Building a retaining wall that also offers corrosion resistance - can be **simple**, **quick** and **cost-effective**.
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What is FoldLock®?

FoldLock is an eco-friendly geosynthetic strip-type reinforcement for reinforced soil walls, which can be used as a substitute for steel reinforcement. It is utilised in large-scale land development, roads, railways, bridges, and other infrastructure. The strip can be directly connected to, or folded into concrete panels and blocks; resulting in high connection strength.

We are proud to be partners with Hanforce Co., Ltd., the creators of FoldLock. It has been in use for over 17 years, and together with its construction method methodology it is registered in 27 European countries. It is compliant with the European EC Certificate of Factory Production and Control (1213-CPD-5392) and ISO 9001:2015 (GIS-1128-QC) compliant. In South Korea, the country of its origin, FoldLock has been awarded various Green Technology and Performance certifications. These include the Certificate of Green Technology (GT-12-00065), Green Specialised Enterprise Certificate (GE-13-00037), and the Excellent Performance Certificate for Small and Medium Business Administrations (15-957).

Highlights at a Glance

1. Unlike existing geogrid reinforcements, the strip does not need transverse ribs, so up to 40% less reinforcement is required. This is further achieved by a more than 20% increase in pull-out resistance when compared to existing reinforcements. A wide range of backfill material can be applied. This may enable the use of in-situ material which is more cost effective.

2. High corrosion resistance makes it applicable to biologically or chemically polluted areas, as well as areas in contact with sea water. Whole-of-life costs are significantly reduced as continuous repair is mitigated.

3. Existing strip-type reinforcements only generates frictional resistance. Our product also generates passive resistance, resulting in enhanced bearing resistance. This means that less reinforcement needs to be used, REW can be built higher and the effects of surcharge are reduced.

4. When used in bridges most concrete works are unnecessary, leading to shorter construction times and 20%-60% reduction in construction costs.

5. Highly resistant to seismic stress – proven during earthquakes in Los Angeles and Kobe, amongst others.

6. Improved performance against settlement of reinforced soil, leading to enhanced durability, even in the face of poor workmanship.

7. High-rise walls of far over 50m are possible.

8. Easy and simple construction process, enabling savings in labour requirements, construction costs.
FoldLock

FoldLock reinforcement is a geosynthetic strip reinforcement with a foldable groove formed along the length of the reinforcement. It is utilised in reinforced soil walls for large-scale land developments, roads, railways, and similar infrastructure. PET fibres are tightly knitted into one fibre and coated with PE to form the FoldLock reinforcement; making it durable against environmental deterioration.

The FoldLock reinforcement can be folded in half along the foldable groove to facilitate connection to the applicable exterior element, resulting in high connection strength. The reinforcement is subsequently laid flat in the backfill layer and formed into a U-shape at the end, creating a rounded band anchor before being threaded through the next connection point. Bearing resistance is increased through a combination of frictional resistance and the aforementioned rounded band anchor. The resulting effect of the increased bearing resistance is that the required length of reinforcement can be minimized, and higher REW wall heights can be achieved. FoldLock is an eco-friendly reinforcement that can be applied to a wide range of backfill materials.
High Efficiency Geosynthetic Strip with Folding Groove

- The FoldLock reinforcement is folded in half along the foldable groove and directly connected to blocks or panels → Enhanced connection strength.
- The reinforcement, laid flat in a backfill layer, forms the frictional resistance part. At the same time, the rounded band anchor is formed at the end as a U-shape → Excellent pull-out resistance characteristic.
- Flexible reaction to external forces enables alleviation of stress concentration at the connection and prevents disjointing.
- PET fibres are tightly knitted into one fibre and coated with PE to form the FoldLock reinforcement. Due to this design it is highly durable against various types of environmental deterioration and can be utilised with a wide range of backfill materials.
- Unlike existing geogrid reinforcements, the strip does not need transverse ribs → Reduction of required reinforcement.
- Existing strip-type reinforcements only generates frictional resistance. Our product also generates passive resistance → Enhanced bearing resistance.

Composition and Data

- The reinforcement is folded in half along the foldable groove and directly connected to the groove formed on the blocks and panels.
- The reinforcement forms a frictional resistance part when laid flat and a U-shape forms a rounded band anchor.

<table>
<thead>
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<th>Product Name</th>
<th>Width (mm)</th>
<th>Specifications</th>
<th>Public Procurement Service (goods) Identification Number</th>
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<td>±1.6 ±15</td>
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<td>FOLDLOCK 25kN</td>
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<td>±1.8 ±25</td>
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<td>FOLDLOCK 70kN</td>
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<td>FOLDLOCK 90kN</td>
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<td>±3.5 ±90</td>
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Reliability Evaluation Test Results of FoldLock Strip (FITI Test Institute: H411-12-00005) Pull-out Test and Performance of FoldLock Strip (Korea Institute of Civil Engineering and Building Technology: 2009-213)

<table>
<thead>
<tr>
<th>Classification</th>
<th>15kN</th>
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<th>Test Method</th>
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<td>KS K ISO 10319</td>
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<td>Tensile force (kN)</td>
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<td>Elongation rate (%)</td>
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<td>Workability</td>
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<td>KS K ISO 10722</td>
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<td>Tensile force (kN)</td>
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<td>Retention rate of tensile force (%)</td>
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<td>Liquid resistance</td>
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<td>Retention rate of tensile force (%)</td>
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<td>100 years</td>
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Pull-out testing apparatus

Variation of pull-out strength with normal stress

<table>
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<tr>
<th>Overburden load</th>
<th>25kN reinforcement τa (kN/m²)</th>
<th>50kN reinforcement τa (kN/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strip</td>
<td>Foldlock Strip</td>
<td>Strip</td>
</tr>
<tr>
<td>50 kN/m²</td>
<td>55.23</td>
<td>91.54</td>
</tr>
<tr>
<td>100 kN/m²</td>
<td>80.43</td>
<td>109.34</td>
</tr>
<tr>
<td>150 kN/m²</td>
<td>97.97</td>
<td>141.51</td>
</tr>
</tbody>
</table>

With rounded band anchor

Without rounded band anchor

FoldLock strip with tailored REW block system

The Tailored REW (Reinforced Earth Walls) Block system maximises connection strength between the block and the reinforcement. The reinforcement is folded in half and directly connected to the block. This leads to superior durability of the reinforcement, without stress concentration points or damage to the reinforcement. Reliability of the structure is furthermore ensured by increased bearing resistance through the rounded band anchor formed by the reinforcement buried in the backfill.
Construction Components

FoldLock Reinforcement
A geosynthetic strip reinforcement with a foldable groove. It is installed in the backfill and holds the structure through force of friction with the soil.

Facing Block
A concrete block forming the entire wall is connected to the reinforcement in order to prevent loss of backfill and improves the visual appearance of the structure.

Backfill
This refers to soil or gravel that is used to fill the rear of the facing blocks. It interacts with the reinforcement to form a reinforced soil system.

Connecting Pin
This connecting plastic pin enables adjustment of the gradient of the wall and improves the connection strength between blocks. The pin is installed into the horizontal joint of the block.

Vegetation Bag (optional)
This is a cloth bag which penetrates the inner part of the block and is connected to the backfill to form the vegetation bed.

Construction Method

Step 1: Concrete foundation construction
Pour the concrete in the cast to make the horizontal foundation, measuring about 200mm in height and 400mm in width.

Step 2: Base block construction
Evenly place the blocks along the concrete foundation perpendicular to the foundation to form the base.

Step 3: Backfilling and compaction
The thickness of the backfilling should be less that 300mm deep. A small roller is used to compact the backfill layer within 1,500mm from the inner-facing wall.

Step 4: Installation of the reinforcement
Connect the reinforcement, folded in half, to the block. Form the reinforcement into a U-shape at the back end and straighten up the round part of the U slightly.

Step 5: Installation of upper blocks
Another block is placed above the base block. Insert a connecting pin in a pin hole built into the block in order to fix the block into position.

Step 6: Completion
Repeat steps 3, 4 and 5 until completion.
Why use FoldLock Strip and Block system?

Due to the connection groove in the block, the thickness of the blocks are reduced

- Block consists of less material.
- Reduced environmental load generated during production, transportation and construction.
- Reduced construction waste (up to 50%) after intended use.
- Improved efficiency of manpower due to light weight blocks.

Enhanced connection strength between block and reinforcement by directly connecting the reinforcement to the block

- Prevents the separation and bulging of blocks.
- Prevents damage due to the connection between the reinforcement and the block.
- Continuously maintains the connection strength.

Improved constructability and stability of reinforced soil walls for cutting slopes

- As spacing between anchors can be freely adjusted according to conditions on the cutting slope foundation, it is easy to construct.
- A wide range of backfills can be used, such as excavated soil, or crushed rock.

Enhanced pull-out resistance of reinforcement

- The reinforcements are fully expanded in the backfill to form both the frictional resistance and U-shaped rounded band anchor.

Improved performance against settlement of reinforced soil

- The connection method allows for an up and down buffering effect of the reinforcement. Stress concentration is therefore alleviated; preventing disjointing.

Including vegetation bags in the retaining wall holds various benefits:

- Relieving the urban island effect by decreasing the wall temperature by more than 5°C.
- Reducing air pollution.
- Preventing reflected light.
- Noise reduction.

Material and energy saving effects of FoldLock reinforcement:

- Unlike existing geogrid reinforcements, the strip does not need transverse ribs, resulting in 40% less required reinforcement.
- Production is a single step process, thereby reducing the environmental load during production.

Material and energy saving effects of FoldLock reinforcement used with concrete block:

- Thickness of the block is reduced, thereby reducing the block weight per square meter by 19-48% (as compared to other existing technologies). Material and transportation costs are saved.
- CO₂ generated from cement production is reduced and environmental load generated from material transportation is lightened.

Quality verification of FoldLock reinforcement and construction method

<table>
<thead>
<tr>
<th>Verification Item</th>
<th>Verification Standard</th>
<th>Verification Result</th>
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<tbody>
<tr>
<td>Reliability of reinforcement performance</td>
<td>RS K 0023</td>
<td>Reliability verification of durability (FITI Test Institute). Test on creep deformation for more than 10,000 hours (Korean Institute of Civil Engineering and Building Technology).</td>
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<tr>
<td>Characteristic of pullout resistance of reinforcement</td>
<td>ASTM D 6706</td>
<td>Pullout resistance improved by additional passive resistance over 20% increase (Korean Institute of Civil Engineering and Building Technology).</td>
</tr>
<tr>
<td>Design program</td>
<td>Design criteria for construction slope</td>
<td>The development of saafety analysis method for pullout resistance and unique design program (Korean Institute of Civil Engineering and Building Technology).</td>
</tr>
<tr>
<td>Safety of entire structure</td>
<td>Field measurement in test site (H = 9m)</td>
<td>Measured results of soil pressure on reinforced soil wall, horizontal displacement of exterior wall and tensile deformation of reinforcements safety maintained after construction (Korean Institute of Civil Engineering and Building Technology).</td>
</tr>
</tbody>
</table>

In the structure pictured, each end of the reinforcement is connected to a cutting slope anchor and facing block, creating a strong and flexible solution. Resistance against external forces is high, alleviating stress at the connection points and enhancing connection strength.
FoldLock Strip with Tailored REW Panel System

Loop-type Connection vs Sleeve-type Connection
Two connection types are available for use in concrete panels where FoldLock reinforcement is used. Both are designed to connect the panel directly with the reinforcement to enhance connection strength.
The plastic C-sleeve is cast into the concrete panel and increases the durability of the reinforcement against various environmental factors. These include corrosive areas, such as contact with sea water; and biologically and chemically polluted areas.

VS

The space between the points connecting the reinforcement to the panel is minimized without any overlap of reinforcements. This effectively enables more reinforcement strips to be installed and allows high-rise reinforced soil walls to be built. This is applicable to high-rise reinforced walls of over 50m in height.
**Construction Components**

**FoldLock Reinforcement**
A geosynthetic strip reinforcement with a foldable groove. It is installed in the backfill and holds the structure through force of friction with the soil.

**Facing Block**
A concrete panel forming the entire wall is connected to the reinforcement in order to prevent loss of backfill and improves the visual appearance of the structure.

**Backfill**
Materials such as soil and crushed rock are used to fill the rear of the facing blocks. It interacts with the reinforcement to form a reinforced soil system.

**Horizontal Sealing Material**
A cork or rubber pad is installed in the horizontal seal of the panel to prevent impact between facing panels and to increase flexibility.

**Vertical Sealing Material**
Non-woven fabric is installed in the vertical seal of the facing panel to prevent a loss of backfill but allows drainage.

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**Construction Method**

**Step 1: Concrete foundation construction**
Pour the concrete in the cast to make the horizontal foundation, measuring about 200mm in height and 400mm in width.

**Step 2: Base-facing panel construction**
Evenly place the panels along the concrete foundation perpendicular to the foundation to form the base.

**Step 3: Backfilling and compaction**
Backfilling and compaction should be done after installation of the reinforcements and panels. A small roller is used to compact the backfill layer within 1,500mm from the inner-facing wall.

**Step 4: Installation of the reinforcement**
Insert the unfolded reinforcement into the C-shaped sleeve, then fold the reinforcement at the entrance of the sleeve in half and reinsert it. Form the reinforcement into a U-shape at the back end and straighten up the round part of the U slightly.

**Step 5: Installation of upper-facing panels**
Another panel is placed above the base panels and horizontal/vertical sealing materials are installed at each horizontal/vertical joint.

**Step 6: Completion**
Repeat steps 3, 4 and 5 until completion.
Field Applications

1 | Bridge Abutment
Unlike existing methodologies where concrete forms the main component within bridge abutments, the main component when using the FoldLock system is the earthworks. Construction processes such as concrete formwork installation and removal, reinforcing bar work, concrete pouring and curing are unnecessary.
This results in the following benefits:
   a. Project management is easy.
   b. Project duration is shortened.
   c. Construction costs are reduced (at least 20% and up to 60%).

2 | Seismic Resistance
This construction method is applicable in soft ground and is highly resistant to seismic forces. This has been proven during earthquakes in Los Angeles and Kobe, amongst others.

3 | Roads and Pavements
Abutment and surface of pavement have uniform settlements; therefore roads have good continuity and driving comfort. This means that the loss of backfill near the abutment wingwalls can be avoided.

4 | Cutting Slopes
In the structure pictured, each end of the reinforcement is connected to a cutting slope anchor and facing block, creating a strong and flexible solution.
Resistance against external forces is high, alleviating stress at the connection points and enhancing connection strength.
   a. Local displacement is minimised.
   b. Spacing between anchors can be freely adjusted according to conditions on the cutting slope foundation, making construction easier.
   c. A wide range of backfills can be used, such as excavated soil, or crushed rock.
5 | Corrosive or Polluted Environments
High corrosion resistance makes it applicable to biologically or chemically polluted areas, as well as areas in contact with sea water.

6 | Structures, Manholes and Columns
In the event that there is a structure in the reinforced soil system (such as a manhole or column), the reinforcement can be folded in half and installed in a radial shape to avoid the nearby structure. The reinforcement can also easily be connected to an anchor bolt on the structure’s surface.
Why use FoldLock Strip and Panel System?

Enhanced connection strength between panel and reinforcement by directly connecting the reinforcement to the panel
- Prevents the separation and bulging of panels.
- Prevents damage due to the connection between the reinforcement and the block.
- Continuously maintains the connection strength.

Enhanced pull-out resistance of reinforcement
- The reinforcements are fully expanded in the backfill to form both the frictional resistance and U-shaped rounded band anchor.

Enhanced connection strength of reinforced structure
- In this structure the reinforcements are directly connected to the panel without any auxiliary joint assembly materials. The reinforcement strips are then laid over the entire backfill following a zigzag pattern which increases durability against ground displacement and differential settlement.

Improved constructability and stability of reinforced soil walls for cutting slopes
- The reinforcements are fully expanded in the backfill to form both the frictional resistance and U-shaped rounded band anchor.

Including vegetation bags in the retaining wall holds various benefits:
- Relieving the thermal island effect.
- Reducing air pollution.
- Preventing reflected light.
- Noise reduction.

Construction images
Construction of the Inje auto-theme park (H = 1 layer of 15.6m)

Expansion project of Geoncheon industrial complex for Kiswire Ltd (H = 2 layers of 12m in total)

Site construction of a factory in Socho-myeon, Wonju (H = 1 layer of 12m)

Development project of the Dongtan logistics complex in Hwaseong (H = 3 layers of 21m)

The second Yeongdong expressway (Gwangju – Wonju), 6th construction section (H = 1 layer of 14.2m)

Andong – Giran (Ibam bypass) highway project (H = 1 layer of 14m)

Construction of the Myeongrye general industrial complex in Busan (H = 2 layers of 22.5m in total)