as ‘NOT USED’.	
6.	Appropriate INSPECTION & TESTING parameters included in Spec 201 (Test Methods, Minimum Testing Frequencies verified).	
7.	ANNEXURES completed (Refer Specification Guidance Notes).	
8.	HANDOVER and AS BUILT requirements addressed.	
9.	Main Roads QS has approved changes to SMM .	
10.	Project Manager certifies completed Specification reflects intent of the design.	
11.	Completed Specification – independent verification arranged by Project Manager	
12.	Project Manager’s review completed.	
13.	SPECIFICATION GUIDANCE NOTES deleted.	
14.	TABLE OF CONTENTS updated.	
15.	Supporting information prepared and submitted to Project Manager.	
Further action necessary:		

Signed: _____ (*Project Manager*) Date: _____

