

**Client:** Glanville Group

**Project:** McDonalds Penygarnddu Industrial Estate Merthyr Tydfil

TensarTech TW1 Wall System, Ret Ht. = 2.85m

Tensar  
Structural Systems

**TW1 Wall System**



#### IMPORTANT NOTES

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#### Method of analysis

The calculation method used to create this Application Suggestion is the simplified method of slices using a circular slip surface following the method given by Bishop (Geotechnique Vol 5, No 1, 1955) modified to take into account the stabilising effect of layers of geogrid reinforcement

**Reference**

O-78037-CA-01 P02

**Date**

22 Jun 2026

**Page**

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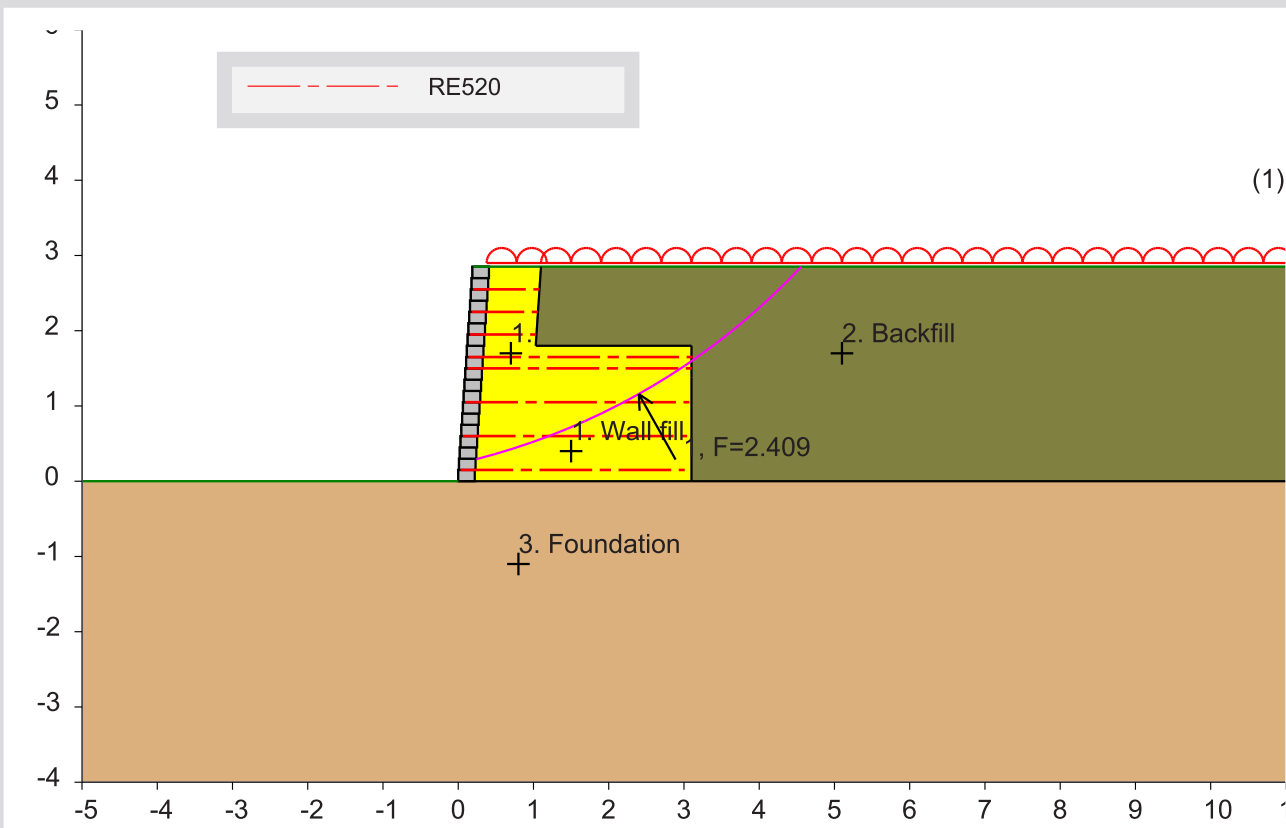


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## Input data and Section

Project:

McDonalds Penygarnddu Industrial Estate Merthyr Tydfil



Tensar Structural Systems **TW1 Wall System**

Static loading case

All dimensions in metres

Scale 1:100

## Soil properties

| Soil zone     | Drained/<br>undrained | c'<br>(kN/m <sup>2</sup> ) | (°)  | Y <sub>bulk,k</sub><br>(kN/m ) |
|---------------|-----------------------|----------------------------|------|--------------------------------|
| 1, Wall fill  | Drained               | 0.0                        | 38.0 | 20.0                           |
| 2, Backfill   | Drained               | 0.0                        | 27.0 | 18.0                           |
| 3, Foundation | Drained               | 0.0                        | 35.0 | 20.0                           |

Soil strength values given above are characteristic values, design values are obtained by applying appropriate partial material factors. Design soil strength parameters are peak values

## Surcharges

| Load | Load acts from x (m) | To x (m) | Load (kN/m <sup>2</sup> ) | Live/Dead |
|------|----------------------|----------|---------------------------|-----------|
| 1    | 0.377                | 100.000  | 5.00                      | Live      |

x values are measured from X=0

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| Stability results                     | Circle number | Disturbing moment (kNm/m) | Resisting moment soil (kNm/m) | Resisting moment geogrids (kNm/m) | Factor of safety |
|---------------------------------------|---------------|---------------------------|-------------------------------|-----------------------------------|------------------|
| Moments per linear metre of structure | 1             | 528                       | 870                           | 319                               | 2.409            |

|                                                      |                                                                                                                                                                                                |                                                                                        |
|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Further information relevant to this Design Analysis | Further information, specifications and bill of quantities descriptions for this Tensar Earth Retaining Structure are given in the following documents which form part of this Design Analysis | System overview<br>Installation guide<br>Case histories<br>Construction Animation Link |
|                                                      | The current versions of these documents may be found by following the website link to "Tensar Documentation" in the Help menu of the TensarSlope program                                       |                                                                                        |
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## Detailed input information

The following tables provide the detailed input information used to define the reinforced fill structure including: coordinates of soil lines and water pressure lines (both internal water pressure and external standing water), geogrid design data and geogrid layout.

In all the tables which follow, X and Y are cartesian coordinates in metres, with Y measured vertically upwards, and measured from X = 0 in the horizontal direction and Y = 0 in the vertical direction.

### Soil lines

The soil type found beneath each line is indicated in the table below.

Where a facing is associated with any line, this is also indicated in the table below.

| Line No. | X <sub>1</sub> (m) | Y <sub>1</sub> (m) | X <sub>2</sub> (m) | Y <sub>2</sub> (m) | Soil No. | Facing type  |
|----------|--------------------|--------------------|--------------------|--------------------|----------|--------------|
| 1        | 0.000              | 0.000              | 0.199              | 2.850              | 1        | TW1 Standard |
| 2        | 0.199              | 2.850              | 1.100              | 2.850              | 1        |              |
| 3        | 3.100              | 0.000              | 20.721             | 0.000              | 3        |              |
| 4        | 1.100              | 2.850              | 15.000             | 2.850              | 2        |              |
| 5        | 0.000              | 0.000              | 3.100              | 0.000              | 3        |              |
| 6        | 0.000              | 0.000              | -15.000            | 0.000              | 3        |              |
| 7        | 3.100              | 1.377              | 3.100              | 0.000              | 1        |              |
| 8        | 1.100              | 2.850              | 1.030              | 1.800              | 2        |              |
| 9        | 1.030              | 1.800              | 3.100              | 1.800              | 1        |              |
| 10       | 3.100              | 1.800              | 3.100              | 1.377              | 1        |              |

### Water pressures

Pore pressures only exist where a soil-specific pore pressure ratio is not zero (see 'Soil properties' above).

### Reinforcement design data

Reinforcement design strength is calculated using the strengths and factors given below

| In soil type 1 - Wall fill |                               |                                                                | Design life (years) 120    |                       | D m r a r (°) 10                      |                     |
|----------------------------|-------------------------------|----------------------------------------------------------------|----------------------------|-----------------------|---------------------------------------|---------------------|
| Tensar Geogrid             | Creep rupture strength (kN/m) | Extrapolation <input type="checkbox"/> manufacturing variation | Installation damage factor | Environmental effects | Characteristic design strength (kN/m) | Sliding coefficient |
|                            | P <sub>c</sub>                | f <sub>m</sub>                                                 | f <sub>d</sub>             | f <sub>e</sub>        | P <sub>des</sub>                      | s                   |
| RE520                      | 27.34                         | 1.00                                                           | 1.48                       | 1.00                  | 18.47                                 | 0.85                |

### Reinforcement layout

Reinforcement level is defined by its Y co-ordinate

| Tensar geogrid | Level | Left end | Right end | Length | Coverage | Pullout interaction factor | Fixed at |       |
|----------------|-------|----------|-----------|--------|----------|----------------------------|----------|-------|
|                | Y (m) | X (m)    | X (m)     | (m)    | (%)      | B                          | left     | right |
| RE520          | 0.150 | 0.010    | 3.010     | 3.000  | 100      | 0.85                       | Yes      | No    |

Reinforcement continued on next page . . .

Reinforcement layout continued

| Tensar<br>geogrid | Level | Left end | Right end | Length | Coverage | Pullout<br>interaction<br>factor | Fixed at |       |
|-------------------|-------|----------|-----------|--------|----------|----------------------------------|----------|-------|
|                   | Y (m) | X (m)    | X (m)     | (m)    | (%)      | B                                | left     | right |
| RE520             | 0.600 | 0.042    | 3.042     | 3.000  | 100      | 0.85                             | Yes      | No    |
| RE520             | 1.050 | 0.073    | 3.073     | 3.000  | 100      | 0.85                             | Yes      | No    |
| RE520             | 1.500 | 0.105    | 3.105     | 3.000  | 100      | 0.85                             | Yes      | No    |
| RE520             | 1.650 | 0.115    | 3.115     | 3.000  | 100      | 0.85                             | Yes      | No    |
| RE520             | 1.950 | 0.136    | 1.036     | 0.900  | 100      | 0.85                             | Yes      | No    |
| RE520             | 2.250 | 0.157    | 1.057     | 0.900  | 100      | 0.85                             | Yes      | No    |
| RE520             | 2.550 | 0.178    | 1.078     | 0.900  | 100      | 0.85                             | Yes      | No    |

**Client:** Glanville Group

**Project:** McDonalds Penygarnddu Industrial Estate Merthyr  
Upper Portion of the Wall

Rt ht: 1.05m

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**TW1 Wall System**



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**Method of analysis**

The calculation method used to create this Tensar software output is the tie-back wedge reinforced soil retaining wall design method with partial factors defined in Section 6.0 of BS 8006-1:2010+A1:2016 "Code of practice for strengthened/reinforced soils and other fills".

**Reference**

O-78037-CA-02 P01

**Date**

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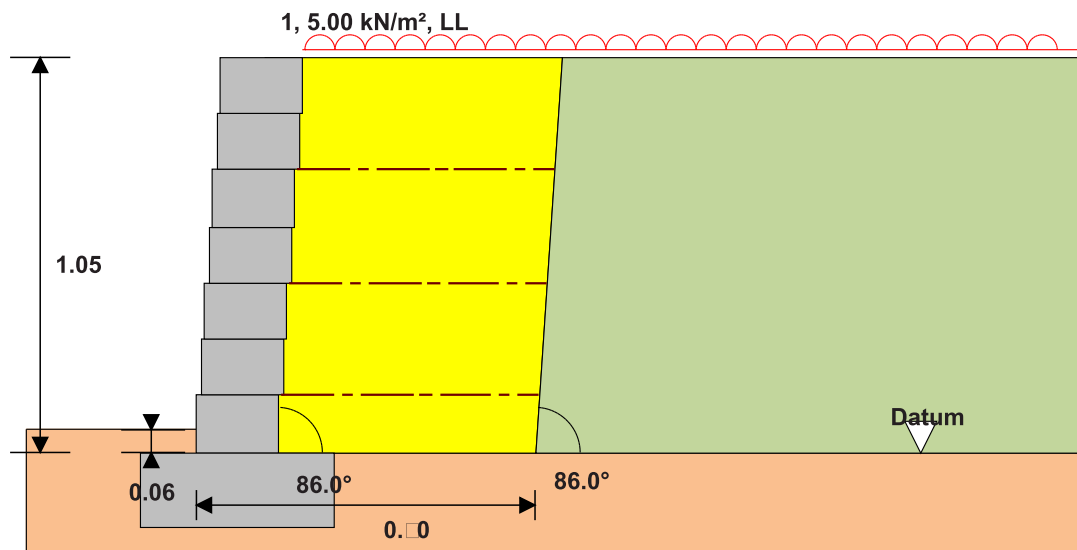


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## Input data and Section

Project:

McDonalds Penygarnddu Industrial Estate Merthyr



## Tensar Structural Systems TensarTech TW1 Wall System

Static loading case

All dimensions in metres

Scale 1:20

### Fill/foundation properties

Design soil strength parameters are peak values

| Soil zone       | Drained/<br>undrained | $c_k$<br>(kN/m <sup>2</sup> ) | $\phi_k$<br>(°) | $\gamma_{bulk,k}$<br>(kN/m <sup>3</sup> ) |
|-----------------|-----------------------|-------------------------------|-----------------|-------------------------------------------|
| Reinforced fill | Drained               | 0.0                           | 38.0            | 20.0                                      |
| Retained fill   | Drained               | 0.0                           | 27.0            | 18.0                                      |
| Foundation soil | Drained               | 0.0                           | 35.0            | 20.0                                      |

Soil strength values are characteristic values, design values are obtained by applying appropriate partial material factors

### Surcharges

| No | Load acts from x (m) | To x (m) | Load (kN/m <sup>2</sup> ) | Temporary/Permanent |
|----|----------------------|----------|---------------------------|---------------------|
| 1  | 0.28                 | 100.57   | 5                         | Temporary           |

x coordinates are measured from the toe of the reinforced fill block.

Unit loads given above are characteristic values, design values are obtained by applying appropriate partial load factors to the resulting actions.

| Water pressure data | Location              | Height of water level above datum (m) | $r_u$ |
|---------------------|-----------------------|---------------------------------------|-------|
|                     | In front of structure | No water pressures                    |       |
|                     | Within fill           | No water pressures                    | NA    |

| Verification of external stability | Mechanism       | Result   | Max/Min   | Critical case | OK? |
|------------------------------------|-----------------|----------|-----------|---------------|-----|
|                                    | Eccentricity    | +0.156 m | +0.300 m  | BQU           | OK  |
|                                    | Sliding on base | 1.565    | 1.200 min | B             | OK  |
|                                    | Bearing         | 3.093    | 1.350 min | A max. OT     | OK  |

| Verification of internal stability | Mechanism                         | OK?    | Mechanism                           | OK?    |
|------------------------------------|-----------------------------------|--------|-------------------------------------|--------|
|                                    | Rupture check                     | OK     | Adherence check                     | OK     |
|                                    | Internal sliding check            | OK     | Wedge check                         | OK     |
|                                    | Post-construction strain (wedges) | < 1.0% | Post-construction strain (stresses) | < 1.0% |

| Reinforcement layout<br>Starting and finishing levels are related to datum | Tensar Geogrid | No of layers | Starting level (m) | Vertical spacing (m) | Finishing level (m) | Coverage (%) | $f_b$ |
|----------------------------------------------------------------------------|----------------|--------------|--------------------|----------------------|---------------------|--------------|-------|
|                                                                            | RE520          | 2            | 0.45               | 0.30                 | 0.75                | 100          | 0.85  |
|                                                                            | RE520          | 1            | 0.15               | -                    | -                   | 100          | 0.85  |

| Partial load factors applied to actions and materials<br><br>As given in Tables 11 and 12 of BS 8006-1:2010 | Partial factors for load case                       |          | A    | B    | C   |
|-------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|----------|------|------|-----|
|                                                                                                             | Mass of reinforced soil body                        | $f_{fs}$ | 1.5  | 1.0  | 1.0 |
|                                                                                                             | Mass of backfill on top of the reinforced soil wall | $f_{fs}$ | 1.5  | 1.0  | 1.0 |
|                                                                                                             | Earth pressure behind the structure                 | $f_{fs}$ | 1.5  | 1.5  | 1.0 |
|                                                                                                             | Traffic load above reinforced soil wall             | $f_q$    | 1.5  | 0    | 0   |
|                                                                                                             | Traffic load behind reinforced soil wall            | $f_q$    | 1.5  | 1.5  | 0   |
|                                                                                                             | Material factor applied to $\tan\phi'$              | $f_{ms}$ | 1.0  | 1.0  | 1.0 |
|                                                                                                             | Material factor applied to $c'$                     | $f_{ms}$ | 1.6  | 1.6  | 1.0 |
|                                                                                                             | Material factor applied to $s_u$                    | $f_{ms}$ | 1.0  | 1.0  | 1.0 |
|                                                                                                             | Sliding across surface of reinforcement             | $f_s$    | 1.3  | 1.3  | 1.0 |
|                                                                                                             | Pullout resistance of reinforcement                 | $f_p$    | 1.3  | 1.3  | 1.0 |
|                                                                                                             | Partial factor applied to bearing capacity          | $f_{ms}$ | 1.35 | 1.35 | NA  |
|                                                                                                             | Partial factor applied to sliding on base           | $f_s$    | 1.2  | 1.2  | NA  |

|                                                                      |                                                            |       |
|----------------------------------------------------------------------|------------------------------------------------------------|-------|
| <b>Partial factor</b><br>As given in<br>Table 9 of BS<br>8006-1:2010 | <b>Partial factor depending on ramification of failure</b> | $f_n$ |
|                                                                      | Applied to reinforcement rupture strength and pullout      | 1.1   |

|                                                                           |                                                                                                                                                                                                   |                                                                                        |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| <b>Further information relevant to this Tensar Earth Retention System</b> | Further information, specifications and bill of quantities descriptions for this TensarTechEarth Retaining Structure are given in the following documents which form part of this Design Analysis | System overview<br>Installation guide<br>Case histories<br>Construction Animation Link |
|                                                                           | The current versions of these documents may be found by following the website link to "Tensar Documentation" in the Help menu of the TensarSoil® program                                          |                                                                                        |
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## Detailed calculation results

The following tables provide the detailed results from the design Analysis, including geogrid design data, together with both external and internal analysis results.

### External stability - characteristic (unfactored) calculated forces

Note: negative forces are upwards and to the right

| Loading direction                             | Units | Vertical | Horizontal |
|-----------------------------------------------|-------|----------|------------|
| <b>Characteristic static force components</b> |       |          |            |
| <b>Forces in or above reinforced block:</b>   |       |          |            |
| Soil mass                                     | kN/m  | 14.390   | 0.000      |
| Facing                                        | kN/m  | 4.462    | 0.000      |
| Dead loads                                    | kN/m  | 0.000    | 0.000      |
| Live loads                                    | kN/m  | 3.452    | 0.000      |
| From water pressure on base                   | kN/m  | 0.000    | 0.000      |
| From water pressure on face                   | kN/m  | 0.000    | 0.000      |
| <b>Forces behind reinforced block:</b>        |       |          |            |
| From soil                                     | kN/m  | -0.242   | 3.460      |
| From dead loads                               | kN/m  | 0.000    | 0.000      |
| From live loads                               | kN/m  | -0.128   | 1.831      |
| From water pressure                           | kN/m  | 0.000    | 0.000      |

### Verification of external stability - sliding

Sliding resistance is verified for Load combination B.

Loads given below are design values (factored).

| Calculation                       | Units | Static loading |
|-----------------------------------|-------|----------------|
| Design horizontal driving force   | kN/m  | 7.936          |
| Design horizontal resisting force | kN/m  | 12.812         |
| $f_s$ (sliding)                   |       | 1.614          |
| $f_s$ (required)                  |       | > 1.20         |
| OK?                               |       | OK             |

### Additional sliding check

For inclined structures an additional sliding check is carried out with the back of the reinforced soil block defined by a series of steeper lines until the lowest  $f_s$  value is obtained.

|                                   |      |        |
|-----------------------------------|------|--------|
| Critical inclination of wall back | deg  | 90.000 |
| Design horizontal driving force   | kN/m | 8.546  |
| Design horizontal resisting force | kN/m | 13.373 |
| $f_s$ (sliding)                   |      | 1.565  |
| Requirement                       |      | > 1.20 |
| OK?                               |      | OK     |

Calculations in accordance with: Tie-back wedge method (BS8006-1:2010+A1:2016) (static loading)

## Verification of external stability - bearing resistance check

Calculations carried using Meyerhof load distribution to take into account eccentricity.

Characteristic bearing resistance is calculated using unfactored loads.

Bearing resistance is verified for Load combination A, Load combination A (max overturning) and Load combination B.

Static load case:

| Calculation                                | Units             | Load case A | LCA max overturning | Load case B |
|--------------------------------------------|-------------------|-------------|---------------------|-------------|
| Total vertical load on base (unfactored)   | kN/m              | 22          | 19                  | 18          |
| Total horizontal load on base (unfactored) | kN/m              | 5           | 5                   | 5           |
| Total moment on base (unfactored)          | kNm/m             | 1           | 2                   | 2           |
| Factor $N_c$                               |                   | 46.124      | 46.124              | 46.124      |
| Factor $N_q$                               |                   | 33.296      | 33.296              | 33.296      |
| Factor $N_y$                               |                   | 45.228      | 45.228              | 45.228      |
| Factor $i_c$                               |                   | 0.563       | 0.513               | 0.494       |
| Factor $i_q$                               |                   | 0.576       | 0.527               | 0.509       |
| Factor $i_y$                               |                   | 0.437       | 0.383               | 0.364       |
| Effective length $L'$                      | m                 | 0.803       | 0.719               | 0.719       |
| Characteristic ultimate bearing capacity   | kN/m <sup>2</sup> | 159         | 125                 | 118         |
| Design bearing resistance                  | kN/m              | 128         | 90                  | 85          |
| Design applied load                        | kN/m              | 33          | 29                  | 18          |
| $f_{ms}$ (bearing resistance)              |                   | 3.877       | 3.093               | 4.645       |
| $f_{ms}$ (required)                        |                   | > 1.35      | > 1.35              | > 1.35      |
| OK?                                        |                   | OK          | OK                  | OK          |

## Verification of external stability - eccentricity

Eccentricity is verified for Load case A, Load case A (max overturning), Load case B, and serviceability.

Static load case:

| Calculation                            | Units | Load case A | LCA max overturning | Load case B |
|----------------------------------------|-------|-------------|---------------------|-------------|
| Design vertical load on base           | kN/m  | 33          | 29                  | 18          |
| Design moment on base about centreline | kNm/m | 2           | 3                   | 3           |
| Eccentricity                           | m     | +0.048      | +0.090              | +0.156      |
| Limit(s)                               | m     | +0.300      | +0.300              | +0.300      |
| OK?                                    |       | OK          | OK                  | OK          |

## Partial load factors as per the SLS limit state.

|                                        |       |        |        |        |
|----------------------------------------|-------|--------|--------|--------|
| Design vertical load on base           | kN/m  | 19     | 19     | 19     |
| Design moment on base about centreline | kNm/m | 1      | 1      | 1      |
| Eccentricity                           | m     | +0.035 | +0.035 | +0.035 |
| Limit(s)                               | m     | +0.150 | +0.150 | +0.150 |
| Requirement                            |       | ≤ 1.00 | ≤ 1.00 | ≤ 1.00 |
| OK?                                    |       | OK     | OK     | OK     |

## Geogrid reinforcement design data

Geogrid design strength is calculated using the strengths and factors given below  
Strength values quoted are per metre width of geogrid, and do not take into account percentage coverage

| Design temperature (°C)               | 10                            | Design life (years)   | 120                 | Limit state | ULS                                |                                |                     |
|---------------------------------------|-------------------------------|-----------------------|---------------------|-------------|------------------------------------|--------------------------------|---------------------|
| Maximum particle size of fill = 125mm |                               |                       |                     |             |                                    |                                |                     |
| Tensar geogrid                        | Creep rupture strength (kN/m) | Extrapolation of data | Installation damage | Weathering  | Chemical and environmental effects | Characteristic strength (kN/m) | Sliding coefficient |
|                                       | $T_{CR}$                      | $f_s$                 | $RF_{ID}$           | $RF_W$      | $RF_{CH}$                          | $T_{D ULS}$                    | $f_{ds}$            |
| RE520                                 | 27.34                         | 1.0                   | 1.48                | 1.0         | 1.0                                | 16.79                          | 0.85                |

## Geogrid reinforcement design data

Geogrid design strength is calculated using the strengths and factors given below  
Strength values quoted are per metre width of geogrid, and do not take into account percentage coverage

| Design temperature (°C)               | 10                                | Design life (years)   | 120                 | Limit state | SLS                                |                                |                     |
|---------------------------------------|-----------------------------------|-----------------------|---------------------|-------------|------------------------------------|--------------------------------|---------------------|
| Maximum particle size of fill = 125mm |                                   |                       |                     |             |                                    |                                |                     |
| Tensar geogrid                        | Load to limit creep strain (kN/m) | Extrapolation of data | Installation damage | Weathering  | Chemical and environmental effects | Characteristic strength (kN/m) | Sliding coefficient |
|                                       | $T_{CS}$                          | $f_s$                 | $RF_{ID}$           | $RF_W$      | $RF_{CH}$                          | $T_{D SLS}$                    | $f_{ds}$            |
| RE520                                 | 11.87                             | 1.0                   | 1.0                 | 1.0         | 1.0                                | 11.87                          | 0.85                |

## Grid coordinates

Levels are measured from the datum and horizontal location is measured from the toe of the wall

| Tensar geogrid | Level | Left end | Right end | Length | Coverage | Pullout interaction factor $f_b$ |
|----------------|-------|----------|-----------|--------|----------|----------------------------------|
|                | (m)   | (m)      | (m)       | (m)    | %        |                                  |
| RE520          | 0.75  | 0.27     | 0.95      | 0.69   | 100      | 0.85                             |
| RE520          | 0.45  | 0.25     | 0.93      | 0.69   | 100      | 0.85                             |
| RE520          | 0.15  | 0.23     | 0.91      | 0.69   | 100      | 0.85                             |

## Verification of internal stability - sliding

Sliding resistance is verified for Load combination B.  
Loads given below are design values (factored).

| Check at level = 0.150 m above datum. | Units | Static loading |
|---------------------------------------|-------|----------------|
| Design horizontal driving force       | kN/m  | 6.167          |
| Design horizontal resisting force     | kN/m  | 16.297         |
| $f_s$ (sliding)                       |       | 2.643          |
| $f_s$ (required)                      |       | 1.300          |
| OK?                                   |       | OK             |

## Grid spacing check - load combination A.

| Tensar<br>geogrid<br>type | Level<br>above<br>datum<br>(m) | Effective<br>vertical<br>spacing<br>(m) | $T_D$<br>(kN/m) | Rupture Check (kN/m) |          |          |          |       |             | Adherence Check |                           |                            |
|---------------------------|--------------------------------|-----------------------------------------|-----------------|----------------------|----------|----------|----------|-------|-------------|-----------------|---------------------------|----------------------------|
|                           |                                |                                         |                 | $T_{pj}$             | $T_{sj}$ | $T_{fj}$ | $T_{cj}$ | $T_j$ | $T_D > T_j$ | $L_{ej}$<br>(m) | Anchor<br>Force<br>(kN/m) | Anchor<br>Force<br>> $T_j$ |
| RE520                     | 0.15                           | 0.45                                    | 16.79           | 0.94                 | 0.72     | 0.0      | 0.0      | 1.66  | OK          | 0.33            | 2.77                      | OK                         |
| RE520                     | 0.45                           | 0.30                                    | 16.79           | 1.37                 | 0.48     | 0.0      | 0.0      | 1.85  | OK          | 0.47            | 7.9                       | OK                         |
| RE520                     | 0.15                           | 0.30                                    | 16.79           | 2.40                 | 0.48     | 0.0      | 0.0      | 2.89  | OK          | 0.61            | 15.41                     | OK                         |

## Grid spacing check - load combination B.

| Tensar<br>geogrid<br>type | Level<br>above<br>datum<br>(m) | Effective<br>vertical<br>spacing<br>(m) | $T_D$<br>(kN/m) | Rupture Check (kN/m) |          |          |          |       |             | Adherence Check |                           |                            |
|---------------------------|--------------------------------|-----------------------------------------|-----------------|----------------------|----------|----------|----------|-------|-------------|-----------------|---------------------------|----------------------------|
|                           |                                |                                         |                 | $T_{pj}$             | $T_{sj}$ | $T_{fj}$ | $T_{cj}$ | $T_j$ | $T_D > T_j$ | $L_{ej}$<br>(m) | Anchor<br>Force<br>(kN/m) | Anchor<br>Force<br>> $T_j$ |
| RE520                     | 0.15                           | 0.45                                    | 16.79           | 0.67                 | 0.0      | 0.0      | 0.0      | 0.67  | OK          | 0.33            | 1.85                      | OK                         |
| RE520                     | 0.45                           | 0.30                                    | 16.79           | 1.07                 | 0.0      | 0.0      | 0.0      | 1.07  | OK          | 0.47            | 5.27                      | OK                         |
| RE520                     | 0.15                           | 0.30                                    | 16.79           | 2.24                 | 0.0      | 0.0      | 0.0      | 2.24  | OK          | 0.61            | 10.27                     | OK                         |

## Grid serviceability check - Allowable post-construction strain =1.0%

| Tensar<br>geogrid<br>type | Level<br>above<br>datum<br>(m) | Effective<br>vertical<br>spacing<br>(m) | $T_D$<br>for<br>SLS<br>(kN/m) | Design loads (kN/m) |          |          |          |       |                      |       | Wedge Check          |       |
|---------------------------|--------------------------------|-----------------------------------------|-------------------------------|---------------------|----------|----------|----------|-------|----------------------|-------|----------------------|-------|
|                           |                                |                                         |                               | $T_{pj}$            | $T_{sj}$ | $T_{fj}$ | $T_{cj}$ | $T_j$ | Avg<br>Strain<br>(%) | <1.0% | Avg<br>Strain<br>(%) | <1.0% |
| RE520                     | 0.5                            | 0.45                                    | 11.87                         | 0.57                | 0.0      | 0.0      | 0.0      | 0.57  | 0.042                | OK    | 0.021                | OK    |
| RE520                     | 0.45                           | 0.30                                    | 11.87                         | 0.78                | 0.0      | 0.0      | 0.0      | 0.78  | 0.045                | OK    | 0.038                | OK    |
| RE520                     | 0.15                           | 0.30                                    | 11.87                         | 1.27                | 0.0      | 0.0      | 0.0      | 1.27  | 0.035                | OK    | 0.021                | OK    |

## Wedge check

Ultimate Limit State: Wedges with highest  $T_{req}$ :

| Front: |       | Back: |       | $\beta$<br>worst | $T_{req}$<br>(kN/m) | $T_{avail}$<br>(kN/m) | OK or<br>not? |  |
|--------|-------|-------|-------|------------------|---------------------|-----------------------|---------------|--|
| x (m)  | y (m) | x (m) | y (m) |                  |                     |                       |               |  |
| 0.215  | 0.0   | 0.784 | 1.05  | 28.46            | 5                   | 26                    | OK            |  |
| 0.229  | 0.21  | 0.684 | 1.05  | 28.44            | 3                   | 13                    | OK            |  |
| 0.244  | 0.42  | 0.585 | 1.05  | 28.39            | 2                   | 15                    | OK            |  |
| 0.259  | 0.63  | 0.485 | 1.05  | 28.28            | 1                   | 5                     | OK            |  |

Ultimate Limit State: Wedges with highest ratio of  $T_{req}/T_{avail}$ :

Note that the critical wedge when considering anchorage may not be the same as the one which requires the maximum reinforcement force.

| Front: |       | Back: |       | $\beta$<br>worst | $T_{req}$<br>(kN/m) | $T_{avail}$<br>(kN/m) | OK or<br>not? |  |
|--------|-------|-------|-------|------------------|---------------------|-----------------------|---------------|--|
| x (m)  | y (m) | x (m) | y (m) |                  |                     |                       |               |  |
| 0.215  | 0.0   | 0.935 | 1.05  | 34.44            | 5                   | 24                    | OK            |  |
| 0.229  | 0.21  | 0.799 | 1.05  | 34.16            | 3                   | 12                    | OK            |  |
| 0.244  | 0.42  | 0.607 | 1.05  | 29.91            | 2                   | 15                    | OK            |  |
| 0.259  | 0.63  | 0.5   | 1.05  | 29.82            | 1                   | 5                     | OK            |  |

**Client:** Glanville Group

**Project:** McDonalds Penygarnddu Industrial Estate Merthyr  
Lower Portion of the Wall

Rt ht: 1.8m

Tensar  
Structural Systems

**TW1 Wall System**



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**Method of analysis**

The calculation method used to create this Tensar software output is the tie-back wedge reinforced soil retaining wall design method with partial factors defined in Section 6.0 of BS 8006-1:2010+A1:2016 "Code of practice for strengthened/reinforced soils and other fills".

**Reference**

O-78037-CA-03 P01

**Date**

22 Jun 2026

**Page**

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Telephone:

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Cert - QM505288  
Applicable to Tensar International  
and Tensar Manufacturing Ltd

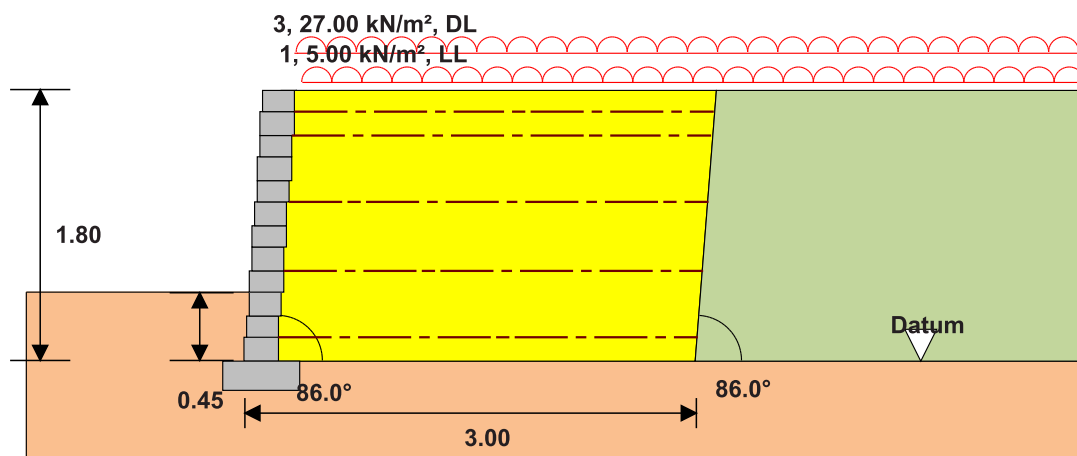


Cert - EMS86463  
Applicable to Tensar Manufacturing Ltd

## Input data and Section

Project:

McDonalds Penygarnddu Industrial Estate Merthyr



## Tensar Structural Systems TW1 Wall System

Static loading case

All dimensions in metres

Scale 1:50

### Fill/foundation properties

Design soil strength parameters are peak values

| Soil zone       | Drained/<br>undrained | $c_k$<br>(kN/m²) | $\phi_k$<br>(°) | $\gamma_{bulk,k}$<br>(kN/m³) |
|-----------------|-----------------------|------------------|-----------------|------------------------------|
| Reinforced fill | Drained               | 0.0              | 38.0            | 20.0                         |
| Retained fill   | Drained               | 0.0              | 27.0            | 18.0                         |
| Foundation soil | Drained               | 0.0              | 35.0            | 20.0                         |

Soil strength values are characteristic values, design values are obtained by applying appropriate partial material factors

### Surcharges

| No | Load acts from x (m) | To x (m) | Load (kN/m²) | Temporary/Permanent |
|----|----------------------|----------|--------------|---------------------|
| 1  | 0.04                 | 100.00   | 5            | Temporary           |
| 3  | 0.00                 | 100.04   | 27           | Permanent           |

x coordinates are measured from the top of the reinforced fill block.

Unit loads given above are characteristic values, design values are obtained by applying appropriate partial load factors to the resulting actions.

Reference

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| Water pressure data | Location              | Height of water level above datum (m) | $r_u$ |
|---------------------|-----------------------|---------------------------------------|-------|
|                     | In front of structure | No water pressures                    |       |
|                     | Within fill           | No water pressures                    | NA    |

| Verification of external stability | Mechanism       | Result   | Max/Min   | Critical case | OK? |
|------------------------------------|-----------------|----------|-----------|---------------|-----|
|                                    | Eccentricity    | +0.094 m | +1.000 m  | BQU           | OK  |
|                                    | Sliding on base | 2.633    | 1.200 min | B             | OK  |
|                                    | Bearing         | 8.165    | 1.350 min | A max. OT     | OK  |

| Verification of internal stability | Mechanism                         | OK?    | Mechanism                           | OK?    |
|------------------------------------|-----------------------------------|--------|-------------------------------------|--------|
|                                    | Rupture check                     | OK     | Adherence check                     | OK     |
|                                    | Internal sliding check            | OK     | Wedge check                         | OK     |
|                                    | Post-construction strain (wedges) | < 1.0% | Post-construction strain (stresses) | < 1.0% |

| Reinforcement layout<br>Starting and finishing levels are related to datum | Tensar Geogrid | No of layers | Starting level (m) | Vertical spacing (m) | Finishing level (m) | Coverage (%) | $f_b$ |
|----------------------------------------------------------------------------|----------------|--------------|--------------------|----------------------|---------------------|--------------|-------|
|                                                                            | RE520          | 1            | 1.65               | -                    | 1.65                | 100          | 0.85  |
|                                                                            | RE520          | 1            | 1.50               | -                    | 1.50                | 100          | 0.85  |
|                                                                            | RE520          | 2            | 0.60               | 0.45                 | 1.05                | 100          | 0.85  |
|                                                                            | RE520          | 1            | 0.15               | -                    | -                   | 100          | 0.85  |

| Partial load factors applied to actions and materials<br>As given in Tables 11 and 12 of BS 8006-1:2010 | Partial factors for load case                       |          | A    | B    | C   |
|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------|----------|------|------|-----|
|                                                                                                         | Mass of reinforced soil body                        | $f_{fs}$ | 1.5  | 1.0  | 1.0 |
|                                                                                                         | Mass of backfill on top of the reinforced soil wall | $f_{fs}$ | 1.5  | 1.0  | 1.0 |
|                                                                                                         | Earth pressure behind the structure                 | $f_{fs}$ | 1.5  | 1.5  | 1.0 |
|                                                                                                         | Traffic load above reinforced soil wall             | $f_q$    | 1.5  | 0    | 0   |
|                                                                                                         | Traffic load behind reinforced soil wall            | $f_q$    | 1.5  | 1.5  | 0   |
|                                                                                                         | Material factor applied to $\tan\phi'$              | $f_{ms}$ | 1.0  | 1.0  | 1.0 |
|                                                                                                         | Material factor applied to $c'$                     | $f_{ms}$ | 1.6  | 1.6  | 1.0 |
|                                                                                                         | Material factor applied to $s_u$                    | $f_{ms}$ | 1.0  | 1.0  | 1.0 |
|                                                                                                         | Sliding across surface of reinforcement             | $f_s$    | 1.3  | 1.3  | 1.0 |
|                                                                                                         | Pullout resistance of reinforcement                 | $f_p$    | 1.3  | 1.3  | 1.0 |
|                                                                                                         | Partial factor applied to bearing capacity          | $f_{ms}$ | 1.35 | 1.35 | NA  |
|                                                                                                         | Partial factor applied to sliding on base           | $f_s$    | 1.2  | 1.2  | NA  |

|                                                                      |                                                            |       |
|----------------------------------------------------------------------|------------------------------------------------------------|-------|
| <b>Partial factor</b><br>As given in<br>Table 9 of BS<br>8006-1:2010 | <b>Partial factor depending on ramification of failure</b> | $f_n$ |
|                                                                      | Applied to reinforcement rupture strength and pullout      | 1.1   |

|                                                                           |                                                                                                                                                                                                   |                                                                                        |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| <b>Further information relevant to this Tensar Earth Retention System</b> | Further information, specifications and bill of quantities descriptions for this TensarTechEarth Retaining Structure are given in the following documents which form part of this Design Analysis | System overview<br>Installation guide<br>Case histories<br>Construction Animation Link |
|                                                                           | The current versions of these documents may be found by following the website link to "Tensar Documentation" in the Help menu of the TensarSoil® program                                          |                                                                                        |
|                                                                           | For program users who do not have a link to the internet contact your nearest Tensar representative or distributor                                                                                | Tensar International Limited<br><br>software@tensar.co.uk<br>Web: www.tensar.co.uk     |

## Detailed calculation results

The following tables provide the detailed results from the design Analysis, including geogrid design data, together with both external and internal analysis results.

### External stability - characteristic (unfactored) calculated forces

Note: negative forces are upwards and to the right

| Loading direction                             | Units | Vertical | Horizontal |
|-----------------------------------------------|-------|----------|------------|
| <b>Characteristic static force components</b> |       |          |            |
| <b>Forces in or above reinforced block:</b>   |       |          |            |
| Soil mass                                     | kN/m  | 100.269  | 0.000      |
| Facing                                        | kN/m  | 7.649    | 0.000      |
| Dead loads                                    | kN/m  | 75.343   | 0.000      |
| Live loads                                    | kN/m  | 13.742   | 0.000      |
| From water pressure on base                   | kN/m  | 0.000    | 0.000      |
| From water pressure on face                   | kN/m  | 0.000    | 0.000      |
| <b>Forces behind reinforced block:</b>        |       |          |            |
| From soil                                     | kN/m  | -0.711   | 10.168     |
| From dead loads                               | kN/m  | -1.185   | 16.947     |
| From live loads                               | kN/m  | -0.219   | 3.138      |
| From water pressure                           | kN/m  | 0.000    | 0.000      |

### Verification of external stability - sliding

Sliding resistance is verified for Load combination B.

Loads given below are design values (factored).

| Calculation                       | Units | Static loading |
|-----------------------------------|-------|----------------|
| Design horizontal driving force   | kN/m  | 45.381         |
| Design horizontal resisting force | kN/m  | 126.099        |
| $f_s$ (sliding)                   |       | 2.779          |
| $f_s$ (required)                  |       | > 1.20         |
| OK?                               |       | OK             |

### Additional sliding check

For inclined structures an additional sliding check is carried out with the back of the reinforced soil block defined by a series of steeper lines until the lowest  $f_s$  value is obtained.

|                                   |      |         |
|-----------------------------------|------|---------|
| Critical inclination of wall back | deg  | 90.000  |
| Design horizontal driving force   | kN/m | 48.871  |
| Design horizontal resisting force | kN/m | 128.673 |
| $f_s$ (sliding)                   |      | 2.633   |
| Requirement                       |      | > 1.20  |
| OK?                               |      | OK      |

Calculations in accordance with: Tie-back wedge method (BS8006-1:2010+A1:2016) (static loading)

## Verification of external stability - bearing resistance check

Calculations carried using Meyerhof load distribution to take into account eccentricity.

Characteristic bearing resistance is calculated using unfactored loads.

Bearing resistance is verified for Load combination A, Load combination A (max overturning) and Load combination B.

Static load case:

| Calculation                                | Units             | Load case A | LCA max overturning | Load case B |
|--------------------------------------------|-------------------|-------------|---------------------|-------------|
| Total vertical load on base (unfactored)   | kN/m              | 195         | 187                 | 181         |
| Total horizontal load on base (unfactored) | kN/m              | 30          | 30                  | 30          |
| Total moment on base (unfactored)          | kNm/m             | 0           | 6                   | 3           |
| Factor $N_c$                               |                   | 46.124      | 46.124              | 46.124      |
| Factor $N_q$                               |                   | 33.296      | 33.296              | 33.296      |
| Factor $N_y$                               |                   | 45.228      | 45.228              | 45.228      |
| Factor $i_c$                               |                   | 0.705       | 0.693               | 0.684       |
| Factor $i_q$                               |                   | 0.714       | 0.702               | 0.694       |
| Factor $i_y$                               |                   | 0.603       | 0.588               | 0.578       |
| Effective length $L'$                      | m                 | 3.000       | 2.932               | 2.964       |
| Characteristic ultimate bearing capacity   | kN/m <sup>2</sup> | 818         | 780                 | 775         |
| Design bearing resistance                  | kN/m              | 2454        | 2287                | 2297        |
| Design applied load                        | kN/m              | 292         | 280                 | 180         |
| $f_{ms}$ (bearing resistance)              |                   | 8.394       | 8.165               | 12.754      |
| $f_{ms}$ (required)                        |                   | > 1.35      | > 1.35              | > 1.35      |
| OK?                                        |                   | OK          | OK                  | OK          |

## Verification of external stability - eccentricity

Eccentricity is verified for Load case A, Load case A (max overturning), Load case B, and serviceability.

Static load case:

| Calculation                            | Units | Load case A | LCA max overturning | Load case B |
|----------------------------------------|-------|-------------|---------------------|-------------|
| Design vertical load on base           | kN/m  | 292         | 280                 | 180         |
| Design moment on base about centreline | kNm/m | 0           | 10                  | 17          |
| Eccentricity                           | m     | -0.001      | +0.034              | +0.094      |
| Limit(s)                               | m     | +1.000      | +1.000              | +1.000      |
| OK?                                    |       | OK          | OK                  | OK          |

Partial load factors as per the SLS limit state.

|                                        |       |        |        |        |
|----------------------------------------|-------|--------|--------|--------|
| Design vertical load on base           | kN/m  | 181    | 181    | 181    |
| Design moment on base about centreline | kNm/m | 0      | 0      | 0      |
| Eccentricity                           | m     | +0.000 | +0.000 | +0.000 |
| Limit(s)                               | m     | +0.500 | +0.500 | +0.500 |
| Requirement                            |       | ≤ 1.00 | ≤ 1.00 | ≤ 1.00 |
| OK?                                    |       | OK     | OK     | OK     |

## Geogrid reinforcement design data

Geogrid design strength is calculated using the strengths and factors given below  
Strength values quoted are per metre width of geogrid, and do not take into account percentage coverage

| Design temperature (°C)               | 10                            | Design life (years)   | 120                 | Limit state | ULS                                |                                |                     |
|---------------------------------------|-------------------------------|-----------------------|---------------------|-------------|------------------------------------|--------------------------------|---------------------|
| Maximum particle size of fill = 125mm |                               |                       |                     |             |                                    |                                |                     |
| Tensar geogrid                        | Creep rupture strength (kN/m) | Extrapolation of data | Installation damage | Weathering  | Chemical and environmental effects | Characteristic strength (kN/m) | Sliding coefficient |
|                                       | $T_{CR}$                      | $f_s$                 | $RF_{ID}$           | $RF_W$      | $RF_{CH}$                          | $T_{D ULS}$                    | $f_{ds}$            |
| RE520                                 | 27.34                         | 1.0                   | 1.48                | 1.0         | 1.0                                | 16.79                          | 0.85                |

## Geogrid reinforcement design data

Geogrid design strength is calculated using the strengths and factors given below  
Strength values quoted are per metre width of geogrid, and do not take into account percentage coverage

| Design temperature (°C)               | 10                                | Design life (years)   | 120                 | Limit state | SLS                                |                                |                     |
|---------------------------------------|-----------------------------------|-----------------------|---------------------|-------------|------------------------------------|--------------------------------|---------------------|
| Maximum particle size of fill = 125mm |                                   |                       |                     |             |                                    |                                |                     |
| Tensar geogrid                        | Load to limit creep strain (kN/m) | Extrapolation of data | Installation damage | Weathering  | Chemical and environmental effects | Characteristic strength (kN/m) | Sliding coefficient |
|                                       | $T_{CS}$                          | $f_s$                 | $RF_{ID}$           | $RF_W$      | $RF_{CH}$                          | $T_{D SLS}$                    | $f_{ds}$            |
| RE520                                 | 11.87                             | 1.0                   | 1.0                 | 1.0         | 1.0                                | 11.87                          | 0.85                |

## Grid coordinates

Levels are measured from the datum and horizontal location is measured from the toe of the wall

| Tensar geogrid | Level | Left end | Right end | Length | Coverage | Pullout interaction factor $f_b$ |
|----------------|-------|----------|-----------|--------|----------|----------------------------------|
|                | (m)   | (m)      | (m)       | (m)    | %        |                                  |
| RE520          | 1.65  | 0.33     | 3.12      | 2.79   | 100      | 0.85                             |
| RE520          | 1.50  | 0.32     | 3.10      | 2.79   | 100      | 0.85                             |
| RE520          | 1.05  | 0.29     | 3.07      | 2.79   | 100      | 0.85                             |
| RE520          | 0.60  | 0.26     | 3.04      | 2.79   | 100      | 0.85                             |
| RE520          | 0.15  | 0.23     | 3.01      | 2.79   | 100      | 0.85                             |

## Verification of internal stability - sliding

Sliding resistance is verified for Load combination B.  
Loads given below are design values (factored).

| Check at level = 0.150 m above datum. | Units | Static loading |
|---------------------------------------|-------|----------------|
| Design horizontal driving force       | kN/m  | 40.434         |
| Design horizontal resisting force     | kN/m  | 118.654        |
| $f_s$ (sliding)                       |       | 2.934          |
| $f_s$ (required)                      |       | 1.300          |
| OK?                                   |       | OK             |

## Grid spacing check - load combination A.

| Tensar<br>geogrid<br>type | Level<br>above<br>datum<br>(m) | Effective<br>vertical<br>spacing<br>(m) | $T_D$<br>(kN/m) | Rupture Check (kN/m) |          |          |          |       |             | Adherence Check |                           |                            |
|---------------------------|--------------------------------|-----------------------------------------|-----------------|----------------------|----------|----------|----------|-------|-------------|-----------------|---------------------------|----------------------------|
|                           |                                |                                         |                 | $T_{pj}$             | $T_{sj}$ | $T_{fj}$ | $T_{cj}$ | $T_j$ | $T_D > T_j$ | $L_{ej}$<br>(m) | Anchor<br>Force<br>(kN/m) | Anchor<br>Force<br>> $T_j$ |
| RE520                     | 1.65                           | 0.23                                    | 16.79           | 0.22                 | 2.29     | 0.0      | 0.0      | 2.51  | OK          | 2.00            | 58.62                     | OK                         |
| RE520                     | 1.50                           | 0.30                                    | 16.79           | 0.60                 | 3.05     | 0.0      | 0.0      | 3.65  | OK          | 2.07            | 69.37                     | OK                         |
| RE520                     | 1.05                           | 0.45                                    | 16.79           | 2.30                 | 4.58     | 0.0      | 0.0      | 6.88  | OK          | 2.29            | 105.19                    | OK                         |
| RE520                     | 0.60                           | 0.45                                    | 16.79           | 3.79                 | 4.58     | 0.0      | 0.0      | 8.37  | OK          | 2.50            | 146.35                    | OK                         |
| RE520                     | 0.15                           | 0.38                                    | 16.79           | 4.50                 | 3.82     | 0.0      | 0.0      | 8.32  | OK          | 2.71            | 191.48                    | OK                         |

## Grid spacing check - load combination B.

| Tensar<br>geogrid<br>type | Level<br>above<br>datum<br>(m) | Effective<br>vertical<br>spacing<br>(m) | $T_D$<br>(kN/m) | Rupture Check (kN/m) |          |          |          |       |             | Adherence Check |                           |                            |
|---------------------------|--------------------------------|-----------------------------------------|-----------------|----------------------|----------|----------|----------|-------|-------------|-----------------|---------------------------|----------------------------|
|                           |                                |                                         |                 | $T_{pj}$             | $T_{sj}$ | $T_{fj}$ | $T_{cj}$ | $T_j$ | $T_D > T_j$ | $L_{ej}$<br>(m) | Anchor<br>Force<br>(kN/m) | Anchor<br>Force<br>> $T_j$ |
| RE520                     | 1.65                           | 0.23                                    | 16.79           | 0.15                 | 1.29     | 0.0      | 0.0      | 1.44  | OK          | 2.00            | 55.83                     | OK                         |
| RE520                     | 1.50                           | 0.30                                    | 16.79           | 0.41                 | 1.72     | 0.0      | 0.0      | 2.13  | OK          | 2.07            | 63.59                     | OK                         |
| RE520                     | 1.05                           | 0.45                                    | 16.79           | 1.61                 | 2.58     | 0.0      | 0.0      | 4.19  | OK          | 2.29            | 89.25                     | OK                         |
| RE520                     | 0.60                           | 0.45                                    | 16.79           | 2.72                 | 2.58     | 0.0      | 0.0      | 5.30  | OK          | 2.50            | 118.47                    | OK                         |
| RE520                     | 0.15                           | 0.38                                    | 16.79           | 3.34                 | 2.15     | 0.0      | 0.0      | 5.49  | OK          | 2.71            | 150.02                    | OK                         |

## Grid serviceability check - Allowable post-construction strain =1.0%

| Tensar<br>geogrid<br>type | Level<br>above<br>datum<br>(m) | Effective<br>vertical<br>spacing<br>(m) | $T_D$<br>for<br>SLS<br>(kN/m) | Design loads (kN/m) |          |          |          |       |                      |       | Wedge Check          |       |
|---------------------------|--------------------------------|-----------------------------------------|-------------------------------|---------------------|----------|----------|----------|-------|----------------------|-------|----------------------|-------|
|                           |                                |                                         |                               | $T_{pj}$            | $T_{sj}$ | $T_{fj}$ | $T_{cj}$ | $T_j$ | Avg<br>Strain<br>(%) | <1.0% | Avg<br>Strain<br>(%) | <1.0% |
| RE520                     | 1.65                           | 0.23                                    | 11.87                         | 0.15                | 1.29     | 0.0      | 0.0      | 1.44  | 0.063                | OK    | 0.139                | OK    |
| RE520                     | 1.50                           | 0.30                                    | 11.87                         | 0.40                | 1.72     | 0.0      | 0.0      | 2.12  | 0.085                | OK    | 0.128                | OK    |
| RE520                     | 1.05                           | 0.45                                    | 11.87                         | 1.53                | 2.58     | 0.0      | 0.0      | 4.11  | 0.119                | OK    | 0.09                 | OK    |
| RE520                     | 0.60                           | 0.45                                    | 11.87                         | 2.51                | 2.58     | 0.0      | 0.0      | 5.09  | 0.091                | OK    | 0.052                | OK    |
| RE520                     | 0.15                           | 0.38                                    | 11.87                         | 2.96                | 2.15     | 0.0      | 0.0      | 5.11  | 0.034                | OK    | 0.012                | OK    |

## Wedge check

Ultimate Limit State: Wedges with highest  $T_{req}$ :

| Front: |       | Back: |       | $\beta$ | $T_{req}$ | $T_{avail}$ | OK or |  |
|--------|-------|-------|-------|---------|-----------|-------------|-------|--|
| x (m)  | y (m) | x (m) | y (m) | worst   | (kN/m)    | (kN/m)      | not?  |  |
| 0.215  | 0.0   | 1.193 | 1.8   | 28.53   | 28        | 84          | OK    |  |
| 0.24   | 0.36  | 1.023 | 1.8   | 28.54   | 21        | 67          | OK    |  |
| 0.265  | 0.72  | 0.853 | 1.8   | 28.55   | 14        | 50          | OK    |  |
| 0.29   | 1.08  | 0.682 | 1.8   | 28.57   | 9         | 34          | OK    |  |
| 0.315  | 1.44  | 0.512 | 1.8   | 28.63   | 4         | 34          | OK    |  |

Ultimate Limit State: Wedges with highest ratio of  $T_{req}/T_{avail}$ :

Note that the critical wedge when considering anchorage may not be the same as the one which requires the maximum reinforcement force.

| Front: |       | Back: |       | $\beta$ | $T_{req}$ | $T_{avail}$ | OK or |  |
|--------|-------|-------|-------|---------|-----------|-------------|-------|--|
| x (m)  | y (m) | x (m) | y (m) | worst   | (kN/m)    | (kN/m)      | not?  |  |
| 0.215  | 0.0   | 1.193 | 1.8   | 28.53   | 28        | 84          | OK    |  |
| 0.24   | 0.36  | 1.023 | 1.8   | 28.54   | 21        | 67          | OK    |  |
| 0.265  | 0.72  | 0.853 | 1.8   | 28.55   | 14        | 50          | OK    |  |
| 0.29   | 1.08  | 0.682 | 1.8   | 28.57   | 9         | 34          | OK    |  |
| 0.315  | 1.44  | 0.512 | 1.8   | 28.63   | 4         | 34          | OK    |  |