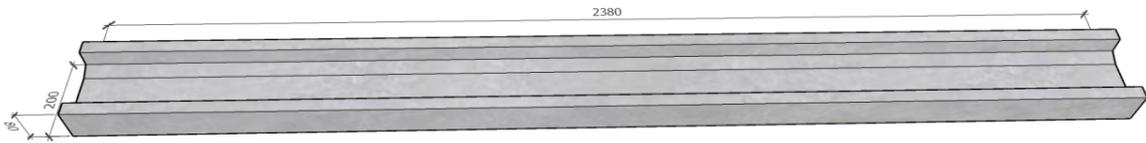
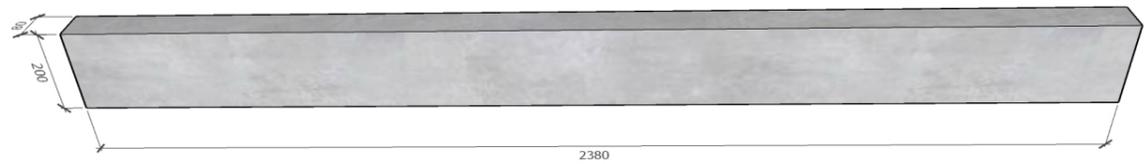


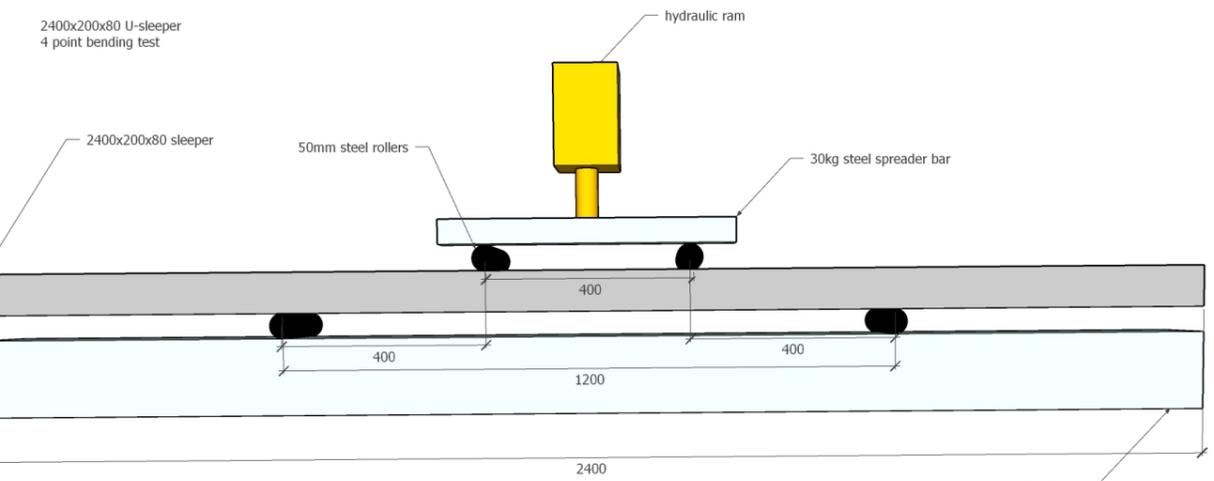
Sleeper end view



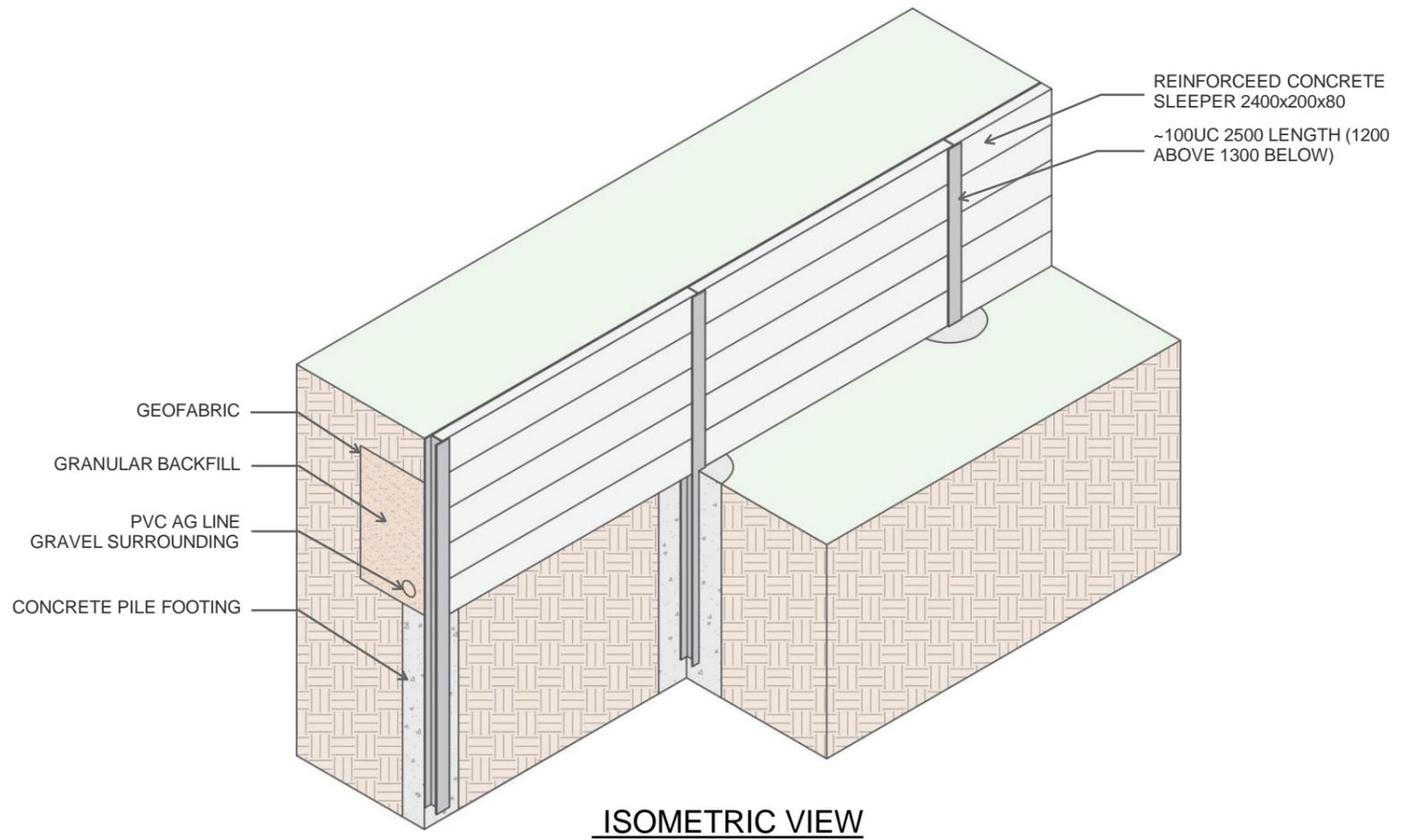
Sleeper side view



Sleeper face view



4 point bending test



ISOMETRIC VIEW

## INFORMATION GALINTEL OUTDOORS SLEEPERS

### SLEEPER INFORMATION FOR CROSS SECTION SHEAR

$f'c = 66 \text{ MPa}$   
 $E = 4.6 \times 10^4 \text{ MPa}$   
 $y = 20.0 \text{ mm UP FROM BASE}$   
 $I_x = 597.0 \times 10^3 \text{ mm}^4$   
 $I_y = 8.229 \times 10^6 \text{ mm}^4$   
**WEIGHT = 44kg**

SLEEPER DESIGN IS COMPLIANT WITH THE AUSTRALIAN STANDARDS.

FOR GALINTEL OUTDOOR SLEEPERS, THE AVERAGE LOAD AT FIRST CRACK IN THE 4 POINT BENDING TEST IS 756kg.

A CREEP TEST OVER 2 YEARS RESULTED IN 0 mm ADDITIONAL DEFLECTION.

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHK.
A	22/04/22	NOT FOR CONSTRUCTION	CD	UHS	MI

**Galintel**<sup>®</sup>

DESIGN UHS ENGINEERING UHS

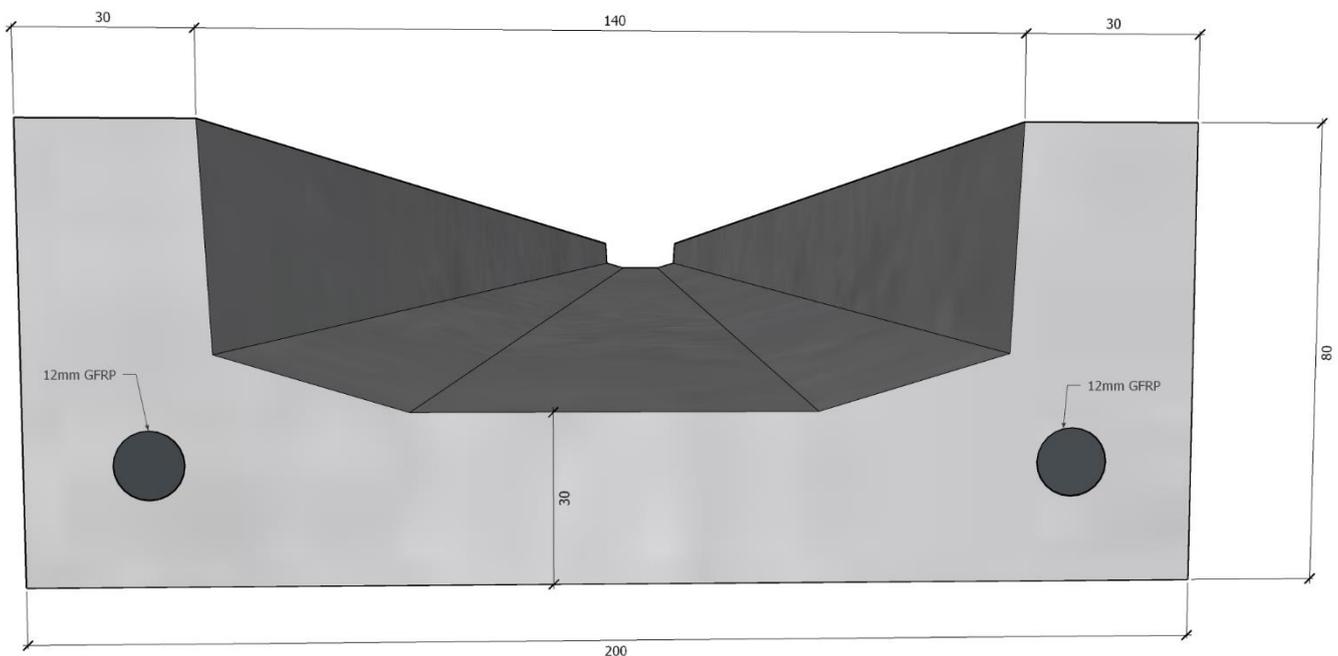
SIZE A3 JOB NUMBER UHS001 SHEET NO. S01 REV. A

# Galintel<sup>®</sup>

## Capacity of Galintel Outdoors Sleepers

This report includes testing Galintel Outdoors reinforced concrete sleepers to assess their strength and report their capacity to retain soil.

The cross-sectional details of the Galintel Outdoors Sleepers are shown in Figure 1.



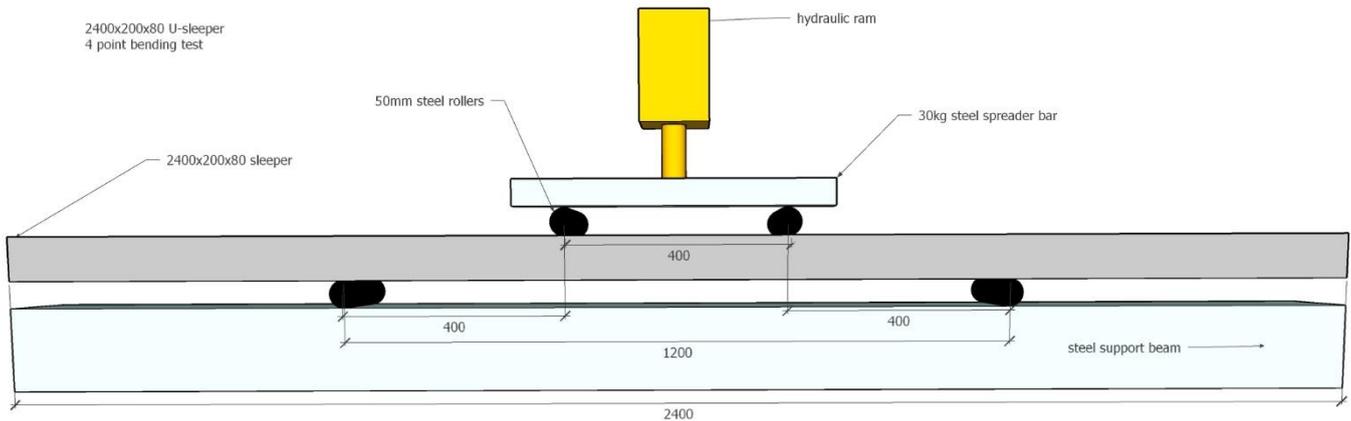
**Figure 1. Cross-sectional details of Galintel Outdoors Sleepers**

The maximum possible length of the Galintel Outdoors Sleepers is 2.4m. It is reinforced with 12mm GFRP bars. GFRP (Glass Fiber Reinforced Polymer) rebar, commonly referred to as Fiberglass reinforcement, is a high-tensile-strength alternative to steel reinforcement. GFRP is made by weaving high-quality glass fibers into a fabric, which is then impregnated with polymers and formed into a round bar. It is reported that the tensile strength is approximately 1340 MPa, with a coefficient variation of 2.8%.

The average compressive strength of glass fiber-reinforced concrete used in Galintel Outdoors Sleepers is 66 MPa. The characteristic strength is estimated to be 42 MPa, taking into consideration the potential variability of materials, variability encountered during casting and curing, and variability within the test sample.

## Bending Tests

Three randomly selected Galintel Outdoors Sleepers (200 mm wide x 80 mm deep x 2.4 m long) were tested under four-point bending. A schematic diagram of the test up is shown in Figure 2. The test specimen was symmetrically supported over a 1200mm span, and the test load was applied symmetrically 400mm apart. As shown in the diagram, the test specimen was laid with its flat surface under tension while loading.



**Figure 2. Test Setup**

From the previous experience on 4-point bending tests on sleepers (where central displacements were recorded), the test load remained steady where the load-displacement graph deviated from its linear behavior. This deviation point could be easily detected during the test, as the load remained steady for some time while loading. Additionally, a slight hair crack began to appear on the bottom tension face of the test specimen when the test load remained steady. Therefore, only the loads were recorded during the current tests.

## Bending test results

The summary results are presented in Table 1 below.

Number of test specimens	3
Average load at the point of deviation from linearity in the load-displacement curve	756.7kg
Coefficient of variation of test results	0.07

## Characteristic bending strength of Galintel Outdoors Sleepers

The variability of the bending capacity of sleeper walls in real-world applications would be influenced by the inherent variability resulting from adopted construction practices and material properties. Hence, to establish the design capacity, the following assumptions were made:

- Coefficient of variation of the materials used in the panels = 0.1
- Coefficient of variation of construction = 0.1 (very low due to the fabrication nature of the sleepers)
- Coefficient of variation of test results = 0.07 (obtained from test

results). Hence, an on-site variability was determined considering the above.

Overall coefficient of variation =  $V_{total} = \text{SQRT}(0.1^2 + 0.1^2 + 0.07^2) = 0.16$

Sampling Factor = 1.7 (ref: AS3600-2009, Table B4.3, CV = 16%, units tested = 3) Average

load resisted by Galintel Outdoors Sleepers = 632.5kg

Therefore, the Ultimate Limit State (ULS) Bending Capacity of sleeper panels tested (tension on flat face) =  $756.7/1.7 = 445.1\text{kg}$ .

Therefore, ULS bending Moment Capacity (tension on flat face) = 0.87 kN.m

### Properties of the sleeper section:

Section modulus  $Z_{xx}$  (flat face) =  $147551.7\text{mm}^3$

Section modulus  $Z_{yy}$  (leg face) =  $83901.9\text{mm}^3$

ULS design bending strength of Galintel Outdoors Sleepers (tension on flat face) = 5.92MPa

## Design of retaining walls

Tables 2, 3, and 4 provide Galintel Outdoors Sleepers lengths and corresponding retaining heights of the wall for different soil types. Typical calculations for one combination of parameters are given in Appendix A.

(a) Dry Clay :

Density = 17.3kN/m<sup>3</sup>

Angle of internal friction = 30<sup>0</sup>

Surcharge pressure (kpa)	5	5	5	10	10	10
Wall height (M)	1.6	1.2	1	1.6	1.2	0.6
Number sleepers	8	6	5	8	6	3
Sleeper length	2	2.4	2.4	1.2	2	2.4

**Table 2. Wall configuration for dry clay**

(b) Wet Clay

Surcharge pressure (kpa)	5	5	5	10	10	10
Wall height (M)	1.6	1.2	0.6	1.2	1	0.6
Number sleepers	8	6	3	6	5	3
Sleeper length	1.2	1.2	2.4	1.2	1.6	2

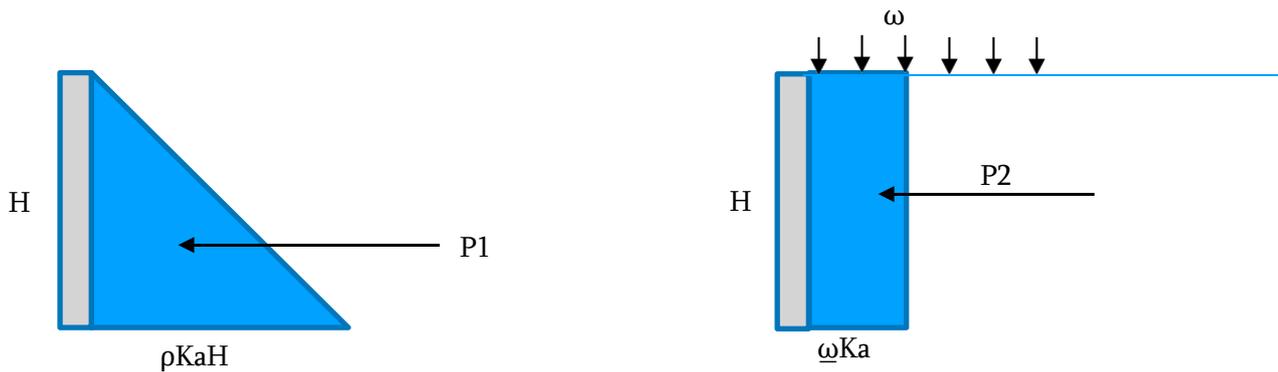
**Table 3. Wall configuration for wet clay**

(c) Sandy soil

Surcharge pressure (kpa)	5	5	5	10	10	10
Wall height (M)	1.6	1.2	1	1.6	1.2	1
Number sleepers	8	6	5	8	6	5
Sleeper length	2	2.4	2.4	2	2.4	2.4

**Table 4. Wall configuration for sandy soil**

## Appendix A: Typical design calculations for Galintel Outdoors Sleepers retaining wall



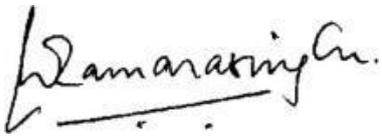
$\rho$  Soil density ( $\text{kN/m}^3$ )  
 $Ka$ : Passive pressure coefficient  
 $H$ : Retaining wall height  
 $\omega$  Surcharge pressure ( $\text{kPa}$ )

Soil Type =	Dry clay
Soil density ( $\text{kN/m}^3$ ) =	17.3
Angle of internal friction of soil (deg)=	30
Passive pressure coefficient ( $Ka$ ) =	0.33
Number of UHS panels in the wall =	5
Module height (m) =	0.2
Wall Height (m) =	1
Surcharge pressure ( $\text{kN/m}^2$ ) =	5
Panel Length (m) =	2.4
Panel supporting length (m) =	0.05
Panel support span (m) =	2.35

Pressure at the <b>top edge</b> of the bottom panel due to surcharge at the top	1.67
( $\text{kN/m}^2$ ) =	
Pressure at the <b>top edge</b> of the bottom panel due to soil ( $\text{kN/m}^2$ ) =	4.61
Design Pressure on bottom UHS panel ( $\text{kN/m}^2$ )=	$1.2 \times (1.67 + 4.61) = 7.54$
Design Load ( $\text{kN/m}$ ) =	Module height $\times 7.54 = 1.51$
Maximum Design B.M. = $wL^2/12$ ( $\text{kN.m}$ ) =	0.69
Section modulus of Galintel Outdoors Sleepers( $\text{mm}^3$ ) =	147551.7
Therefore, maximum Design bending stress (MPa) =	$0.69 \times 10^6 / 147551.7 = 4.7$
ULS design bending capacity of Galintel Outdoors Sleepers(MPa)=	$5.92 > 4.7$
Check the suitability	Pass

**Notes:**

- (i) Groundwater level is not applicable since water can easily drain out from the Galintel Outdoors Sleepers walls.
- (ii) Passive pressure coefficient ( $K_a$ ) =  $(1 - \sin \phi) / (1 + \sin \phi)$ , where  $\phi$  is angle of internal friction of soil.



Dr Sam Samarasinghe  
B.Sc (Eng), Ph.D, MIEAust (Structural)



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