DESIGN PROPOSAL WITH FIBROGRID AS REINFORCEMENT GEOGRIDS WITH KEYSTONE WALL AS FRONT FAÇADE FOR THE REHABILITATION WORKS NEAR THE DEWAN AT JALAN GENTAM SEBERANG, DAERAH KUALA PILAH, NEGERI SEMBILAN.

Dec 8. 2023

Ref: DC 23012-N-R1

Prepared by:

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Table of Content

DESIGN PROPOSAL WITH FIBROGRID AS REINFORCEMENT GEOGRIDS WITH KEYSTONE WALL AS FRONT FAÇADE FOR THE REHABILITATION WORKS NEAR THE DEWAN AT JALAN KG. GENTAM SEBERANG, SAWAH LEBAR, DAERAH KUALA PILAH, NEGERI SEMBILAN.

– Design Proposal

1.0 INTRODUCTION

This report presents the design proposal using Keystone Wall stabilization works system for the rehabilitation works near the Dewan at Jalan Kg. Gentam Seberang, Sawah Lebar, Daerah Kuala Pilah, Negeri Sembilan Darul Khusus.

The design and analysis methodology and assumptions will be first presented, followed by the evaluation of analysis results and finally recommendations for the proposed slope stabilization works to be installed will be highlighted.

Based on the information gather, it showed that the height of the wall varies between 1.5m to mm high for a length of approximately 250m. We will base on the average height of 2.5m for the estimation cost purposes.

Pictures

2.0 ASSUMPTIONS

Due to the lack of information about the site (history, hydrology, subsoil & topography survey data, underground services, etc.), some assumptions were made to accomplish the design proposal based on the knowledge and engineering judgements of the designer. All engineering assumptions have to be verified and confirmed by soil investigation and topography survey. It is also difficult to assume the quantity as we do not know what the existing angle of slope is and also the amount of earth that needs to be excavated and refill with good material.

3.0 DESIGN & ANALYSIS

Section of the proposed slope rehabilitation was modelled and checked for stability. The acceptable slope stability safety factor for the proposed slope treatment is set to minimum 1.5.

Using the reinforced slope stability analysis German software GGU Stability, numerous trial slip circles were tried out and the slip for the lowest safety factor was presented.

The related design parameters are shown in the next page

a. Soil Engineering Parameters

Layer (top down)	Description	Soil Model	Bulk unit weight, γ □(kN/m^3)	Design cohesion, C' (kN/m^2)	Design soil internal friction, □' (°)
1	Backfill soil or Reinforced soil	Mohr-Coulomb	18	5	28
2	Existing/Retained soil	Mohr-Coulomb	18	3	30
3	Foundation Soil (original)	Mohr-Coulomb	18	5	30
4	Foundation Aggregate (compacted)	Mohr-Coulomb	20	0	34

b. FibroGrid Parameters

Ultimate Tensile, T_u (kN/m)	Installation damage factor, f_1	Durability factor, f_2	Creep factor, f_3	Design Value, T_{des} (kN/m)
FG 60	1.05	1.1	1.47	36

The allowable long-term design tensile for the reinforcement FG60 for example,

$T_a = T_u/(f_1 + f_2 + f_3)$ =36 kN/m

Both the internal and global stabilities were checked and the lowest safety factors were determined.

The result of the analysis shows satisfactory safety factor using an approximate height of the Keystone Wall of 1.5m high in a single tier up to 3.5m high with Reinforcing FibroGrid elements, FG 60/30 as shown in the drawings in Appendix B.

The factors of Safety (FOS) were shown in the analyses attached in Appendix A. The table below summarizes the different FOS for different wall heights.

4.0 RECOMMENDATIONS & CONCLUSIONS

Basically, our proposal with Keystone Wall design is a combination of the following elements:

1. Drainage controls – subsoil drainage media to cater for the under-ground water and infiltration during and after construction.

2. Wall reinforcement – the use of FibroGrid geogrid as reinforcement behind the wall system not only stabilized the slope but also reduced the cost as compared to RC wall system.

3. Temporary protection – the excavation for the wall construction shall ensure the short-term stability of the excavation slopes.

The proposed design can be constructed easily without the need of heavy machinery. Excellent flexibility aspect of the geogrid-FibroGrid as reinforcement and with Keystone wall system as the fascia is another advantage over the conventional rigid wall system like RC wall. We believe the above proposal suits the tight budget constraint of the project without sacrificing the stability aspect.

5.0 LIMITATIONS

The design proposal was performed using the degree of care and skill ordinarily exercised, under similar circumstances, by engineers practising in this or similar localities. No warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

The assumptions and engineering judgements made to accomplish the proposal are believed to be representative of the entire contract area. However, as revealed by many previous developments, the actual soil and geological conditions faced during the construction may vary drastically from the soil investigation result. If this occurs, the changed of conditions must be evaluated by geotechnical engineer and revision or alteration of design may be made accordingly.

Appendix A

Slope Stability Analysis

Appendix A1

Slope Stability Analysis

For

1.5m High Keystone Wall

Calculation: Internal Stability Analysis - Static Condition (General Wedge failure mechanism)

Section/Detail: Typocal Cross Section

MTS Fibromat (M) Sdn. Bhd.
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-
Tel: 019 361 6528

Project: Keystone wall at Sawah Lebar, K.Pilah, NS.

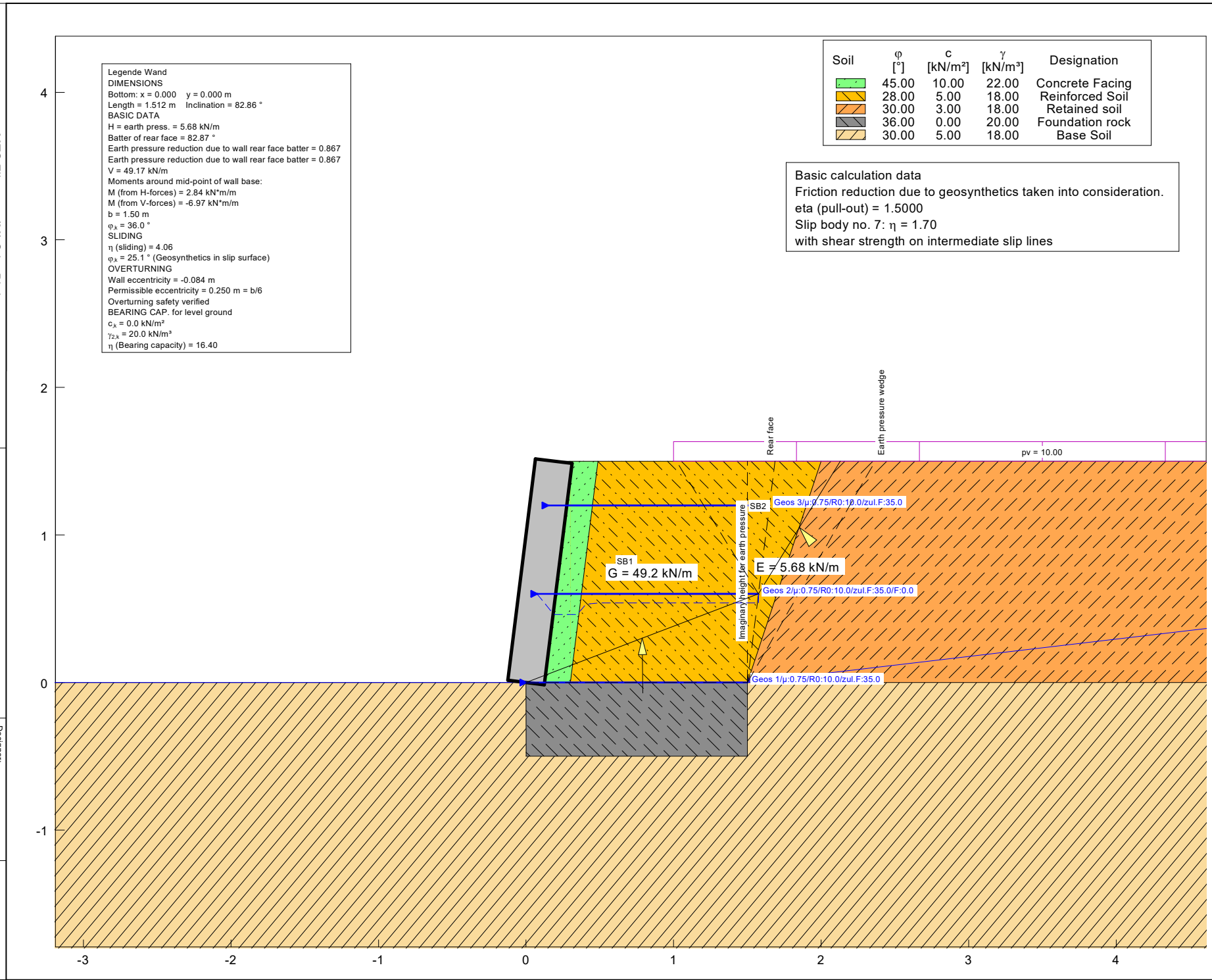
Designer: KH

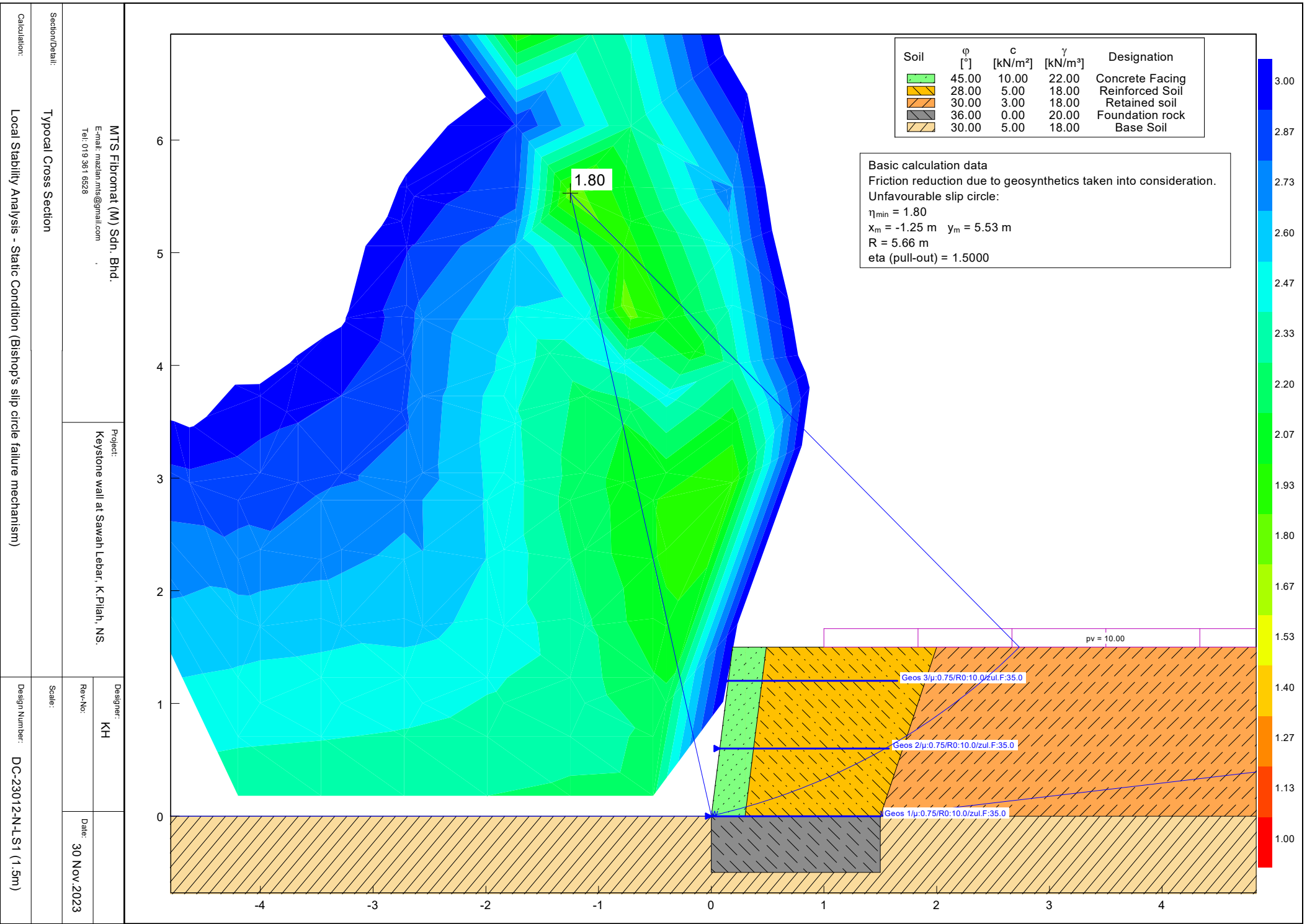
Rev-No:

Scale:

Date: 30 Nov 2023

Design Number: DC-23012-N-IS1 (1.5m)





Calculation:
Local Stability Analysis - Static Condition (Bishop's slip circle failure mechanism)

Section/Detail:
Typocal Cross Section

MTS Fibromat (M) Sdn. Bhd.
E-mail: mazlan.mts@gmail.com
Tel: 019 361 6528

Project:
Keystone wall at Sawah Lebar, K.Pilah, NS.

Designer:
KH

Rev-No:

Scale:

Date:
30 Nov 2023

Design Number:
DC-23012-N-LS1 (1.5m)

Appendix A2

Slope Stability Analysis

For

2.5m High Keystone Wall

Calculation: Internal Stability Analysis - Static Condition (General Wedge failure mechanism)

Section/Detail: Typocal Cross Section

MTS Fibromat (M) Sdn. Bhd.
E-mail: mazlan.mts@gmail.com
-
Tel: 019 361 6528

Project: Keystone wall at Sawah Lebar, K.Pilah, NS.

Designer: KH

Rev-No:

Scale:

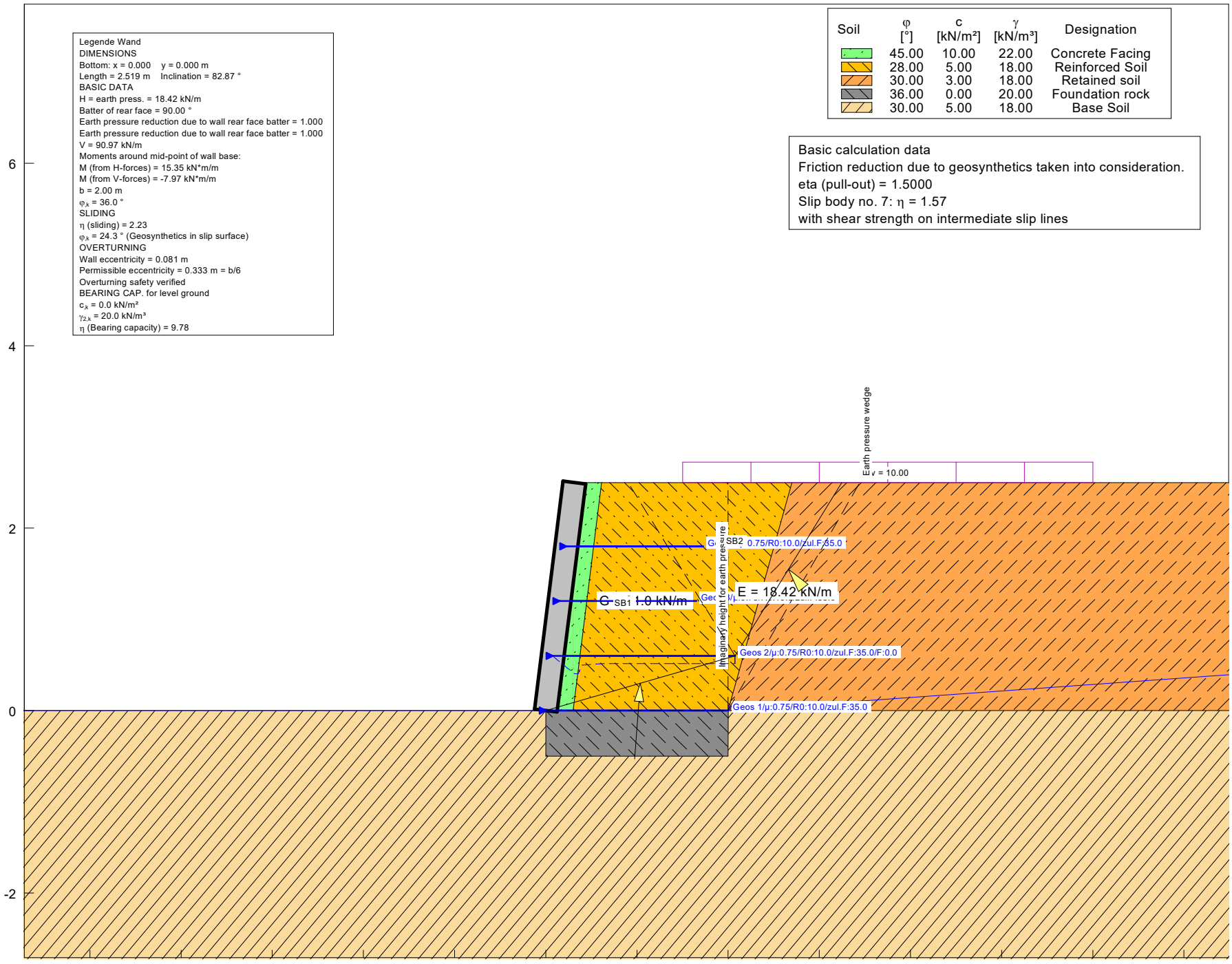
Date: 30 Nov.2023

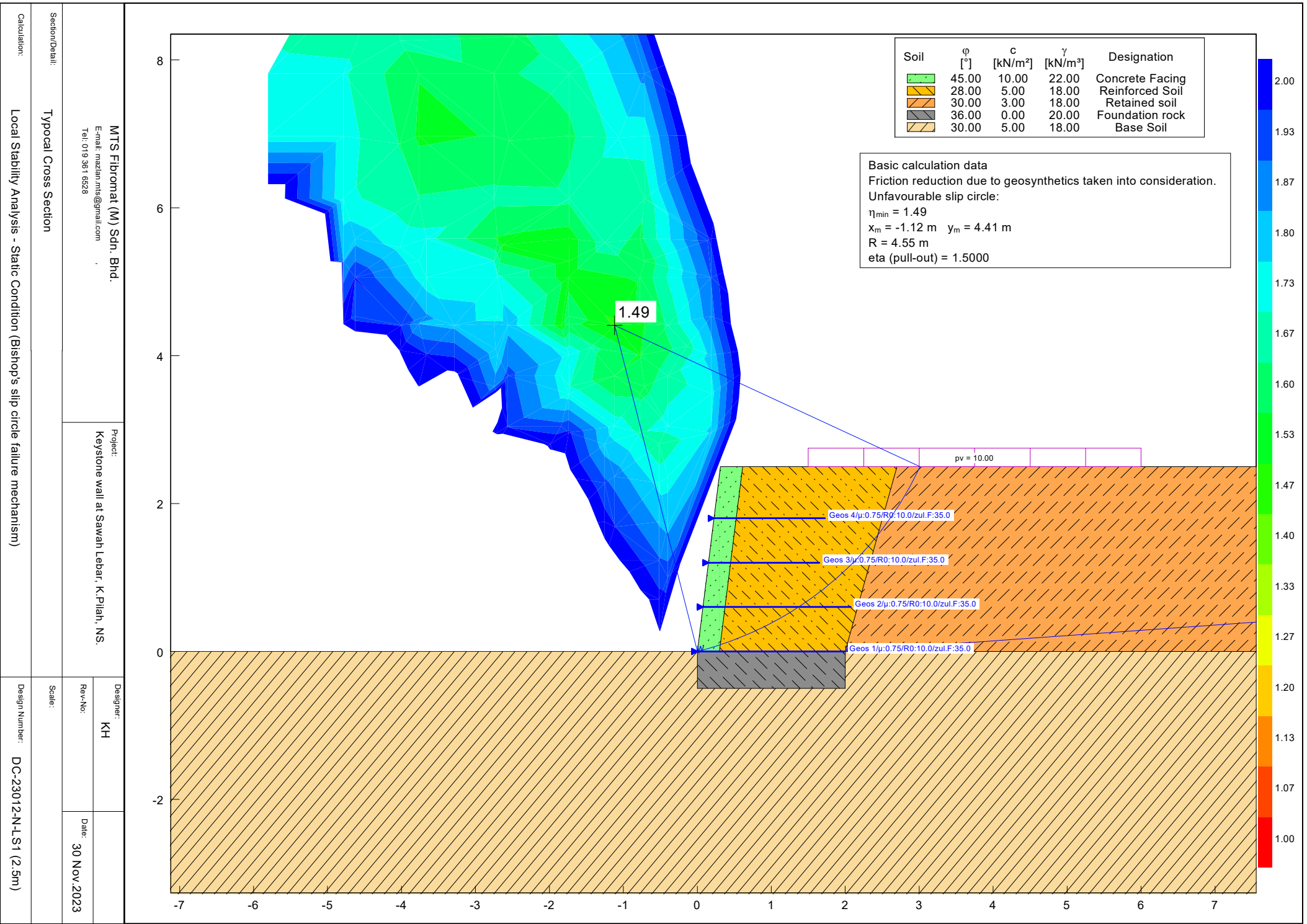
Design Number: DC-23012-N-IS1 (2.5m)

Legende Wand
DIMENSIONS
Bottom: x = 0.000 y = 0.000 m
Length = 2.519 m Inclination = 82.87 °
BASIC DATA
H = earth press. = 18.42 kN/m
Batter of rear face = 90.00 °
Earth pressure reduction due to wall rear face batter = 1.000
Earth pressure reduction due to wall rear face batter = 1.000
V = 90.97 kN/m
Moments around mid-point of wall base:
M (from H-forces) = 15.35 kN*m/m
M (from V-forces) = -7.97 kN*m/m
b = 2.00 m
φ_k = 36.0 °
SLIDING
η (sliding) = 2.23
φ_k = 24.3 ° (Geosynthetics in slip surface)
OVERTURNING
Wall eccentricity = 0.081 m
Permissible eccentricity = 0.333 m = b/6
Overturning safety verified
BEARING CAP. for level ground
c_k = 0.0 kN/m²
$\gamma_{2,k}$ = 20.0 kN/m³
η (Bearing capacity) = 9.78

Soil	φ [°]	c [kN/m²]	γ [kN/m³]	Designation
	45.00	10.00	22.00	Concrete Facing
	28.00	5.00	18.00	Reinforced Soil
	30.00	3.00	18.00	Retained soil
	36.00	0.00	20.00	Foundation rock
	30.00	5.00	18.00	Base Soil

Basic calculation data
Friction reduction due to geosynthetics taken into consideration.
eta (pull-out) = 1.5000
Slip body no. 7: η = 1.57
with shear strength on intermediate slip lines





Calculation:
Local Stability Analysis - Static Condition (Bishop's slip circle failure mechanism)

Section/Detail:
Typocal Cross Section

MTS Fibromat (M) Sdn. Bhd.
E-mail: mazlan.mts@gmail.com
Tel: 019 361 6528

Project:
Keystone wall at Sawah Lebar, K.Pilah, NS.

Designer:
KH

Rev-No:

Scale:

Date:
30 Nov 2023

Design Number:
DC-23012-N-LS1 (2.5m)

Appendix A3

Slope Stability Analysis

For

3.5m High Keystone Wall

Calculation: Internal Stability Analysis - Static Condition (General Wedge failure mechanism)

Section/Detail: Typocal Cross Section

MTS Fibromat (M) Sdn. Bhd.
E-mail: mazlan.mts@gmail.com
-
Tel: 019 361 6528

Project: Keystone wall at Sawah Lebar, K.Pilah, NS.

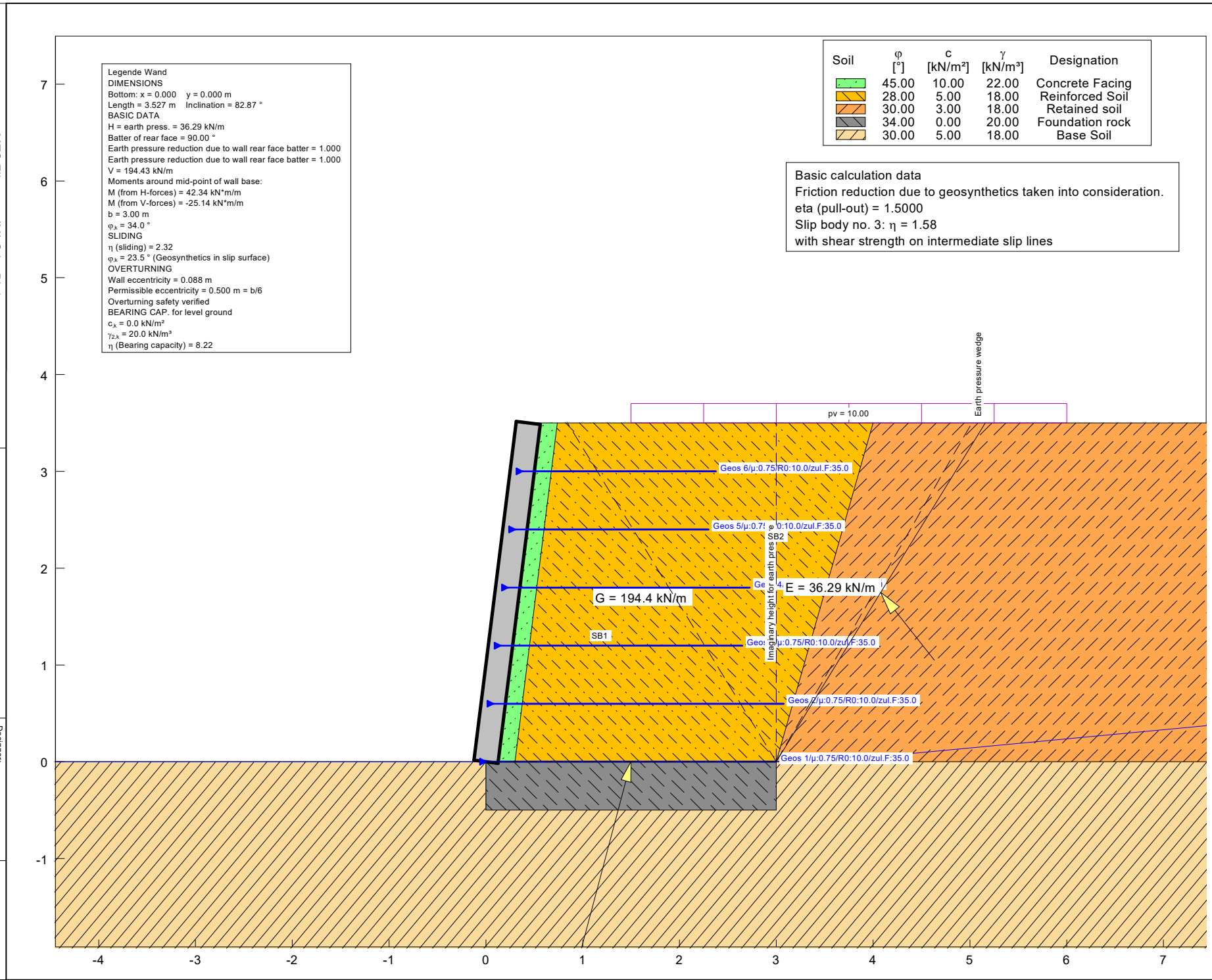
Designer: KH

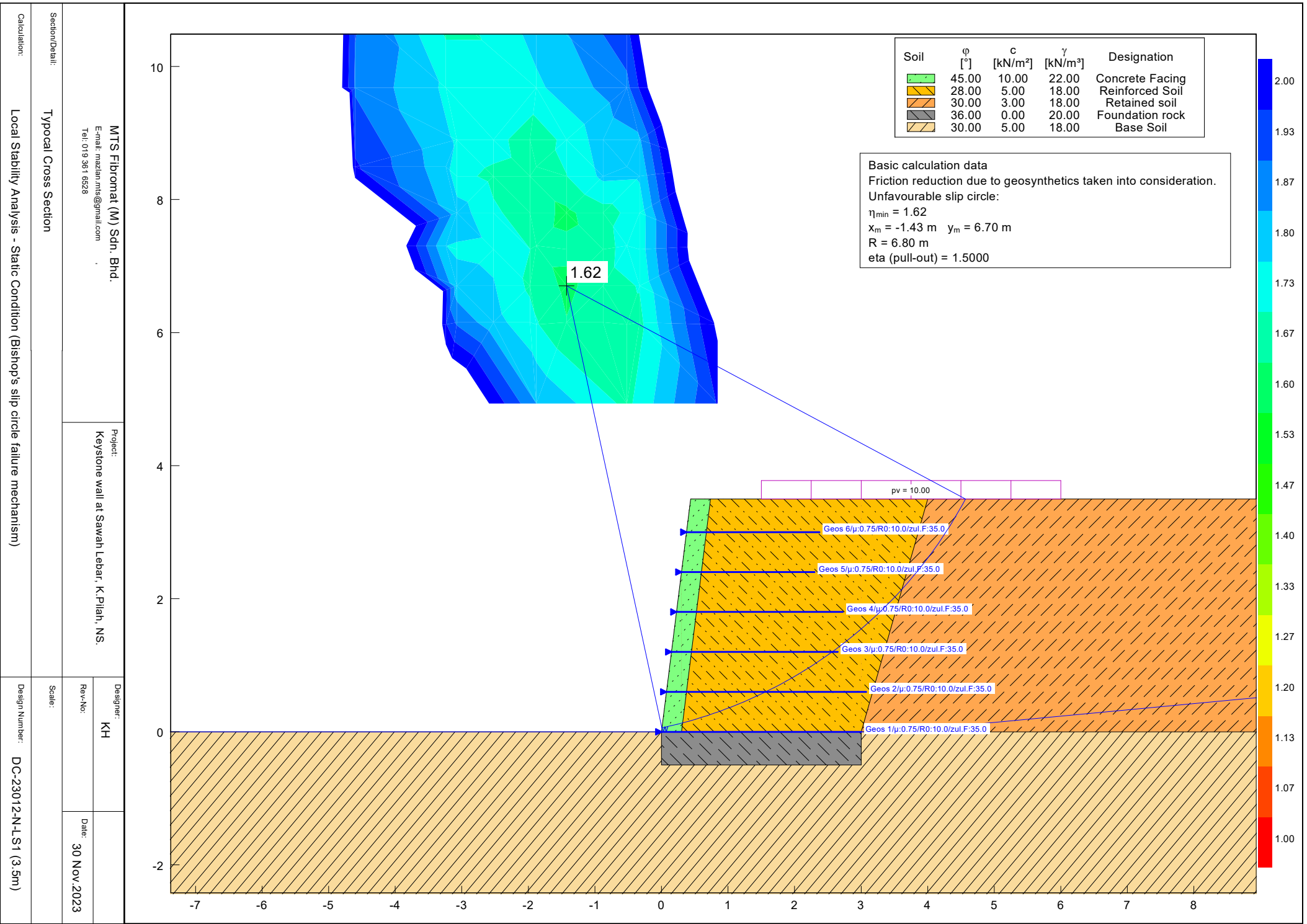
Rev-No:

Scale:

Date: 30 Nov.2023

Design Number: DC-23012-N-IS1 (3.5m)





Calculation: Local Stability Analysis - Static Condition (Bishop's slip circle failure mechanism)

Section/Detail: Typocal Cross Section

MTS Fibromat (M) Sdn. Bhd.
E-mail: mazlan.mts@gmail.com
Tel: 019 361 6528

Project: Keystone wall at Sawah Lebar, K.Pilah, NS.

Designer: KH

Rev-No:

Scale:

Date: 30 Nov.2023

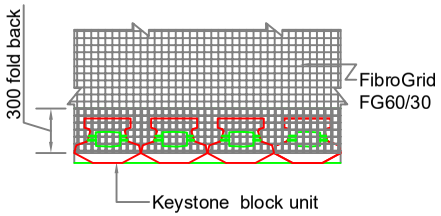
Design Number: DC-23012-N-LS1 (3.5m)

Appendix B

Drawings

Std Keystone Block size: 450x300x200

Capping Keystone size: 450x250x75



Details of Keystone Block Unit

Not to scale

NOTES:

1) All dimension units are in milimetres unless otherwise specified.

2) This drawing shows some typical conceptual design details based on several assumptions, which shall be checked and verified and modified accordingly by qualified Professional Engineer before adoption for construction.

3) Detail construction drawing shall be prepared, checked and endorsed by qualified Profesional Engineer after detail analysis based on adequate SI and site conditions, etc.

4) The internal stability for the proposed geogrid reinforced wall/slope is based on the following parameters:-

   a) Approved suitable fill shall be used as reinforced soil. Minimum compaction shall be 95% B.S standard compaction. At least 1 field density shall be carried out per 250 cu.m of fill or as directed by the qualified site engineer.

   b) Assumed design parameters:

Properties of soil			
	unit weight (kN/m³)	C' (kN/m²)	Phi (°)
Reinforced soil	18	5	28
Retained soil	18	3	30
Base soil	18	5	30

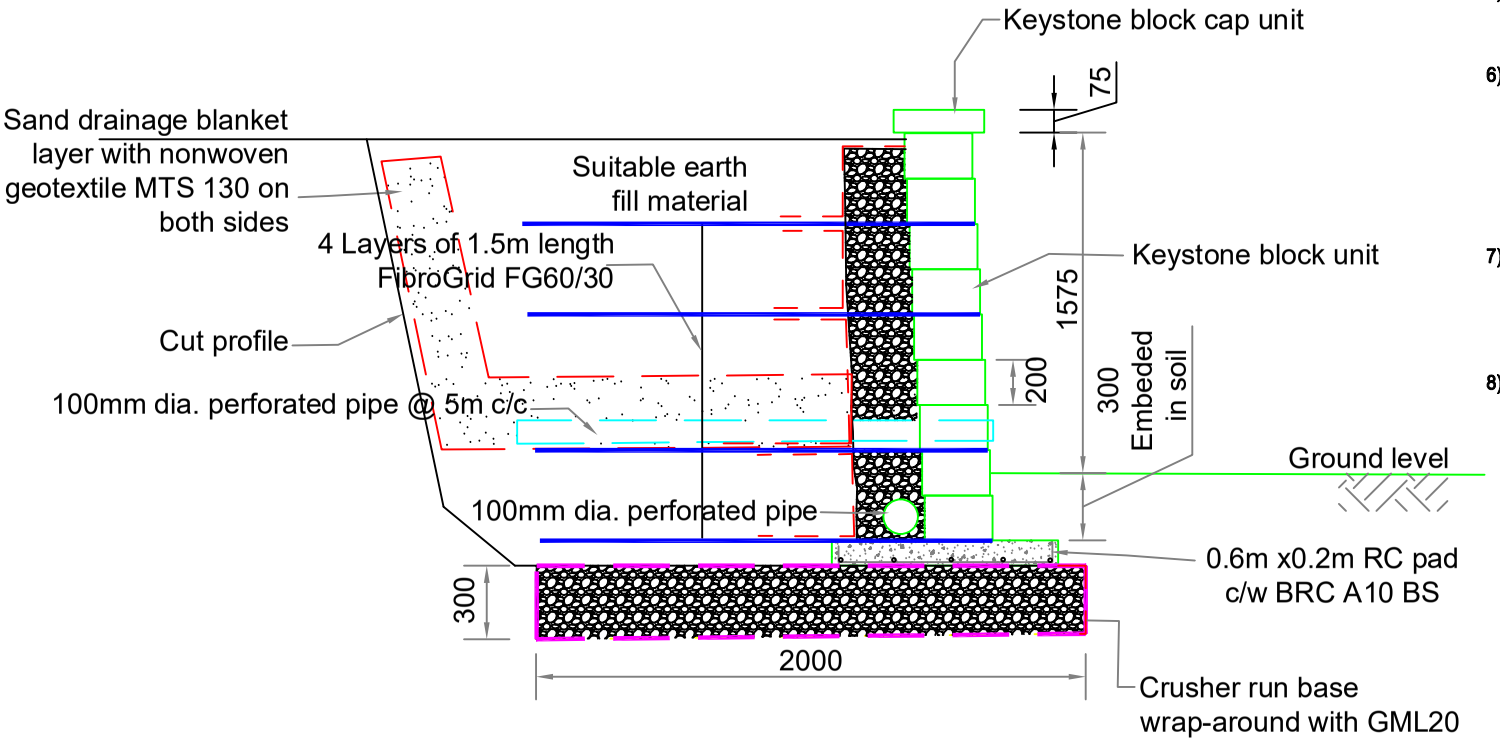
   c) CIU tests based on typical selected compacted samples shall be carried out to verify the assumptions (minimum 1 series of CIU tests per 500 cu.m of fill or as directed by the Engineer.

5) External stability for the geogrid reinforced wall/slope shall be checked and verified by the earthwork consultant after all survey data and confirmatory SI at site are completed and available.

6) All unsuitable material under the foundation for the proposed Fibromat reinforced geogrid-Fibrogrid retaining wall system with Mackintosh Probe counts < 40 blow/ft shall be removed and replaced by crusher run material or as instructed by the qualified site engineer. Confirmatory Mackintosh probes and other suitable tests shall be carried out on site and decided by the qualified site engineer after site inspection.

7) Good temporary site drainage shall always be maintained to prevent any localized ponding. Fill material (before and after compaction) if exposed to rain and with moisture content exceeding optimum moisture + 3% shall be rejected or removed from the site immediately.

8) Locations for the proposed geogrid reinforced wall/slope shall be set-up at site by the contractor and verified by the qualified site engineer before carrying out the proposed confimatory tests mentioned above.



Typical Section of Keystone Wall, 1.5m High.

Not to scale

Project.:
PROPOSED KEYSTONE WALL FOR THE VERTICAL WALL NEAR THE DEWAN AT JALAN KG. GENTAM SEBERANG, SAWAH LEBAR, DAERAH KUALA PILAH, NEGERI SEMBILAN. (1.5m high exposed wall).

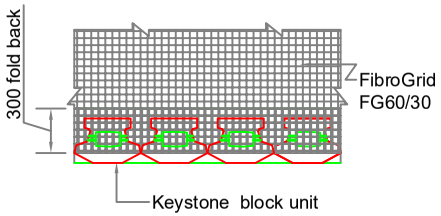
Title:
Keystone Reinforced Wall Details

Drawing No.:	Revision:	Date:
DC23012-N-D1	00	8-Dec.-2023

MTS FIBROMAT (M) SDN BHD
E-mail: mazlan.mts@gmail.com
Website: www.fibromat.com.my
Tel: 019 3616528

Std Keystone Block size: 450x300x200

Capping Keystone size: 450x250x75



Details of Keystone Block Unit

Not to scale

NOTES:

1) All dimension units are in milimetres unless otherwise specified.

2) This drawing shows some typical conceptual design details based on several assumptions, which shall be checked and verified and modified accordingly by qualified Professional Engineer before adoption for construction.

3) Detail construction drawing shall be prepared, checked and endorsed by qualified Profesional Engineer after detail analysis based on adequate SI and site conditions, etc.

4) The internal stability for the proposed geogrid reinforced wall/slope is based on the following parameters:-

a) Approved suitable fill shall be used as reinforced soil. Minimum compaction shall be 95% B.S standard compaction. At least 1 field density shall be carried out per 250 cu.m of fill or as directed by the qualified site engineer.

b) Assumed design parameters:

Properties of soil			
	unit weight (kN/m³)	C' (kN/m²)	Phi (°)
Reinforced soil	18	5	28
Retained soil	18	3	30
Base soil	18	5	30

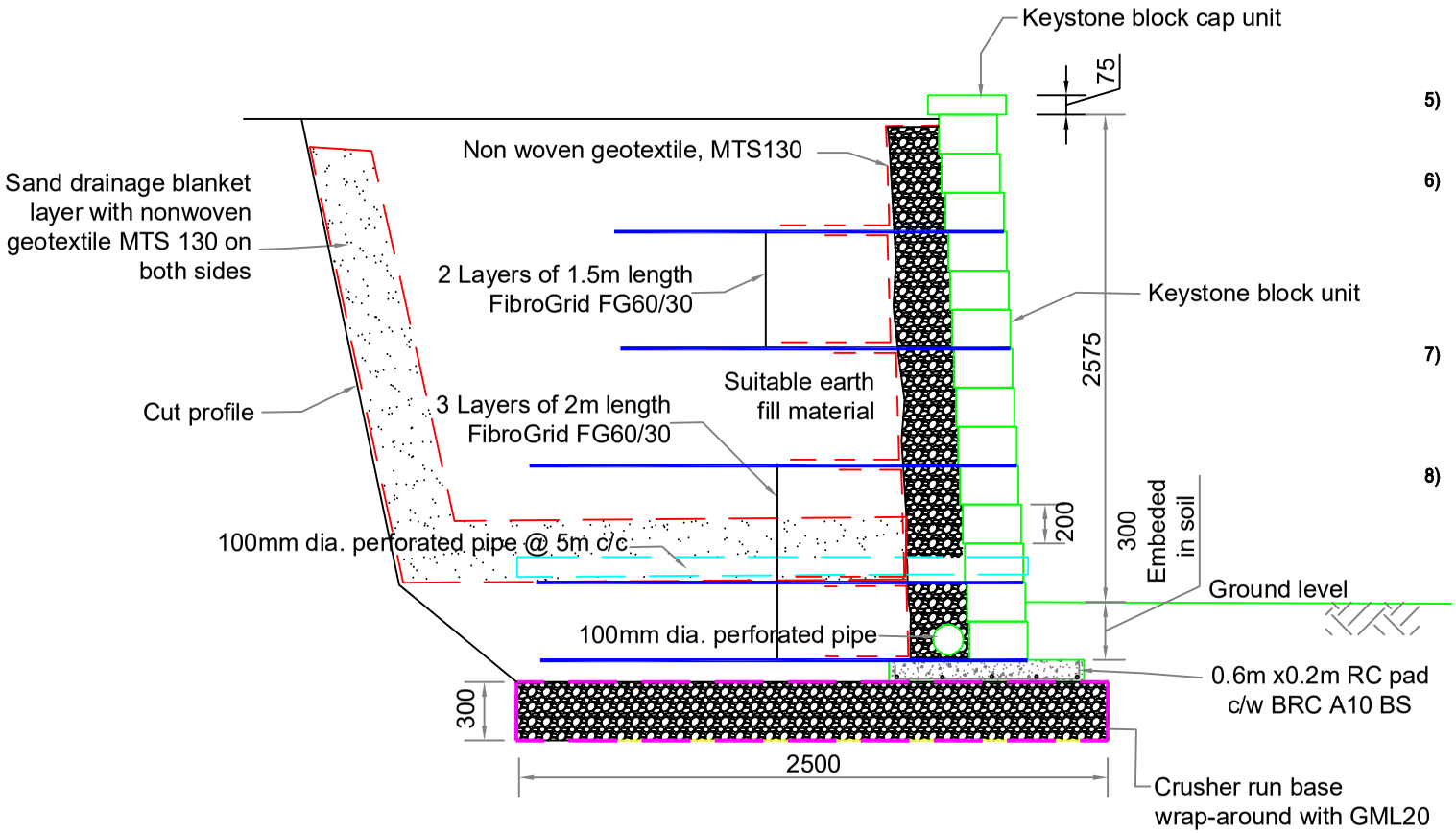
c) CIU tests based on typical selected compacted samples shall be carried out to verify the assumptions (minimum 1 series of CIU tests per 500 cu.m of fill or as directed by the Engineer.

5) External stability for the geogrid reinforced wall/slope shall be checked and verified by the earthwork consultant after all survey data and confirmatory SI at site are completed and available.

6) All unsuitable material under the foundation for the proposed Fibromat reinforced geogrid-Fibrogrid retaining wall system with Mackintosh Probe counts < 40 blow/ft shall be removed and replaced by crusher run material or as instructed by the qualified site engineer. Confirmatory Mackintosh probes and other suitable tests shall be carried out on site and decided by the qualified site engineer after site inspection.

7) Good temporary site drainage shall always be maintained to prevent any localized ponding. Fill material (before and after compaction) if exposed to rain and with moisture content exceeding optimum moisture + 3% shall be rejected or removed from the site immediately.

8) Locations for the proposed geogrid reinforced wall/slope shall be set-up at site by the contractor and verified by the qualified site engineer before carrying out the proposed confimatory tests mentioned above.



Typical Section of Keystone Wall, 2.5m High.

Not to scale

Project.:
PROPOSED KEYSTONE WALL FOR THE VERTICAL WALL NEAR THE DEWAN AT JALAN KG. GENTAM SEBERANG, SAWAH LEBAR, DAERAH KUALA PILAH, NEGERI SEMBILAN. (2.5m high exposed wall).

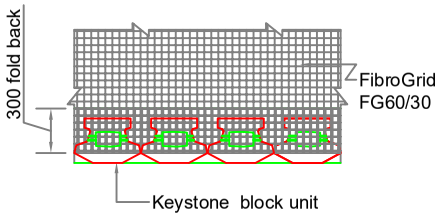
Title:
Keystone Reinforced Wall Details

Drawing No.:	Revision:	Date:
DC23012-N-D2	00	8-Dec.-2023

MTS FIBROMAT (M) SDN BHD
E-mail: mazlan.mts@gmail.com
Website: www.fibromat.com.my
Tel: 019 3616528

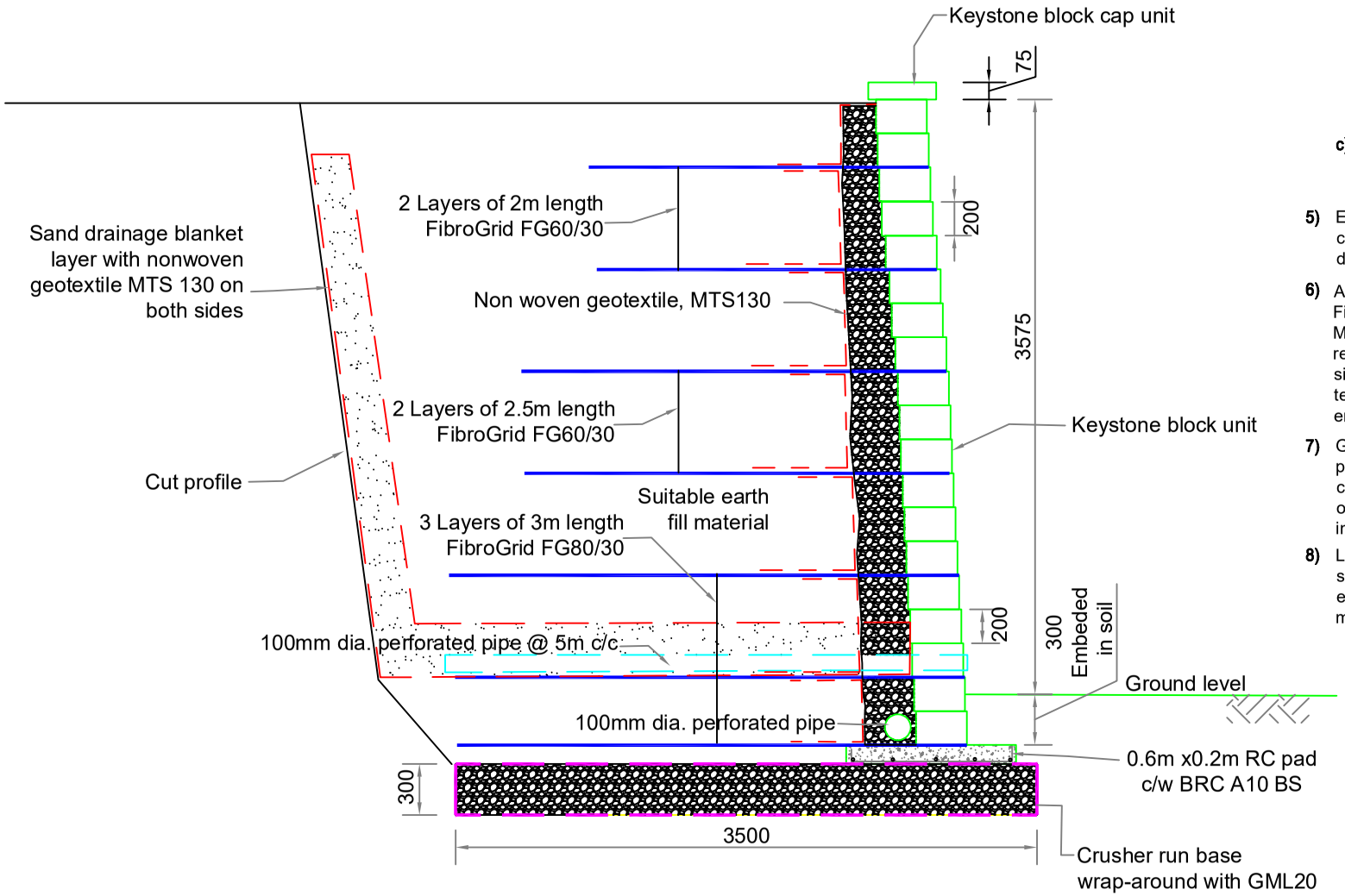
Std Keystone Block size: 450x300x200

Capping Keystone size: 450x250x75



Details of Keystone Block Unit

Not to scale



Typical Section of Keystone Wall, 3.5m High.

Not to scale

NOTES:

1) All dimension units are in milimetres unless otherwise specified.
2) This drawing shows some typical conceptual design details based on several assumptions, which shall be checked and verified and modified accordingly by qualified Professional Engineer before adoption for construction.
3) Detail construction drawing shall be prepared, checked and endorsed by qualified Profesional Engineer after detail analysis based on adequate SI and site conditions, etc.
4) The internal stability for the proposed geogrid reinforced wall/slope is based on the following parameters:-
   a) Approved suitable fill shall be used as reinforced soil. Minimum compaction shall be 95% B.S standard compaction. At least 1 field density shall be carried out per 250 cu.m of fill or as directed by the qualified site engineer.
   b) Assumed design parameters:

Properties of soil			
	unit weight (kN/m³)	C' (kN/m²)	Phi (°)
Reinforced soil	18	5	28
Retained soil	18	3	30
Base soil	18	5	30

   c) CIU tests based on typical selected compacted samples shall be carried out to verify the assumptions (minimum 1 series of CIU tests per 500 cu.m of fill or as directed by the Engineer.
5) External stability for the geogrid reinforced wall/slope shall be checked and verified by the earthwork consultant after all survey data and confirmatory SI at site are completed and available.
6) All unsuitable material under the foundation for the proposed Fibromat reinforced geogrid-Fibrogrid retaining wall system with Mackintosh Probe counts < 60 blow/ft shall be removed and replaced by crusher run material or as instructed by the qualified site engineer. Confirmatory Mackintosh probes and other suitable tests shall be carried out on site and decided by the qualified site engineer after site inspection.
7) Good temporary site drainage shall always be maintained to prevent any localized ponding. Fill material (before and after compaction) if exposed to rain and with moisture content exceeding optimum moisture + 3% shall be rejected or removed from the site immediately.
8) Locations for the proposed geogrid reinforced wall/slope shall be set-up at site by the contractor and verified by the qualified site engineer before carrying out the proposed confimatory tests mentioned above.

Project.:
PROPOSED KEYSTONE WALL FOR THE VERTICAL WALL NEAR THE DEWAN AT JALAN KG. GENTAM SEBERANG, SAWAH LEBAR, DAERAH KUALA PILAH, NEGERI SEMBILAN. (3.5m high exposed wall).

Title:
Keystone Reinforced Wall Details

Drawing No.:	Revision:	Date:
DC23012-N-D3	00	8-Dec.-2023

MTS FIBROMAT (M) SDN BHD
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Appendix C

Specification

integrated

integrated brickworks sdn. bhd.

KEYSTONE® RETAINING WALL SYSTEMS
A CONTECH COMPANY

"Where Excellence is the Standard"

In a market filled with choices, KEYSTONE® still sets the standard.

In today's world of imitation products, KEYSTONE® Retaining Wall Systems continues to set the worldwide benchmark for segmental retaining wall performance and aesthetics, from soil retention and erosion control to landscape systems in over 35 countries.

As the industry's leader, KEYSTONE® has set the bar for excellence, innovation and technology within the industry, being a product of the energy, passion and focus of the people dedicated to ensure that KEYSTONE® products and services offer the best site solutions for residential, commercial, recreational, industrial and institutional applications.

KEYSTONE® created the mortar-less segmental retaining wall market with its patented interlocking modular design nearly two decades ago, and still retains that distinct difference of outer beauty and inner strength - the beauty of natural stone, the durability of granite and positive unit connection internally.

The high-strength KEYSTONE® concrete units and patented interlocking pin system ensures a conveniently easy positive connection between KEYSTONE® units, as well as between the KEYSTONE® units and soil reinforcement elements. Additionally, KEYSTONE® patented pins aid in horizontal alogment, while also providing the ability to vary the wall set-back, a feature unique to KEYSTONE®.

PRODUCT ATTRIBUTES

KEYSTONE® Retaining Wall modular units are dry-cast from high strength low absorption concrete for durable long-lasting structures.

All structural units are interconnected using high-strength fiberglass pins for strong shear connection. The connecting pins allow for ease of unit alignment and a secure positive mechanical connection with soil reinforcement.

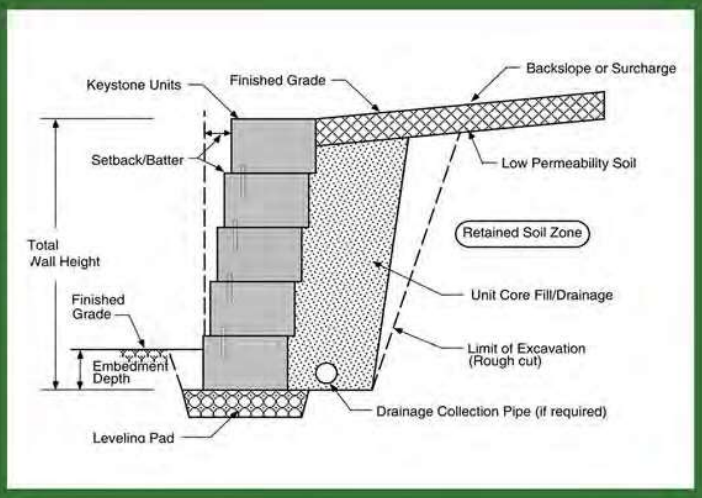
KEYSTONE®'s patented pin system is the critical diffrence providing the safety and security of a structurally sound retaining wall solution.

KEY FEATURES

- High Strength Pin Connection System
- Open Cores
  - Increases vertical drainage through the face units
  - Allows for block interlock across block interfaces
  - Improves connection strength between blocks and geogrid
  - Improves unit-to-unit shear resistance
- Versatility
  - Multiple fascia and texture options
  - "Near" vertical or battered set-back options are built-in
- Shape
  - Tapered sides allow easy curves, corners and circles
  - Units have a "tail" element for easy handling

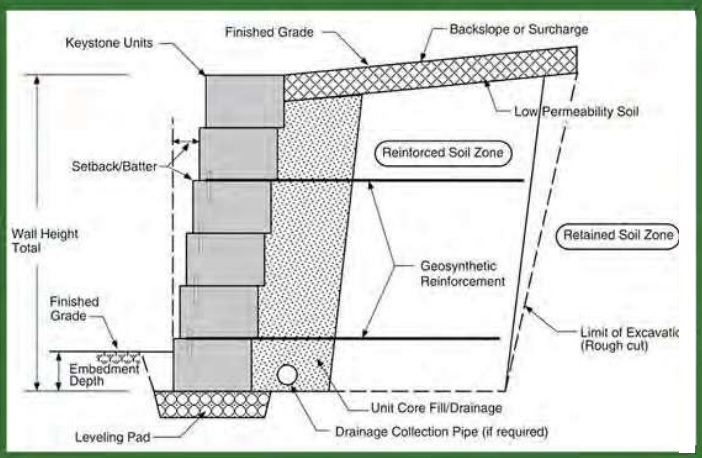
THE "TECHNICAL" SIDE

The two most common retaining wall structures built today are simple gravity walls and larger reinforced soil wall structures. KEYSTONE® offers products and specific design methodology for both structure types.



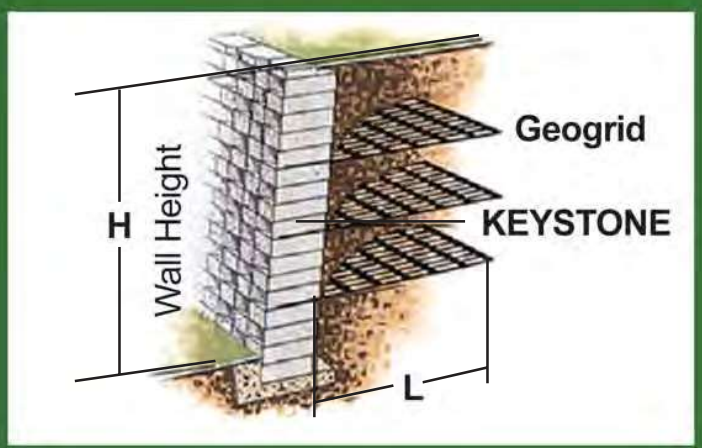
GRAVITY WALLS

One of the most basic types of retaining walls, the gravity wall, relies on its mass and cross-sectional geometry to resist the earth pressure that is exerting force to move the structure in a lateral direction. KEYSTONE® retaining walls are able to resist lateral pressure with their unit weight and deep embedment shape. The mortarless, yet structurally interconnected KEYSTONE® units also promote the freeflow of water drainage to prevent hydrostatic loads. For low, non-critical applications, KEYSTONE® products make highly cost-effective gravity wall structures.



REINFORCED SOIL WALLS

For taller or more critical walls, KEYSTONE® units are combined with soil reinforcement options (such as extensible geogrids, geotextiles, inextensible tie-back anchor or galvanized steel ladder reinforcing) to create large composite structures. With this properly designed combination, the reinforced soil mass can support greater earth pressures and surcharge loads. These composite structures have permitted the construction of retaining wall structures over 18m high.



GEOGRID REINFORCEMENT

Since the early 1980's, geogrids have proven successful in providing durable soil reinforcement for the retaining wall industry. Proper design methodology today incorporates the laboratory testeds connection strength of concrete units and geogrid in all reinforced retaining wall systems. Geogrids are made from high-density polyolefins of high-tenacity woven polyester yams.

THE KEYSTONE® RANGE

RETAINING WALL SYSTEMS
A CONTECH COMPANY

Retaining Excellence™

STANDARD UNIT

Size (HxWxD)	**8" x 18" x 21½"** *(±0.203 x 0.457 x 0.546m)*
Exposed Face Area	**1 ft²/pc : 8" x 18"** *(0.093 m^2/pc)*
Unit Weight	±42.8 kg. *

COMPAC UNIT

Size (HxWxD)	**8" x 18" x 12"** *(±0.203 x 0.457 x 0.305m)*
Exposed Face Area	**1 ft²/pc : 8" x 18"** *(0.093 m^2/pc)*
Unit Weight	±38.5 kg *

MINI & CAP UNIT

Size (HxWxD)	**4" x 18" x 10½"** *(±0.102 x 0.457 x 0.267m)*
Exposed Face Area	**½ ft²/pc : 4" x 18"** (0.046 m^2/pc)
Unit Weight	±20.2 kg. *

** depending on variation of unit type, fascia treatment and soil reinforcement elements*

CONNECTION PIN

Size (HxWxD)	**½" Ø x 5¼"** *(±0.012 Ø x 0.133m)*
Flexural Strength	Min 128,000 psi *(±883 MPa)*
Short Beam Shear Strength	Min 6,400 psi *(±44 MPa)*

Product reference standards : MS 27 : 1996, BS 6073 : 1981, ASTM C 1372-97, ASTM C 90-75, ASTM C 140-75

Additional information, products and services available on request

a. Technical Brochure
b. KeyWall Design Software
c. KeyWall Design Manual and Operating Guide
d. KEYSTONE® Specifications
e. Geogrid Specifications
f. Segmental Retaining Wall (SRW) Specifications
g. Specialist Tools and Handling Equipment
h. Method Statement
i. Preliminary Design Assistance
j. Installation Guidelines
k. Contractors' Installation Training Programme
l. Construction Detail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Jalan Tun Razak
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Upland Gyratory
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