多数アンカー式補強土壁工法

Multi-Anchor ReinforcedSoil Wall Method

多数アンカーはわが国で独自に

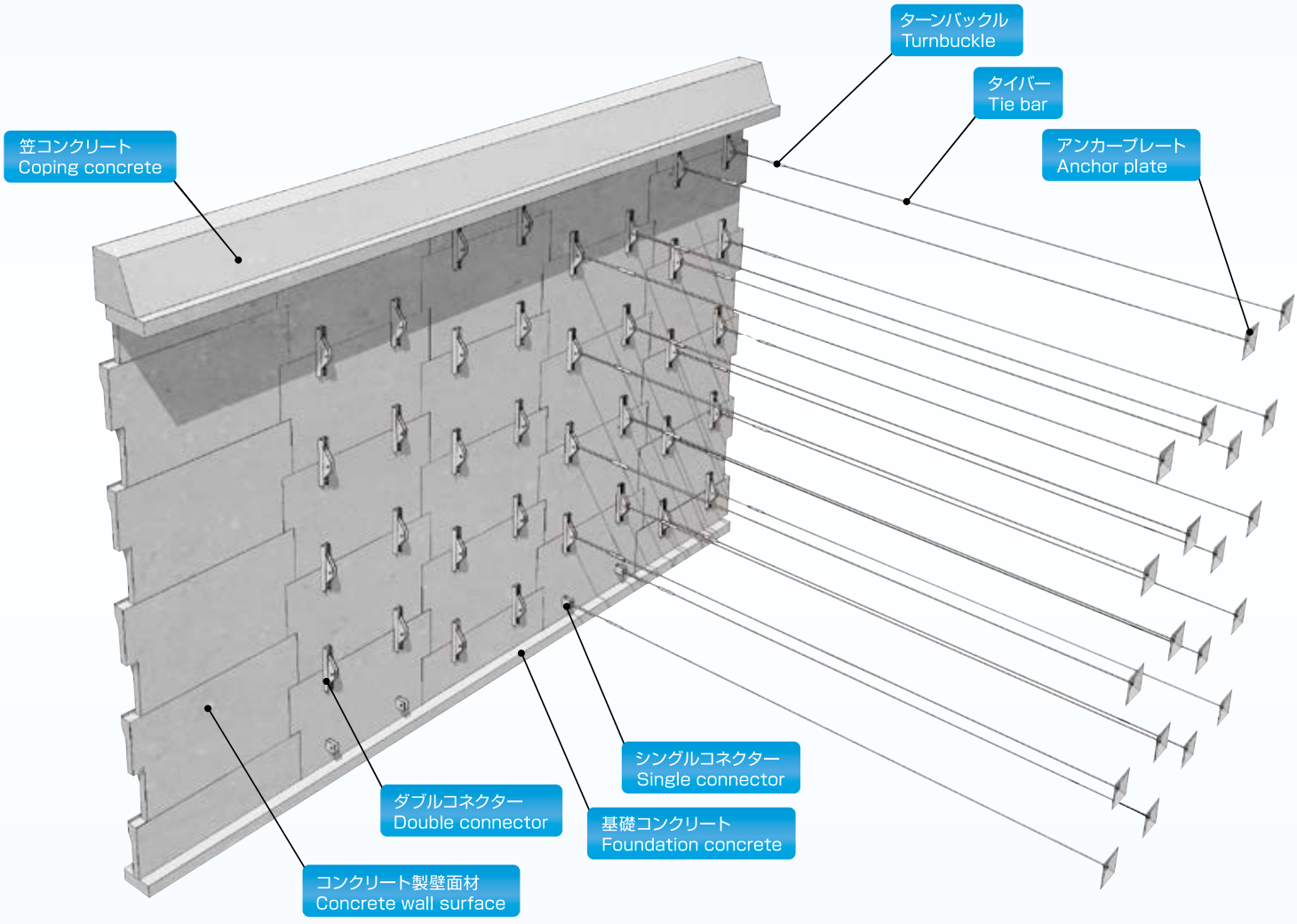
Multi-anchor is a reinforced soil wall construction

多数アンカー式補強土壁工法は、１９７０年に旧建設省土木研究所にて考案された「杭張材を用いた盛土安定増大工法」を原案とするわが国独自開発の補強土壁工法です。幅広い盛土材を適用できる特性を活かしての建設発生土の有効利用や高い耐震性、環境負荷の軽減、そして優れた安定性を併せ持っています。これまでの３０年以上の実績を踏まえ、２０１４年８月には「多数アンカー式補強土壁工法設計・施工マニュアル第４版」(一般財団法人土木研究センター)が発刊され、ますます信頼性が向上しました。

The multi-anchor reinforced soil wall construction method is based on the "fill stability improvement construction method using tensile member" invented by the former Ministry of Construction Public Works Research Institute in 1970. Its ability to be applied to a wide variety of backfill materials allows for the efficient use of surplus soil, provides strong earthquake protection, reduces environmental burdens, and offers superior stability. Looking back over 30 years of results in applying the method, the "Multi-Anchor Reinforced Soil Wall Construction Method Design/Construction Manual Edition 4" (Public Works Research Center) was published in August 2014. The construction method continues to grow even more reliable.

開発された補強土壁工法です

method independently developed in Japan



時代とともに進化する多数アンカー式

The six advantages of the multi-anchor reinforced soil wall

1 現場発生土の有効利用

Effective use of surplus on-site soil

補強のメカニズムからも、現場発生土を最大限利用できる工法のため、砂質土、岩ズリ、礫質土、粘性土などの有効活用が可能です。道路計画のゼロエミッションの推進に有効な工法です。

The reinforcement mechanism allows for the optimal use of surplus on-site soil, meaning sandy soil, rock muck, gravelly soil, cohesive soil, and more can be used effectively. The construction method is also effective in promoting zero-emissions in road projects.

2 掘削量削減「ロックアンカー」

"Rock anchor" reduces excavation volume

補強領域背面の岩盤が強固な場合は、ロックアンカーとの併用で掘削土量の削減を有効にします。現場発生土の抑制を推進するわが国の施策をふまえた合理的な工法です。

Multi-anchor can be used with rock anchors when natural ground behind the reinforced soil wall is solid bed rock,effectively reducing the amount of soil to excavate. This economical construction method matches the Japanese policies to control the amount of surplus on-site soil.

3 工期短縮と安全性

Shorter construction period and safety

タイバーに組み込んだターンバックルにより壁面の鉛直度調整が容易です。また、部材は全て工場製作のため、工期短縮が図れます。全ての作業が盛土上でできることから険しい傾斜地での施工もスムーズ。工事の安全性を高めています。

Turnbuckles incorporated into tie bars make it easy to adjust the perpendicularity of wall surfaces. All components are factory-made, for reduced construction period. All operation is possible on backfills, for smooth construction on steeply sloping ground. This makes construction safer.

補強土壁工法の6つの特長

construction method, which continues to evolve with the times

4 確かな構造安定性
Reliable structural stability

近年頻発する大型地震の震源地近くの実態調査でも、その優れた性能が確認され、極めて安全で安定した工法であることを実証しました。これまで、最大壁高 25m 超の実績があります。

Multi-anchor's superior performance has been confirmed even during surveys near the epicenters of recent large-scale earthquakes, proving that it is an extremely safe and secure construction method. There are cases where walls with a maximum height exceeding 25 m have had been built using multi-anchor.

5 幅広い盛土現場に
Supports a wide variety of fill shapes

用地確保が困難な都市部から、河川断面を侵せない峡谷部の付替え道路まで、あらゆる盛土の現場に適応します。垂直壁を雛壇状に構築する多段盛土や、壁面材で土を挟み込む両面盛土などの計画も可能です。

Multi-anchor is applied to a wide variety of fill sites, from urban areas where site procurement is difficult, to replacement roads in ravine areas that cannot enter river cross-sections. A variety of projects are possible, such as multistage fills where vertical walls are built in tiered platform shapes, or two-sided fills that confirm soil in wall surface materials.

6 維持管理・補修
Maintenance management and repair

これからのインフラ長寿命化を見据え、維持管理方法をマニュアル化し、点検、記録項目を明確化しています。コンクリート製壁面材の軽微なひび割れや断面欠損も容易に補修可能です。

In anticipation of future infrastructures with longer service lives, maintenance methods are being formalized into a manual, while inspection and recording items are being clarified. Slight cracks and partial damage in concrete wall surface material can also be easily repaired.

盛土現場のニーズに対応

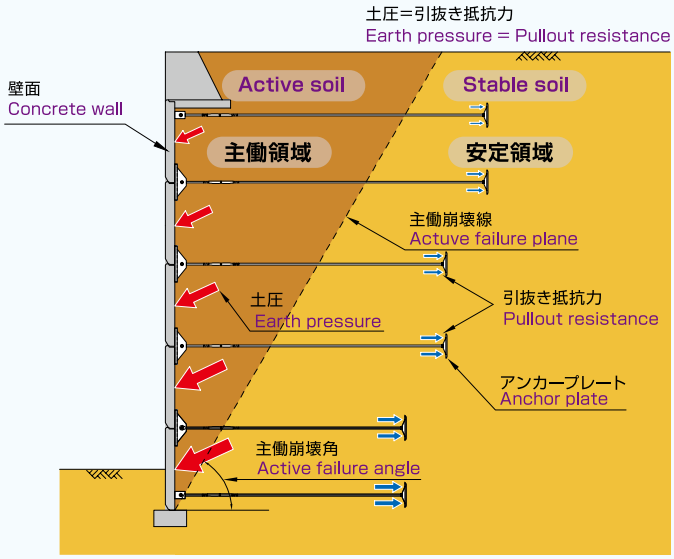
Supports construction site needs

柔軟な発想の柔構造

Flexible structures from flexible ideas

本工法は、壁面材と土中に設置した多数のアンカープレートとをタイバーで緊結することにより直壁を有する土構造物を構築するもので、壁面に作用する土圧と釣り合う引抜き抵抗力で土が拘束補強されるため、様々な盛土現場で幅広く活用されています。

In this construction method, the wall material and multiple anchor plates installed in the earth are bound with tie bars to build an earth structure with a vertical wall. The earth pressure acting on the concrete wall surface and proportional pullout resistance restrains and strengthens the earth. This allows this construction method to be used at a variety of embankment sites.

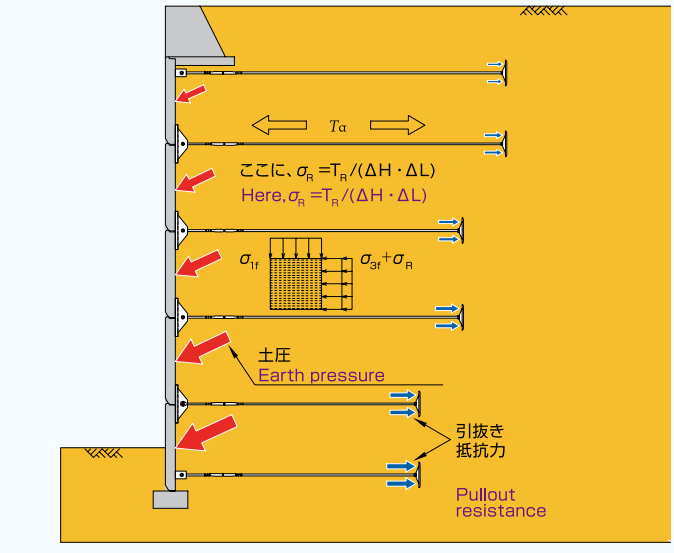


さらなる技術の革新

Continuing innovation

1983 年の初採用以来、施工件数は 7,000 件以上、累計壁面積 180 万㎡超の実績を挙げ *、一層の品質向上と研究開発に努めています。その結果、優れた耐震性を安定計算に反映させるとともに性能設計の概念を導入。さらに、現場発生土の有効活用やロックアンカーの使用による地山掘削の低減を推進してきました。従来の摩擦系補強土壁工法と異なる理論に立脚した「多数アンカー式補強土壁工法設計・施工マニュアル」が 1994 年に発刊され、その後、部材改良や技術革新に伴い、第２版、第３版、第４版と継続的な研究がなされています。
* 2015 年３月現在。

Since it was first used in 1983, the multi-anchor construction method has been used in over 7,000 construction projects with a cumulative total wall surface area of 1.8 million m²*. The construction method continues to be researched and developed in order to improve quality even further. As a result, the method's superior earthquake resistance can now be factored into stability calculations, and a concept of performance design has been introduced. The construction method has also promoted reduced earth excavation through the effective utilization of on-site soil and the use of rock anchors. The multi-anchor construction method is based on logic that differs from that of friction-based reinforced soil wall construction methods. The "Multi-Anchor Reinforced Soil Wall Construction Method Design/Construction Manual (Public Works Research Center)" was therefore published in 1994, and research has continued since then, with Editions 2, 3, and 4 published along with component improvements and technological advances.
* As of March 2015



様々な盛土材への適応

Adapts to a variety of fill materials

粘性土
Cohesive soil

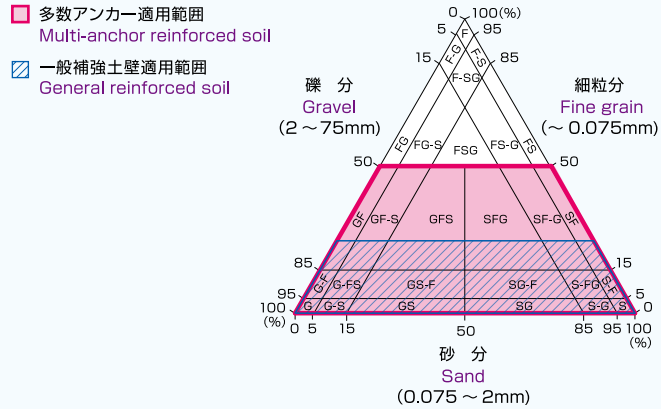
砂質土
Sandy soil

人工軽量盛土材
Artificial lightweight backfill material

エアモルタル
Aerated mortar

多数アンカー式補強土壁は，アンカーの支圧抵抗力を拠所とすることから、粒度の大きい岩から細粒土などの現場発生土まで様々な盛土で補強土を構築することができます。

Multi-anchor reinforced soil walls are based on anchor plate bearing resistance. This makes it possible to build reinforced soil walls on a variety of backfill materials from highly granular surplus on-site soil to aerated mortar.



岩ずりは最大限に活用する

Optimal use of rock muck

多数アンカー式補強土壁は、アンカープレートの支圧抵抗により安定を図ることから、岩ずり等の礫質材料もそのまま盛土材として使用することができます。
※最大粒径の規定あり。

Multi-anchor reinforced soil walls attempt to reach stability via the bearing resistance of the anchor plate, and can use detritus and other gravelly materials as is for backfill materials.
* The maximum grain diameter is regulated.

多様なシーンに活かされている構造安定性と優

Structural stability and superior design used in a variety of

ロケーション　Locations

道路　Roads

高規格道路や農・林道など様々な施工条件に柔軟に対応し国土のネットワーク強化を推進します。

Multi-anchor can flexibly adapt to a variety of construction conditions (such as high-standard roads and agricultural/forest roads), and promotes stronger national networks.

構造物取付　Approach-ways

構造物を最小限に留め取付け部を多数アンカーで施工することにより、コスト縮減が可能となります。

When installing structures to walls, using multi-anchor to keep the number of retaining installation parts to a minimum can reduce costs.

地盤改良上　Soil improvement

補強材が短いことにより、地盤改良範囲もコンパクト、軟弱地盤上でも安全性と経済性を発揮します。

The reinforcing materials are short, so the area of the soil improvement is compact and it is possible to achieve safety and economic efficiency, even on soft ground.

ロックアンカー　Rock anchors

ロックアンカーを併用できるので、地山の固い岩盤を掘削する手間が大きく省けます。

Multi-anchor can be used with rock anchors to drastically reduce labor excavating solid bedrock in the ground.

造成　Filling

垂直補強土壁である多数アンカーは用地の有効利用と盛土材の節減に効果的です。

Multi-anchors are vertical reinforced soil walls, and are effective in using sites efficiently and reducing the amount of fill material used.

れた意匠

situations

ロケーション　Locations

災害復旧　Disaster recovery

多発する自然災害からのより安定確実な復旧を目指す手段として注目されています。

Multi-anchor is becoming increasingly noteworthy as a secure construction method that offers improved safety when recovering from frequently-occurring natural disasters.

海岸　Seashores

自然条件の厳しい沿岸部においても、様々な設計と部材の工夫により補強土壁構築を推進

A variety of designs and materials are used to implement reinforced soil wall construction—even in maritime areas with strict natural conditions.

水辺・ダム　Watersides/Dams

水の影響を受けにくい、透水性の良い盛土材を用いることで、壁面が水没するような箇所でも安定した盛土の構築を可能にしています。

Multi-anchor uses fill material that is strong against water and that offers excellent permeability. Stable fills can be constructed even in locations where the wall surface is submerged.

両面壁　Parallel walls

立体交差などのアプローチ部分の取付け道路において、経済的で安定した両面壁を有した盛土が可能です。

Multi-anchor allows for fills with parallel walls that are economical and secure in roads attached to approach-ways on overhead crossings and other structures.

診断対応型　Diagnosis support

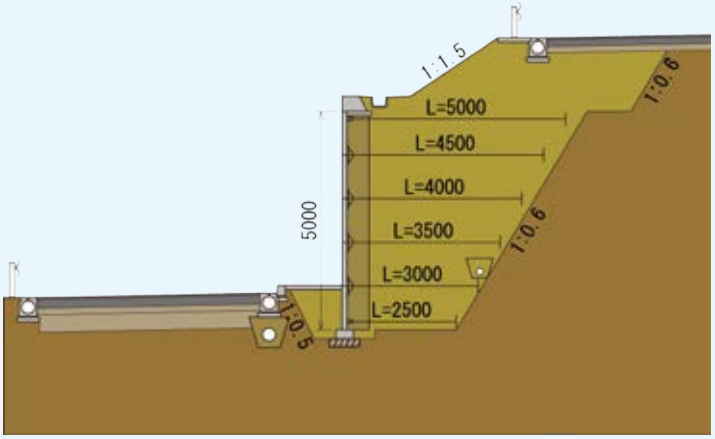
実際に機能している鋼製部材について、超音波探傷法やリフトオフ試験で施工後に健全性を診断することができます。

It is possible to use ultrasonic flaw detection and lift-off tests to diagnose the soundness of functioning steel elements after the construction.

道路（高規格道路）

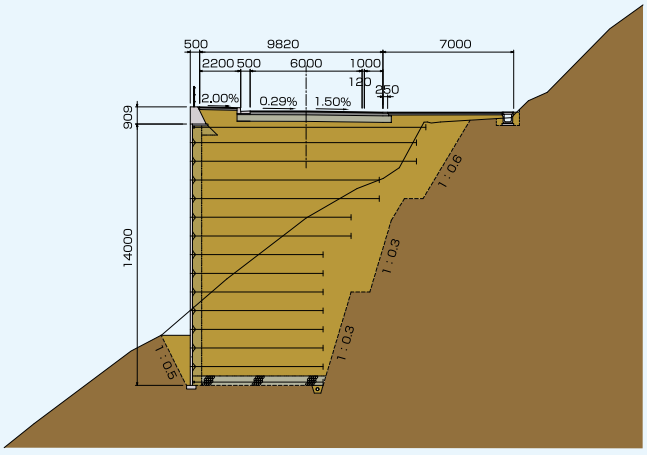
Roads (Hi-Standard Roads)

地域をより豊かにする道路ネットワーク構築に貢献　Contributing to building road networks that enrich regions



道路(農道・林道)

Roads (Agricultural/Forest roads)

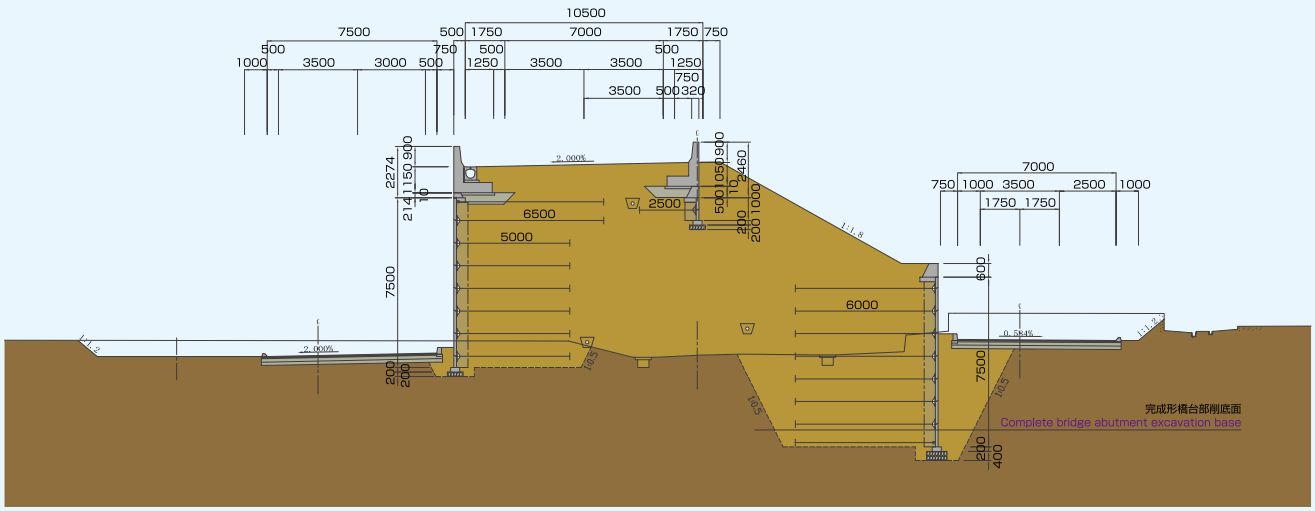


構造物取付

Approach-ways

ターンバックルによる鉛直精度で自然な境界面

Turnbuckles provide perpendicular accuracy, making natural boundary surfaces possible

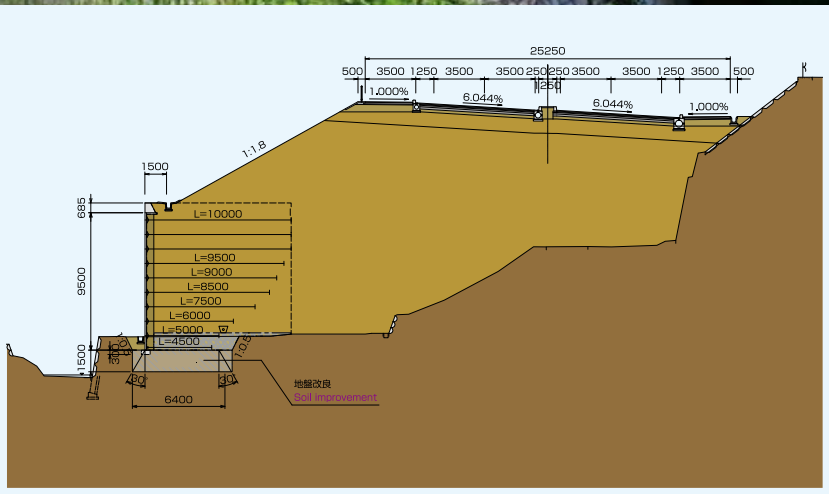


地盤改良上

Soil improvement

工法独自の特性で地盤改良範囲を極力コンパクトに

Extremely compact soil improvement area due to the unique characteristics of the construction method



ロックアンカー

Rock anchors

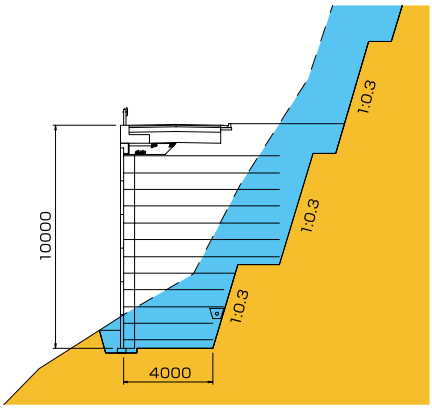
ロックアンカー併用で掘削量の抑制と迅速な施工を推進

When used with rock anchors, multi-anchor curbs excavation volume and promotes speedy construction

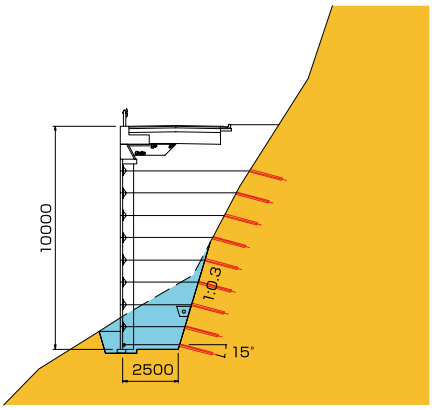
一般的な補強土壁の場合、その盛土中にはある程度の補強材の定着長が必要となることから地山掘削が多くなりがちです。
多数アンカーでは、補強領域の背後に岩盤がある場合、ロックアンカーを打ち込み抵抗力を受け持たせることで補強土壁を構築することが可能です。これにより、地山の掘削を極力抑えたスマートでスピーディーな施工を実現します。

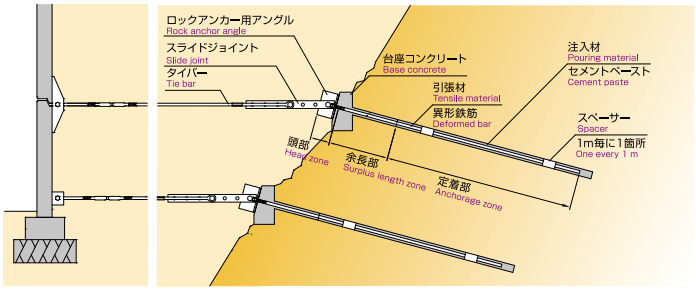
Standard reinforced soil walls tend to require that a greater amount of earth be excavated, as a fixing layer of reinforcement material with a certain thickness must be built in the backfill.
With Multi-anchor, if there is bedrock in a location with a stable fill a reinforced soil wall can be constructed by driving rock anchors into the bedrock so that the bedrock bears the resistance force. This allows for smart and rapid construction that keeps earth excavation to the bare minimum.

一般的な補強土壁
Standard reinforced wall



多数アンカー（ロックアンカー使用）
Multi-anchor (rock anchor use)

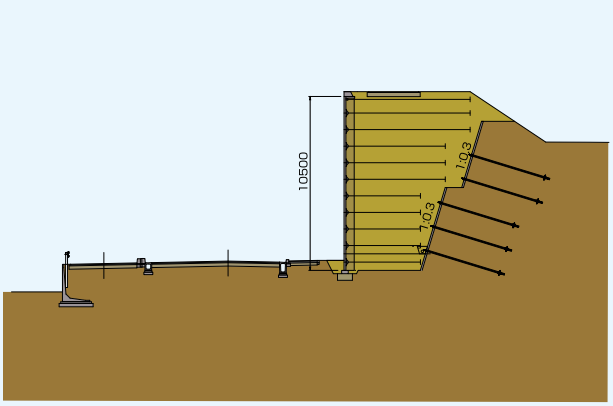




造成

Filling

土量を抑えコスト縮減に寄与する　Reducing soil volume and contributing to reduced costs

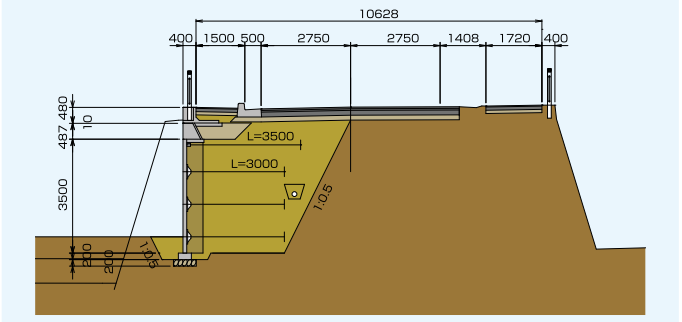


災害復旧

Disaster Recovery

震災や豪雨災害に負けないインフラへ

Helping to build infrastructures that can withstand earthquake and torrential rain disasters

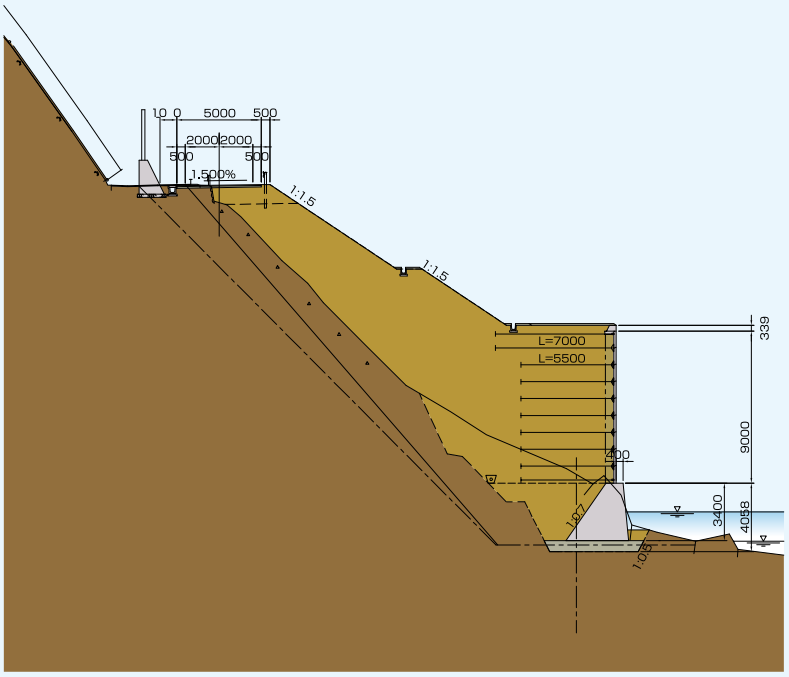


海岸

Seashores

自然条件の厳しい環境下でも継続的に機能維持

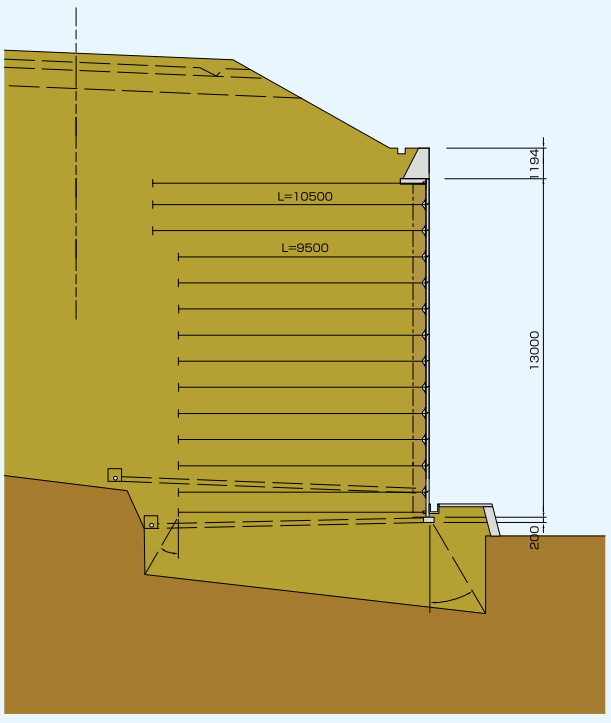
Continuous functionality even in environments under severe natural conditions

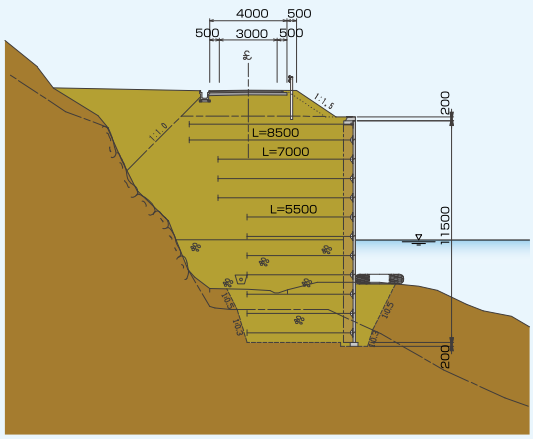


水辺・ダム

Watersides/Dams

環境負荷を抑え自然との共生を目指す Reducing environmental burdens and aiming for coexistence with nature

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両面壁

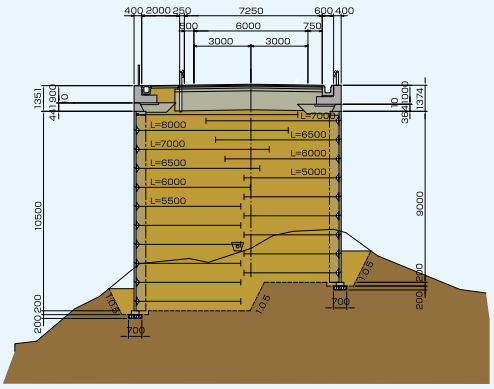
Parallel walls

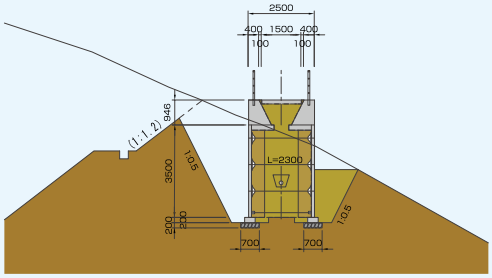
省スペース、シンプルな構造で耐震性や安全性を確立

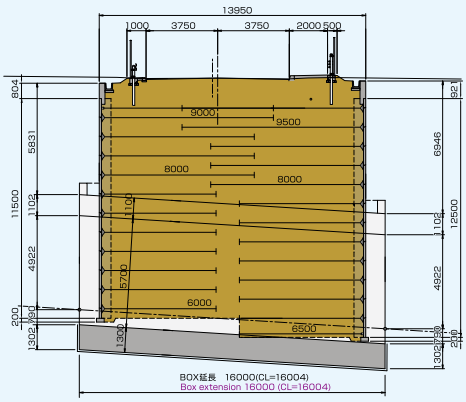
Space-saving and simple structure offers earthquake resistance and safety

盛土を補強土壁でサンドイッチする両面壁の構築において、多数アンカー式補強土壁では両面をタイバーで緊結して安定させることができます。

For construction where fills are sandwiched between reinforced soil walls on both sides, binding walls with tie bars when using multi-anchor reinforced soil walls can improve stability.







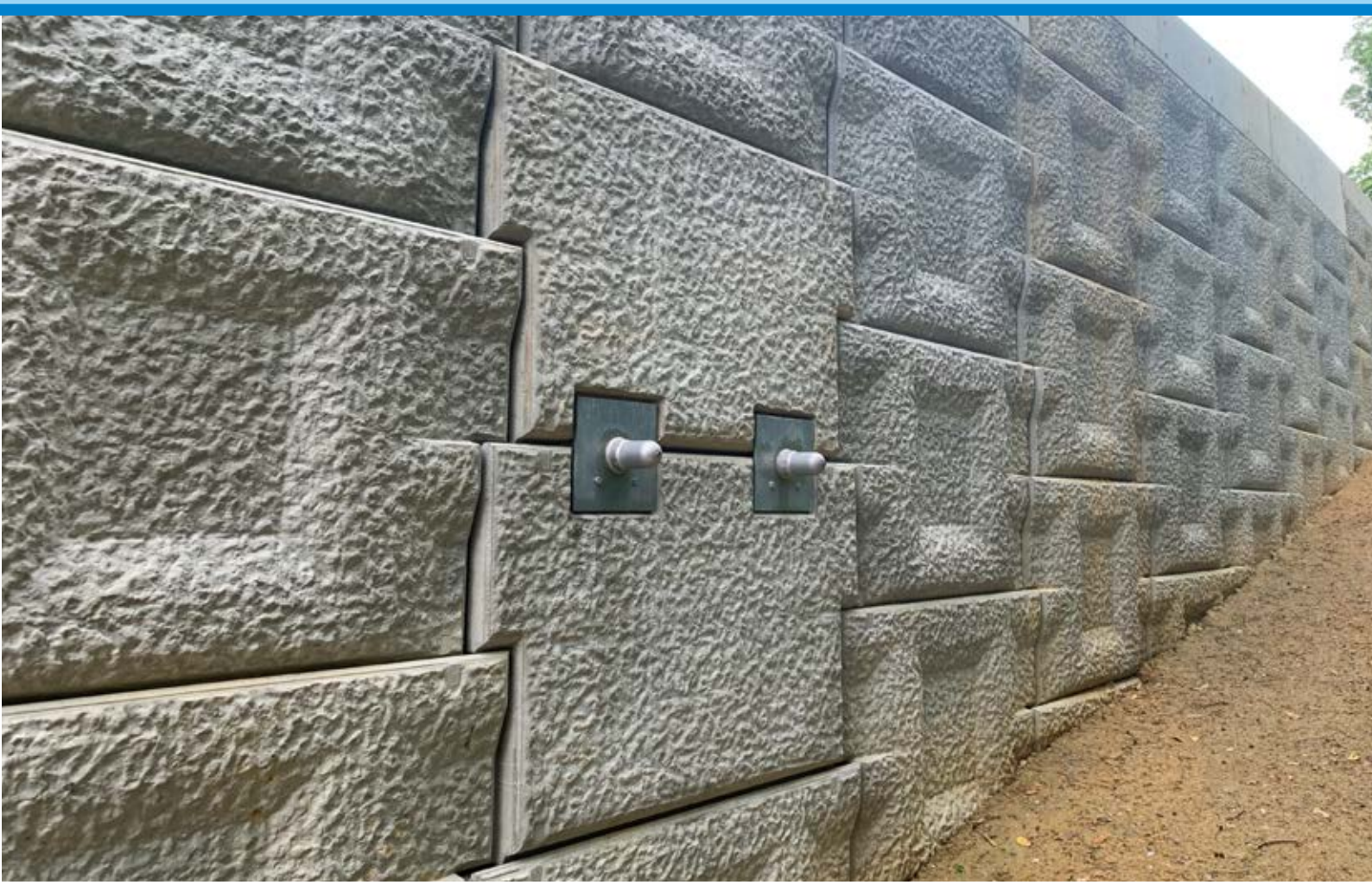
診断対応型

Diagnosis support

NETIS：KT-220155-A

非破壊での健全性診断が可能な壁面材（NDパネル）

A lineup of wall surface materials that make non-destructive diagnosis of soundness possible



ダミー供試体ではない実際に機能している鋼製部材について、超音波探傷法やリフトオフ試験での診断が可能です。

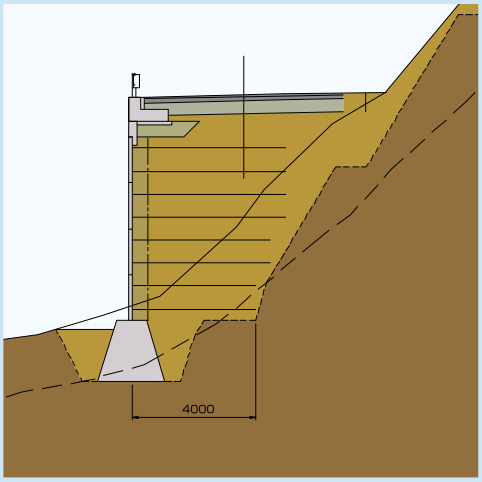
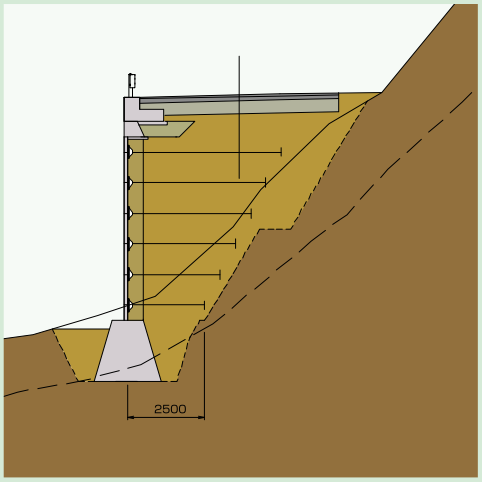
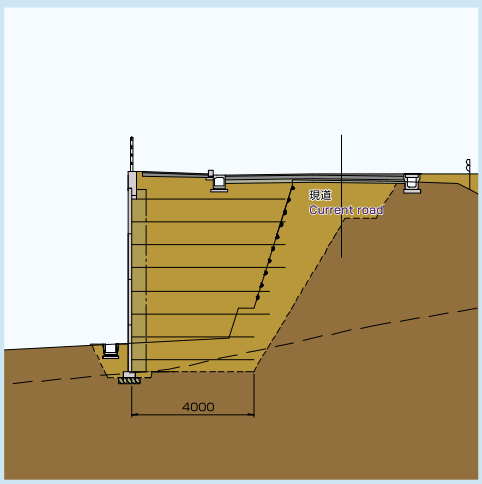
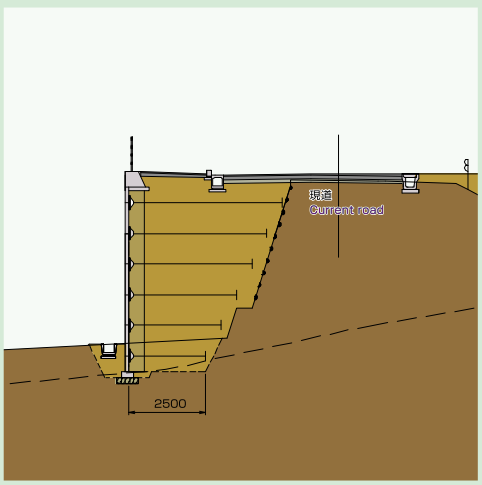
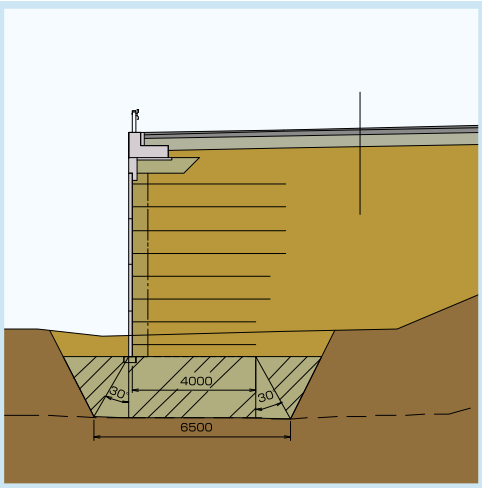
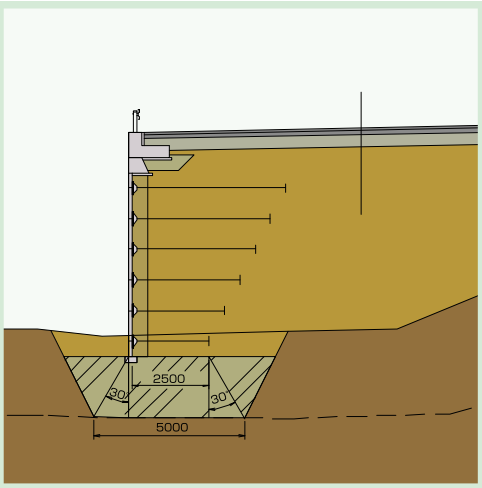
It is possible to use ultrasonic flaw detection and lift-off tests to diagnose steel reinforcements that are actually functioning, not testing dummy specimens.

補強材長の利点

The Reinforcement Material Length Advantage

土木研究センターから発刊されている補強土壁の設計・施工マニュアルのなかでも、多数アンカーは最も補強材長さが短い工法です。
補強材が短いことにより、補強土壁外の要因でも経済性を発揮します。

Among the construction methods described in reinforced soil wall design/construction manuals published by Public Works Research Center, multi-anchor has the shortest reinforcement material length.

	一般的な補強土壁 General reinforsed soil wall	多数アンカー式補強土壁 Multi-anchor reinforced soil wall
山岳道路の掘削低減 Reduced excavation of mountain roads		
現道拡幅時の現道確保 Existing roads secured during widening of said roads		
地盤改良を伴う場合の改良範囲の縮小 Narrower improvement area when improving foundations		

施工手順

Procedures

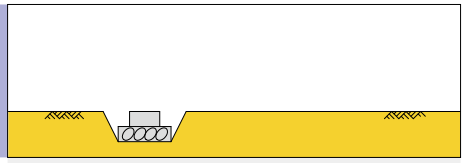
多数アンカー式補強土壁工法は、現場規模にかかわらず少人数での施工が可能で、しかも、壁面材の設置を先行しながら盛土上で作業を行うため、施工中の安全が図れます。土と一体化して構造物を安定させる本工法は、土の工学的特性を有効活用するため、まき出し・転圧等の作業は、多数アンカー式補強土壁設計施工マニュアル第４版(平成26年８月)に沿って施工してください。

The multi-anchor reinforced soil wall construction method requires only a few workers to perform, regardless of the scale of the site. It can also offer improved safety, as work can be performed on the backfill while at the same time prioritizing the establishment of wall surface materials. This construction method stabilizes structures by integrating them with the soil, and makes effective use of the engineering characteristics of earth. Therefore, be sure to follow the construction procedure in the "Multi-Anchor Reinforced Soil Wall Design/Construction Manual Edition 4 (August 2014)" for work such as spreading soil and surface compaction.

機　種	規　格	台数	備　考
トラッククレーン	油圧式 4.9ｔ級	1	壁面材吊込み
ブルドーザ	11ｔ級	1	盛土材のまき出し、敷均し
バックホウ	0.45m³	1	壁面際の盛土材料のまき出し
タイヤローラ	8～20ｔ級	1	盛土材料の締固め
振動ローラ	ハンドガイド式 1.0ｔ級	1	壁面際の盛土材料の締固め

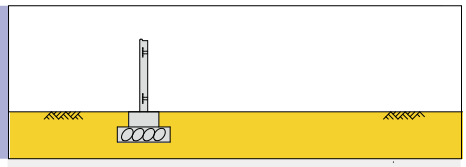
Equipment	Type	Qty	Purpose
Truck crane	Hydraulic 4.9t	1	Panel hanging
Bulldozer	11t	1	Spreading/laying filler
Backhoe	0.45m³	1	Spreading filler aside the wall
Tire roller	8 to 20 t	1	Compaction of filler material
Vibrating roller	Hand-guided type 1.0 t	1	Compaction of filler material on wall surface edges

1



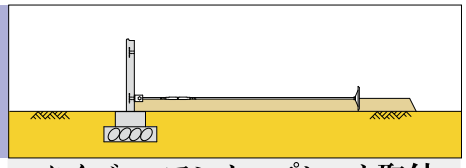
基礎
Foundation

2



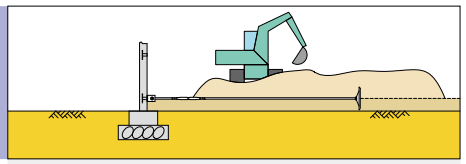
壁面材設置
Wall surface material application

3



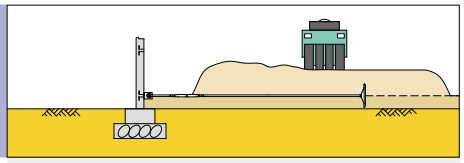
タイバー、アンカープレート取付
Connecting tie bar and anchor plate

4



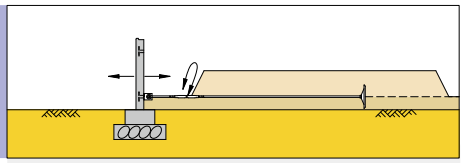
土の敷均し
Soil spreading

5



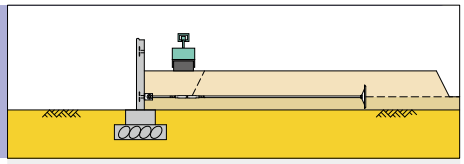
転圧
Compaction

6



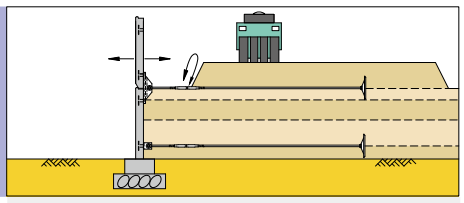
壁面調整
Wall surface adjustment

7



転圧（壁背面）
Compaction (wall rear surface)

8



繰返し
Repeat the process

施工上の注意

- 使用するボルト、ナットは設計で指示されたものを指示された箇所にのみ使用してください。
- 設計に使用した土質条件より低品質な盛土材料で施工しないでください。
- 盛土材料が設計値と異なる場合は、多数アンカー式補強土壁協会までご相談ください。

Construction precautions

- Use only bolts and nuts indicated in the design, and only in indicated locations.
- Do not use backfill materials that are of lower quality than the soil quality conditions in the design.
- Contact the Multi-anchor Reinforced Soil Wall Association if backfill materials differ from design values.

トルクデータを活用した盛土の品質管理

Quality control of embankment using torque data

NETIS：HK-220006-A

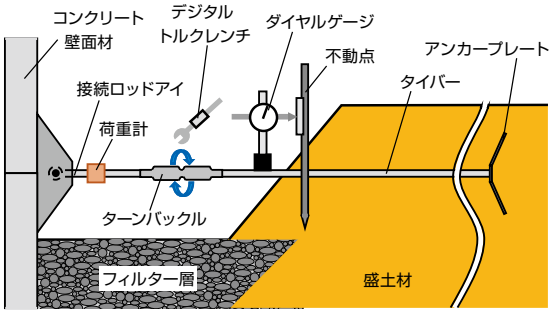
補強土壁の変状は盛土材の不良に起因することが多く、その理由として盛土材の含水比の増加、盛土材採取場所の途中変更などによる土質の変化等に適切に対応できないことが挙げられます。
一般的に施工中の盛土材の品質管理として、500 ㎥に１回現場密度試験を実施しますが、盛土材の変化に対応するための頻度としては十分ではないことも多く、特に不適切な盛土材が搬入された場合は、現場技術者の経験知(熟練度)に依存するところが高いため、結果として手直しによる工程や経済的な損失が大きくなります。
「トルクデータを活用した多数アンカー式補強土壁の品質管理」は、盛土材の締固め作業の直後に補強材に付属しているターンバックルをトルクレンチによって回転させることにより、補強材に引張力を作用させ、アンカープレートの引抜き抵抗力を間接的にトルク値として計測することにより、簡便な方法で連続的に盛土材の状態を把握できる品質管理方法です。そのため盛土材の状態の変化を迅速に捉えることが可能となります。

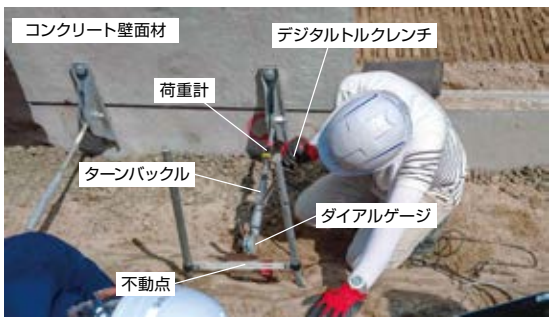
Deformation of reinforced soil walls is often caused by defective embankment materials, which may be due to an increase in the water content ratio of the embankment material or an inability to properly respond to changes in soil quality caused by changes in the location of the embankment material collection site during construction.
In general, an on-site density test is conducted once every 500 ㎥ for quality control of fill material during construction, but this frequency is often not sufficient to respond to changes in fill material, especially when inappropriate fill material is delivered. As a result, the process and economic loss due to rework is significant.
The "Quality Control of Multi-Anchor Reinforced Soil Wall Using Torque Data" is a simple and continuous method to control the quality of multiple-anchor type reinforced soil wall by rotating the turnbuckle attached to the reinforcing material with a torque wrench immediately after compaction of the fill material, thereby applying a tensile force to the reinforcing material and indirectly measuring the pull-out resistance of the anchor plate as torque value , which enables the rapid detection of changes in the condition of the embankment material.

トルクデータ管理　品質管理システム

Torque Data Management Quality Control System

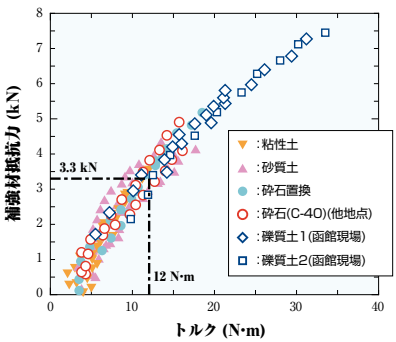
システム概要図
System Overview Chart

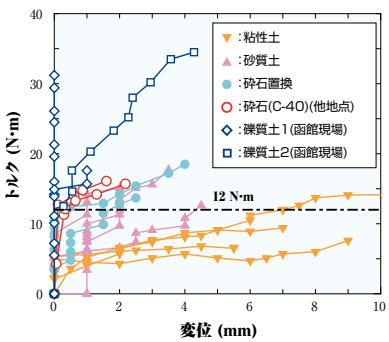




実証実験において、盛土材の土質によらずターンバックル回転時のトルクと補強材抵抗力の関係は同様であり、ターンバックル回転時のトルクとアンカープレート側の変位を計測することで、盛土材の適否や良し悪しを簡便に確認することが確認されました。

In the test, the relationship between the torque at turnbuckle rotation and the resistance force of the reinforcement was similar regardless of the soil type of the embankment material, and it was confirmed that the suitability of the embankment material could be easily confirmed by measuring the torque at turnbuckle rotation and the displacement of the anchor plate side.





安全な国づくりの一翼を担う耐震性能

Anti-earthquake performance to help build a safe nation

近年頻発する大規模地震や豪雨の際には、補強土壁工法の被災状況の確認・調査がその都度実施されています。その結果は設計・施工の貴重な情報として活かされ、高い安全性の確立に向けた改良に反映されます。
かたや実際の被災現場においては、補強土壁の復旧を図るうえで、体系的な性能評価が必要不可欠になり、特に構造物の管理者は、客観的に補強土壁の被災度の評価、さらには災害復旧に際しての種々の判断や作業を迅速に行う必要が生じ、その指標となる基準が求められていました。
そこで平成17年、(財)土木研究センターにより「補強土工法の被災度評価および災害復旧に向けての基本方針に関する報告書」がまとめられました。

The level of damage suffered by structures built using reinforced soil wall construction methods are confirmed and surveyed whenever there is a large-scale earthquake or torrential rain disaster. There have been many such disasters recently. These results serve as valuable design and construction information, and are used in making improvements to methods with the goal of realizing a high level of safety.
Meanwhile, systematic performance evaluations are essential in attempting to restore reinforced soil walls damaged at actual disaster sites. In particular, structure managers must objectively evaluate the level of damage suffered by reinforced soil walls during disasters, and must quickly make a variety of decisions and perform many tasks in recovering from a disaster. This requires that guidelines be set that can act as indicators used in making such decisions.
In response, the Public Works Research Center prepared the "Report on Disaster Damage Level Evaluation for Reinforced Soil Construction Methods and Basic Policies toward Disaster Recovery" in 2005.

新潟県中越地震や東日本大震災で実証された高い耐震性能

Strong earthquake resistance proven during the Niigata Chuetsu Earthquake and Great East Japan Earthquake

平成16年10月に発生した新潟県中越地震では、中越地方に施工されている46の物件について影響を調査。各地の盛土構造物や擁壁が機能を失い、道路が寸断されているのが確認される中、補強土壁により構築された道路に壊滅的な状況を示す事例は見当たりませんでした。
平成23年3月11日に発生した東北地方太平洋沖地震では、震度6弱以上を記録した岩手・宮城・福島・茨城の4県における被災状況を調査しました。その結果、コンクリート壁面材同士が激しくぶつかり合ったと思われる角欠けやクラック、笠コンクリートの山側への傾斜などが見られましたが、補強土壁自身が安定性を損なうような損傷や変状は一切なく、道路としての使用に問題が生じた場所はありませんでした。

被災台帳
Disaster registry

被災度応急判定表
Disaster damage level emergency aid decision table

A survey was conducted on 46 sites in the Chuetsu region that were impacted by the Niigata Chuetsu Earthquake that struck in October 2004. Surveyors confirmed that reinforced soil wall structures and retaining walls in each area lost functionality, while roads were torn to pieces. However, there were no cases noted in which there was catastrophic damage to roads constructed with reinforced soil walls.
A survey on the extent of damage suffered during the Great East Japan Earthquake on March 11, 2011 was conducted in four prefectures (Iwate, Miyagi, Fukushima, and Ibaraki) that recorded earthquakes at an intensity of at least six lower. Results showed corner chipping and cracking (likely due to concrete wall surface materials violently crashing against each other), slanting coping concrete mountainsides, and other damage.
However, there was no sign of damage or deformation that could result in reduced stability in actual reinforced soil walls, and there were no locations with damage that could hinder their use as roads.

被害が発生した従来擁壁(左手前)と、持ちこたえた多数アンカー式補強土壁(右奥)。
Common retaining wall that suffered damage (left side, toward the front), and a multi-anchor reinforced soil wall that held up (right side, toward the rear).

長寿命化を見据えた維持管理

Maintenance for long term performance

これからの土木施設は予防保全の観点からメンテナンスの容易さが重要な要素となります。多数アンカー式補強土壁協会では、ドローンによる点検や劣化診断が可能な新部材の提供など、メンテナンスサイクルに基づく管理をサポートします。

For preventive maintenance, the ease of maintenance will be an important element far civil engineering facilities from now on. For multi-anchor reinforced sail walls, we support management based on the maintenance cycle from various aspects such as inspection using drones, and the supply of new members and materials that enable deterioration diagnosis.

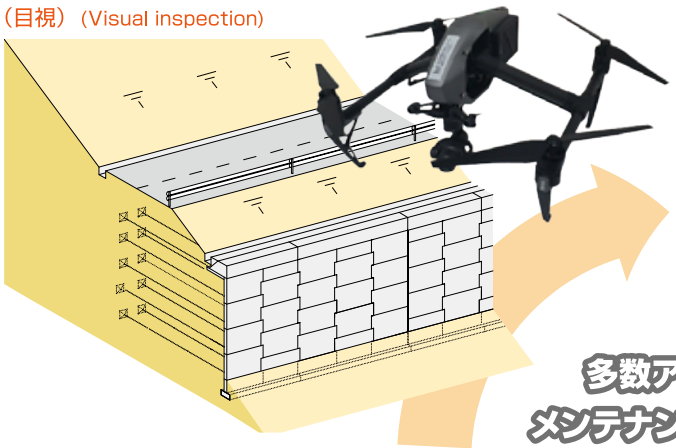
メンテナンスの各フェーズとオプション Phases and options for maintenance

点検 Inspection

多数アンカー構築後、ドローンを活用して壁面の立ち具合を撮影し、初期値として記録が可能です。

After constructing the Multi anchor reinforced wall, we can use drones to obtain images of how the wall surface is standing and keep a record of that as the initial values.

（目視）(Visual inspection)



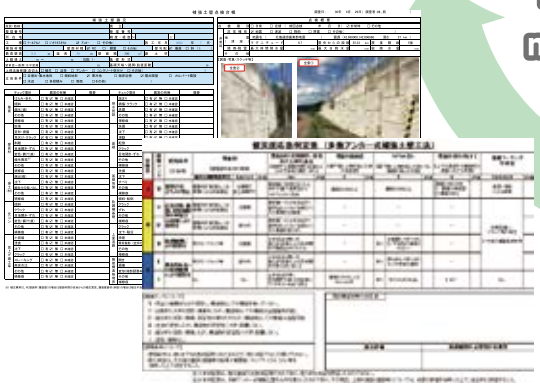
診断 Diagnosis

実際に機能している鋼製部材の健全性を、非破壊により診断できる壁面材を開発。壁面材を破壊することなく、様々な検査が可能です。

We have developed wall surface materials that enable the non-destructive diagnosis of the soundness of actually functioning steel reinforcements. Various inspections are possible without destroying the wall surface materials.

多数アンカー
メンテナンスサイクル

Multi-anchor wall
maintenance cycle



記録 Recording

点検者の違いや各補強土の違いによって判定基準にばらつきが生じないよう、判定方法や記録方法を提案します。

We propose judgment methods and recording methods to ensure that the judgment criteria do not vary between different inspectors or between each reinforced soil location.

措置 Action

盛土の安定性の問題や補強材の異常が認められた場合は、グラウンドアンカーやミニアンカーを新たに補強材として増強することが可能です。

If it is recognized that there is a problem with the stability of an embankment. or an abnormality in the reinforcing materials. then it is possible to increase the strength by newly adding ground anchors or mini-anchors as reinforcing materials.

点検と診断
Inspection and Diagnosis

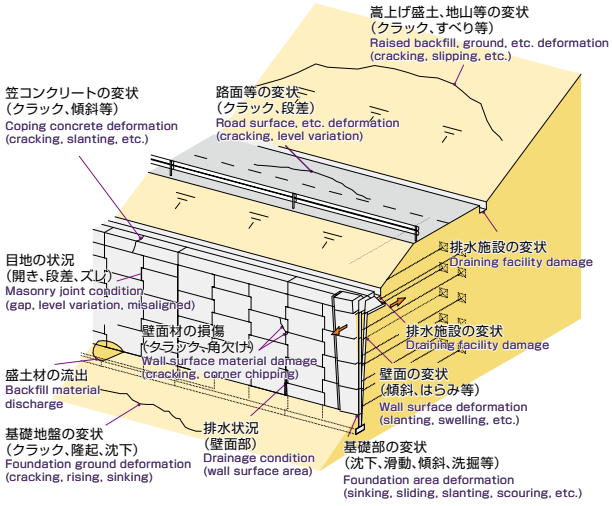
多数アンカー式補強土壁はきわめて安定的なものですが、供用期間中に機能を良好状態に保ち災害を未然に防止することを目的とした維持管理が必要です。これからの土木構造物が維持管理に軸足を置く必要があることを重視し、平成 26 年に改訂された「多数アンカー式補強土壁工法設計・施工マニュアル」においても新章を設け点検項目・点検方法・修復方法などの維持管理手法を提示しています。特にいち早く異常を察知し、その要因を特定する点検と診断が、維持管理の重要なカギとなります。

Although the multi-anchor reinforced soil wall is extremely stable, maintenance management is required to keep soil walls functioning well when they are being shared and to prevent them from being damaged during disasters. Under the realization that maintenance management is important for civil engineering structures. the "Multi-Anchor Reinforced Soil Wall Construction Method Design/ Construction Manual" was revised in 2014 with a new chapter on maintenance management that includes topics such as inspection items, inspection methods. and repair methods. Particularly, inspection and diagnosis, which enable to detect disorder immediately and identify cause of disorder, are key factors for maintenance management.

点検 Inspection

「多数アンカー式補強土壁工法設計・施工マニュアル」では、特定土工点検等で実施が必要とされる近接目視のチェックポイントを分かりやすく丁寧に解説されております。これにより、簡単な方法で異常をいち早く発見することが可能となりました。さらに補強土壁共通の調査台帳に完全対応しているため、専用の調査台帳を準備する必要はありません。

The “Multi-Anchor Reinforced Soil Wall Construction Method Design/ Construction Manual" provides clear and detailed explanations of the checkpoints for the close visual inspection required in specified earthwork inspections. This makes it possible to quickly detect abnormalities using a simple method. Furthermore, since it is fully compatible with the common recording form for nominal reinforced soil walls, there is no need to prepare a dedicated recording form.



補強土壁共通台帳
Recording form for nominal reinforced soil walls

診断 Diagnosis

補強土壁は一般に、その安定を確保するうえで非常に重要な構成部材である補強材が盛土材の中に埋設されており、供用後にモニタリングができないという維持管理上の課題を有しています。そこで開発されたのが、補強材を突出させ壁面を外から支持する「診断対応型壁面材（NDパネル）」。実際に構造を支えている補強材に対して引張試験や各種の非破壊検査を容易に実施することが出来ます。これらの非破壊検査のほか、補強材の引抜き試験を行うことが可能です。

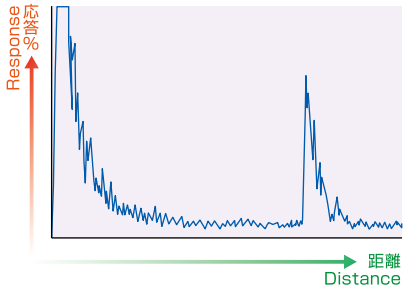
In general, the reinforcing materials of reinforced soil walls are buried inside the banking material as constituent parts that are extremely important for the securing of stability. The problem for their maintenance and management is that it is not possible to conduct monitoring after they are put into use. The “diagnosis support panel" was developed in response to this and has reinforcing materials protruding out so that they support the wall surface from the outside. This makes it easy to implement tensile testing and various non-destructive inspections on the reinforcing materials that are actually supporting the structure. In addition to these nondestructive tests, we can also perform pull-out tests on reinforcement.

点検と診断
Inspection and Diagnosis

非破壊検査 Non-destructive inspections

超音波探傷法（補強材破断・欠損診断） Ultrasonic flaw detection (Reinforcing material fracture or loss diagnosis)

観測波形例
Example waveform observed



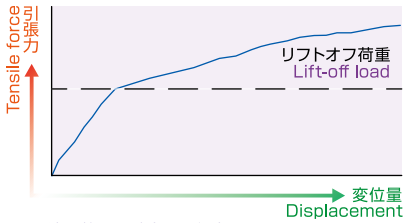
1 超音波探触子をタイバー端部に押し付けて入力した超音波の応答を測定する。
The ultrasonic probe is pressed against the end of the tie bar and measures the response to the ultrasonic wave that was input.

2 超音波の応答が所定のタイバーの長さの位置にあり、かつ他の位置に応答がない場合は、タイバーは損傷していないと診断する。
If the response to the ultrasonic wave is at the designated tie bar length position, and also there is no response at other points, then the diagnosis is that the tie bar is not damaged.

3 超音波の応答が所定のタイバーの長さの位置にない場合は、タイバーが損傷していると診断する。
If the response to the ultrasonic wave is not at the designated tie bar length position, then the diagnosis is that the tie bar is damaged.

リフトオフ試験（補強材張力診断） Lift-off tests (Reinforcing material tension diagnosis)

荷重～変位関係の例
Example of relationship between load and displacement



※適用範囲：壁高8m程度以下
*Scope of application: Wall height around 8 m or less

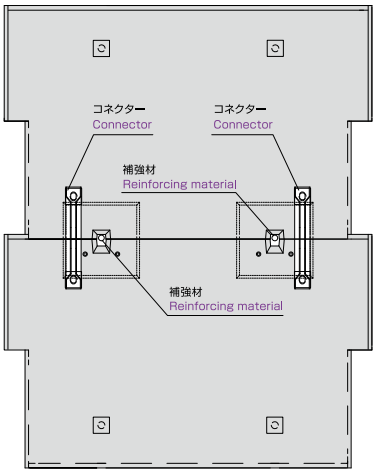
1 壁面材から突出している補強材に対し、頭部にテンションバーを取付け架台、油圧ジャッキ、荷重計、及び変位計を設置する。
A tension bar is attached to the head of the reinforcing material protruding from the wall surface material, and a frame, a hydraulic jack, a load indicator and a displacement gage are installed.

2 引張力を段階的に載荷する。
The tensile force is loaded gradually.

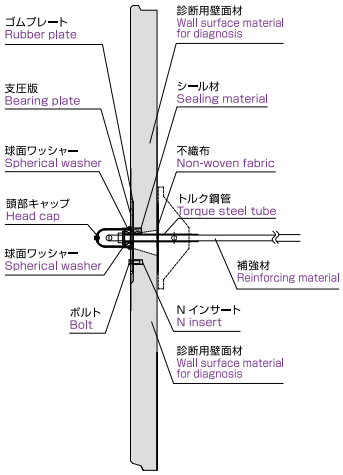
3 荷重～変位関係からリフトオフ荷重を判定し、現在タイバーに作用している張力を測定する。
The lift-off load is judged from the relationship between load and displacement and the tension on the tie bar at the current time is measured.

上下の壁面材はダブルコネクターにより連結
The upper and lower wall surface materials are joined with double connectors

背面図 Rear view



側面図 Side view



引抜き試験 Pull-out test

従来型の壁面材の場合においても、壁面材の一部を除去することにより、補強材の引抜き試験による健全度の確認を行うことが可能です。

Even in the case of conventional wall materials, it is possible to check the integrity of the reinforcement by pulling tests by removing a portion of the wall material.

引抜き試験状況 Pull-out test

壁面修復作業 Repairing

壁面修復後 After repair

措置技術

Technology for repair

診断の結果、多数アンカー式補強土壁に措置が必要と判断された場合に備え、様々な技術を用意しています。

A variety of techniques are available in case the diagnosis indicates that repair need to be taken for multi-anchored reinforced soil walls.

壁面材の修復 Wall surface material repair

多数アンカー式補強土壁は壁面材の補修・交換が可能であり、「多数アンカー式補強土壁工法設計・施工マニュアル第 4 版」（財団法人土木研究センター）に詳しく記載されています。

Multi-anchor allows for repairing and exchanging wall surf ace material. This is described in detail in "Multi-Anchor Reinforced Soil Wall Construction Method Design / Construction Manual Edition 4" (Public Works Research Center).

壁面材撤去　Removal

鉄筋配置　Setting steel bars

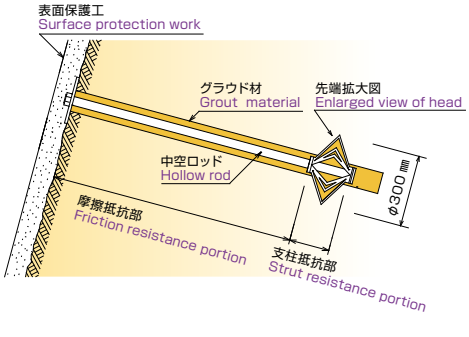
型枠設置　Setting mold

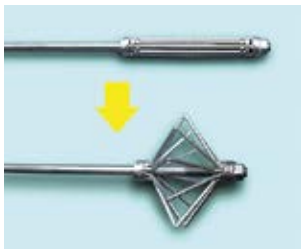
修復後　After repairing

補強材の増強 Enhancement of reinforcement materials

盛土の安定性の問題や補強材の異常等が認められた場合は、グラウンドアンカーやミニアンカーを新たに補強材として増強することも可能です。

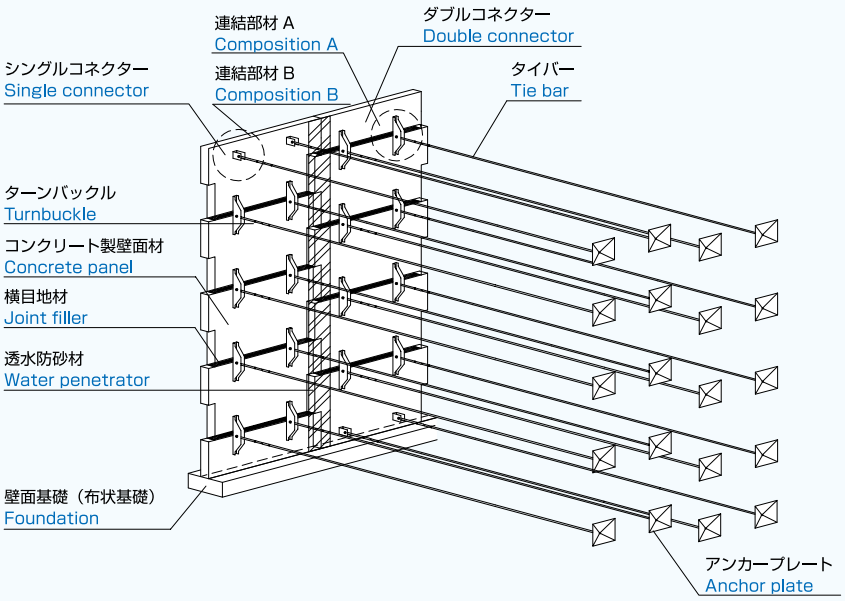
When a problem with the stability of the embankment, an abnormality in the reinforcement material, or some other problem is recognized, ground anchors or Mini-anchors can be added as new reinforcement material.



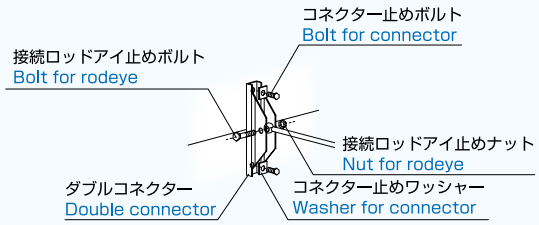


部品・規格寸法
Plans of parts/final view

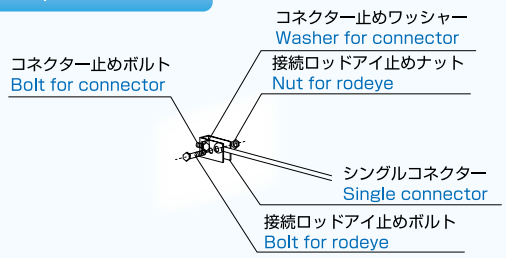
各部名称（全体）
Layout in general



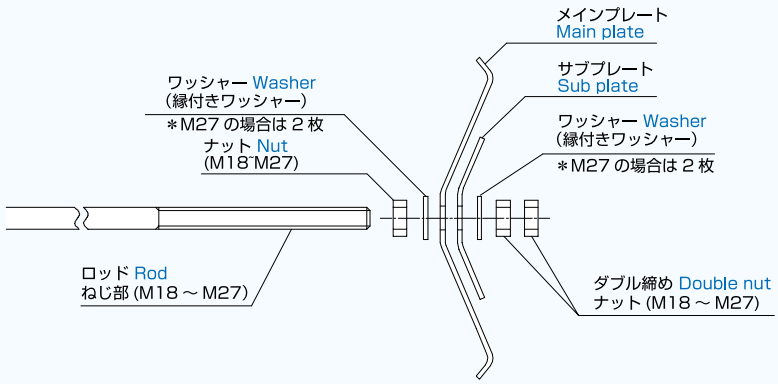
連結部材 A 詳細図
Composition A



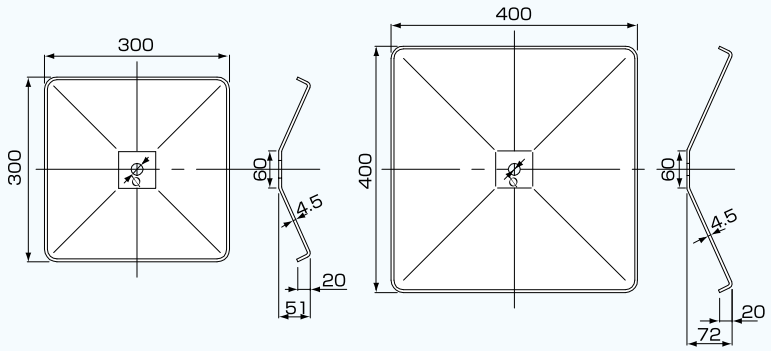
連結部材 B 詳細図
Composition B



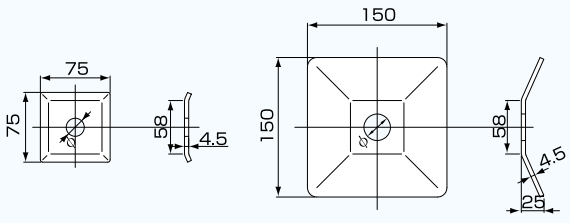
各部名称（プレート部）
Anchor plate composition



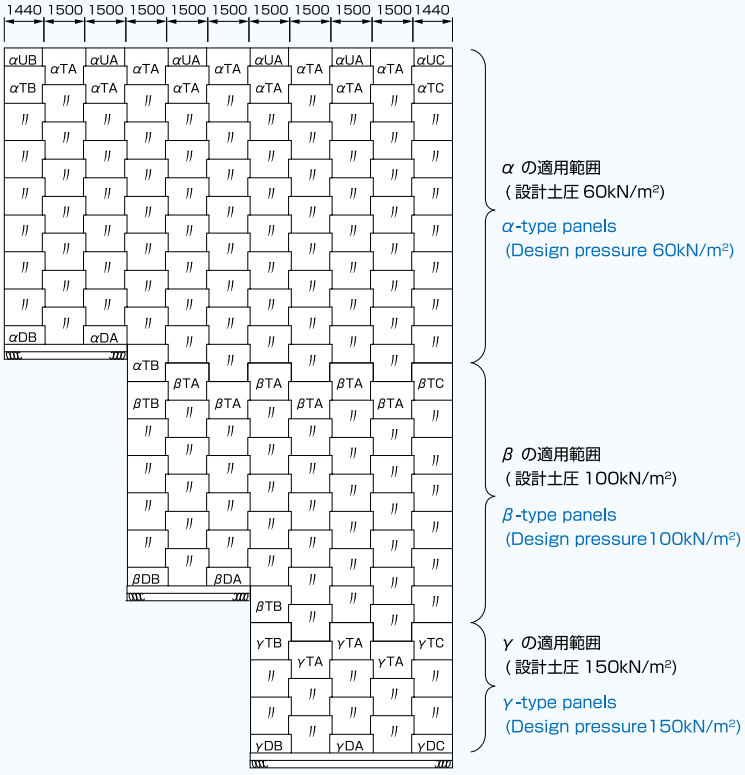
メインプレート
Main plate



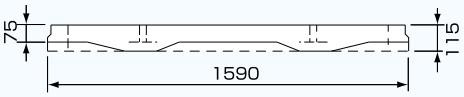
サブプレート
Sub plate

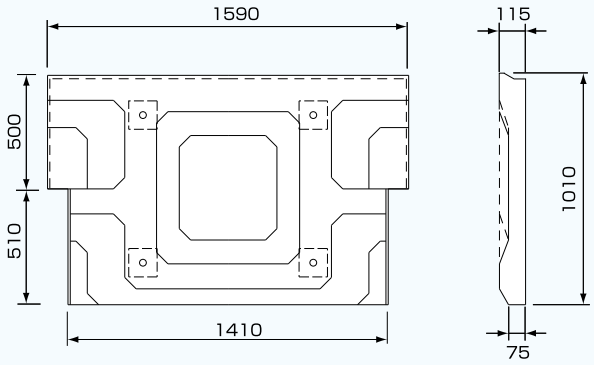


組立図例と使用パネル
Standard panel applications

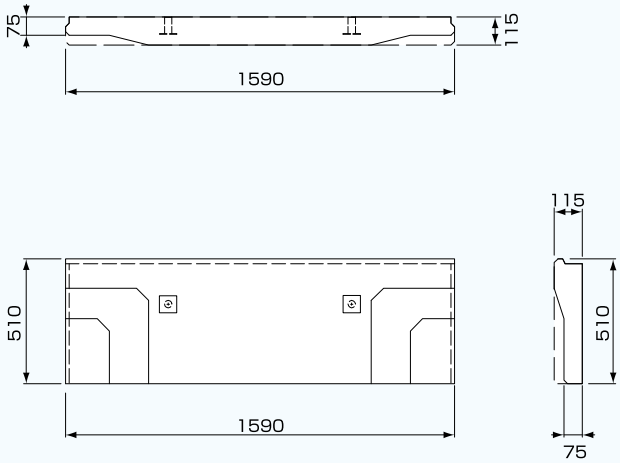


壁面材（TA タイプ） 重量 351 kg
Concrete panel (TA type) weight: 351 kg

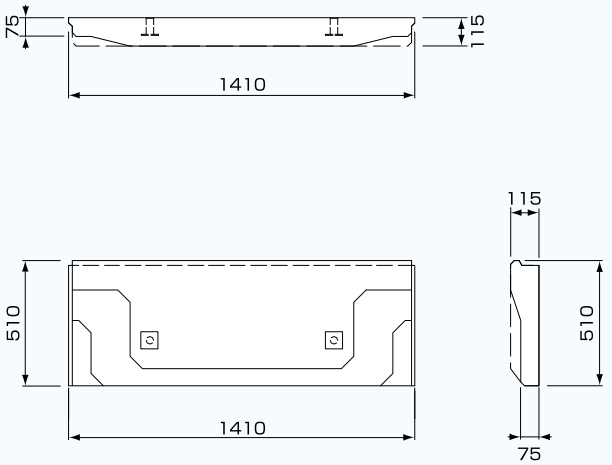




壁面材（DA タイプ）重量 200kg
Concrete panel (DA type)　weight: 200 kg



壁面材（UA タイプ）重量 183kg
Concrete panel (UA type)　weight: 183 kg



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