TR

CURTAIN NET

High-Energy Absorption
Rockfall Protection Construction

TOKYO ROPE MFG. CO., LTD.

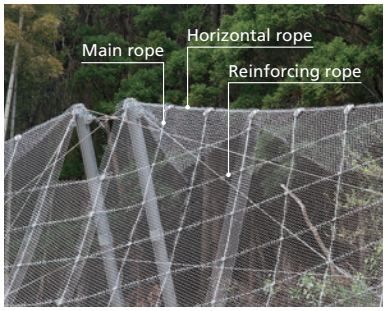
Curtain Net method can absorb rockfall energy with the whole wire net, which provides high-energy-absorption performance.

With the Curtain Net, struts and suspension ropes are not installed on the slope intended to draw falling rocks, but unique robust struts are installed on both stable sides less prone to rockfall and are secured by suspension ropes and stay ropes. With this arrangement, falling rocks do not strike directly on the struts or suspension ropes, but the rockfall energy is absorbed only by the curtain as it is an elastic body. Thus, it is a high-energy absorbing, rockfall protection construction method.

Features

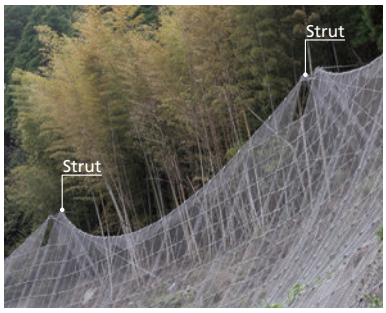
Tough and excellent in absorbing rockfall energy

The horizontal ropes along the top of the curtain and strut suspension ropes are stronger and more flexible than the wire ropes used in conventional pocket-type rock nets. Besides, the vertical and horizontal ropes (both main and reinforcing ropes) are placed densely, so that falling rocks of large size are received integrally by both the rope and net members together, rather than by the net alone.
The larger deal load of the curtain means a greater difference in energy before and after collision, which results in substantial increase in the capacity to absorb rockfall energy.



Struts can be placed wider apart

Unlike the conventional pocket-type rock net, strut-to-strut intervals can be increased. Consequently, struts can be installed on stable locations, avoiding dangerous slope and swamp areas susceptible to rockfall and unstable cliffs. This arrangement prevents falling rocks from striking directly on the struts and suspension ropes. On undulating slopes, the undulation can be utilized, that is, anchors can be installed directly in stable ground to extend the top horizontal top ropes to install the curtain.



Rocks falling from high elevations can be received securely

The struts supporting the curtain are tall at 2.5 to 8.0 meters and form a large opening in the upper pocket, which reliably accommodates rocks bounding down from high elevations.

Prone to less damage and easy in maintenance

The curtain that receives falling rocks is less prone to damage because its wire ropes and nets are composed of strong and flexible materials. In addition, falling rocks are guided more desirably to the foot of slope than in the pocket-type rock net, so that accumulated rocks can be removed more easily.

High corrosion resistance and durability

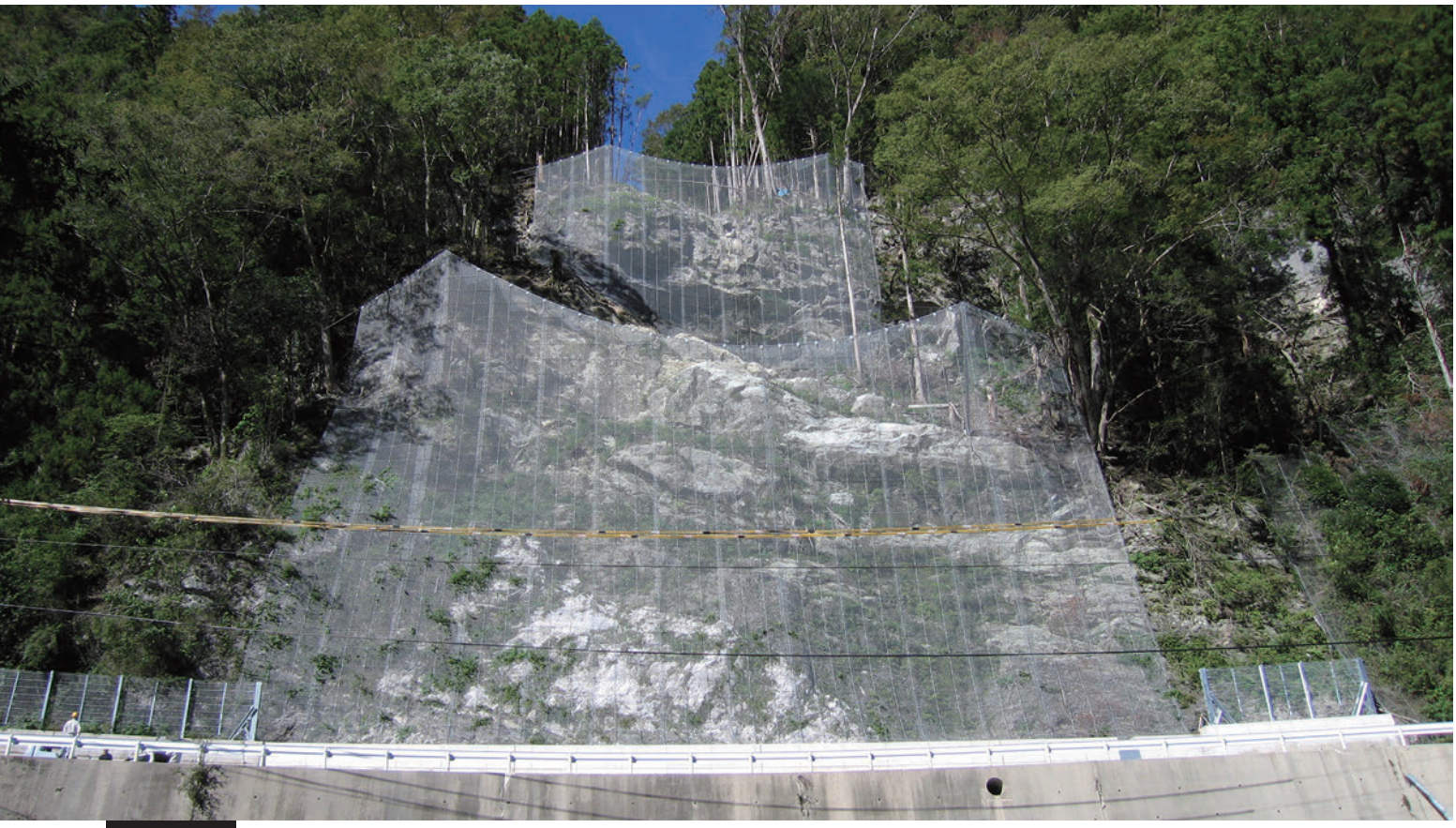
High durability versions provide an expected service life of more than 50 years in mountainous areas.
Excellent corrosion resistance and durability result from the galvanization on all members. Wires, such as those used in wire nets and wire ropes, which are low in plating coating weight, are applied with zinc-aluminum alloy plating to improve corrosion resistance and durability.

It is not desirable that important facilities built to prevent rockfall accidents loose their function in short times due to corrosive deterioration of any particular component member. Based on this idea, standard plating specifications assure at least 50 years of corrosion resistance in mountainous areas, which are typical locations for such facilities.

Environmentally compatible (Toff-coated) version

"Toff-coated products" are offered as environmentally compatible versions, which are applied with modified saturated polyester resin coating on the plated surface. The coating film of these products provides resistance to peeling, resistance to scratches, and high adhesiveness, which together serve to prevent salt damage. The Toff-coated version also features acid/alkali resistance that has not been achieved by metal-based rust prevention. Furthermore, the film strength and elongation provide high reliability for the coating of deformation-susceptible products such as wire rope and wire net. When the Toff-coating is applied to winding grips, the power of fixing with the rope remains conformant to the standard value.

Example of construction



Curtain Net The construction site: Tokushima Prefecture, Japan (CN-5.0)

Curtain Net The construction site: Chiba Prefecture, Japan (CN-5.0)

Curtain Net The construction site: Chiba Prefecture, Japan (CN-4.0)

Curtain Net Super The construction site: Hiroshima Prefecture, Japan (CN-S)

CURTAIN NET

The models are CN-5.0ZA and CN-4.0ZA for rhombus wire nets of 5.0ϕ and 4ϕ wires, respectively, plated with zinc aluminum alloy, and CN-5.0G and CN-4.0G for rhombus wire nets of galvanized element wires. Further, Model TF refers to nets applied with Toff-coating over the galvanized surface.
When a net of Model 5.0 uses top horizontal ropes and strut suspension ropes of 7x7 30ϕ, it is referred to as Model CN-5.0ZA (G, TG)-30.

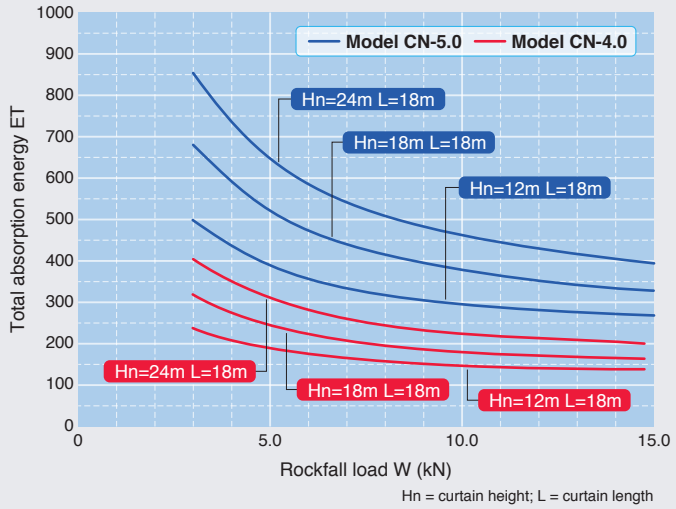
Model CN-5.0ZA (G, TF) Model CN-4.0.0ZA (G, TF)

Model

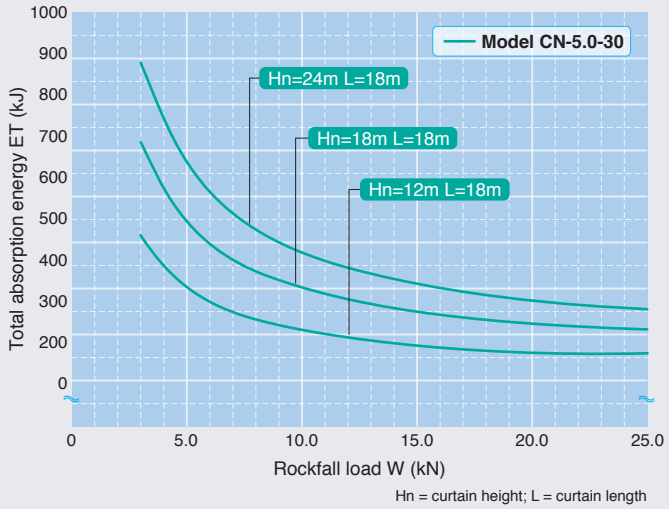
	Model CN-5.0ZA (G, TF)	Model CN-4.0ZA (G, TF)
Wire net	5.0ϕ×50×50	4.0ϕ×50×50
Top horizontal rope	7×7　24ϕ	7×7　20ϕ
Vertical/horizontal ropes	3×7　18ϕ	3×7　16ϕ
Vertical/horizontal reinforcing ropes	3×7　14ϕ	3×7　12ϕ
CN strut (with ladder)	H-200×200×8×12, 2-M33×1200	H-175×175×7.5×11, 2-M30×1200
Strut suspension rope	7×7　24ϕ	7×7　20ϕ
Strut side stay rope	3×7　18ϕ	3×7　16ϕ
Anchor fitting	25t×450×450, 4-M30×1200	25t×450×450, 4-M27×1200
TR Cement Jaw Anchor	M33×1200	M33×1200
FR anchor	FRC190　7×7　30ϕ　6.0m	FRC130　7×7　30ϕ　5.0m
Saddle (for FR anchor)	16×600×1000	16×600×1000
Root anchor	114.3ϕ×4.5×1800	114.3ϕ×4.5×1800
Turnbuckle J&E	1･1/2(38ϕ)×419 M24×350	1･1/2(38ϕ)×419 M24×350
Turnbuckle E&E for Strut connection	M24×350	M24×350
Wire grip	F24-25	F20-22
Thimble	A-28	A-22
Winding grip	For 18ϕ For 14ϕ	For 16ϕ For 12ϕ
Suspension fitting	For 24ϕ	For 20ϕ
Cross grip	4.5t×60×75	4.5t×60×75 and 3t×60×60
Coupling coil	4.0ϕ×70×300	4.0ϕ×70×300

Note: All parts are galvanized. For standard versions (ZA), the wire nets, wire ropes, and winding grips, which are low in plating coating weight, are plated with a highly durable alloy of zinc and 10% aluminum. For TF versions, members with a plating coating weight of 550 g/m² or more (HDZ-55) are applied with powder coating baking.

Selection Chart



Hn = curtain height; L = curtain length



Hn = curtain height; L = curtain length

Model CN-5.0ZA (G, TF)-30

Model

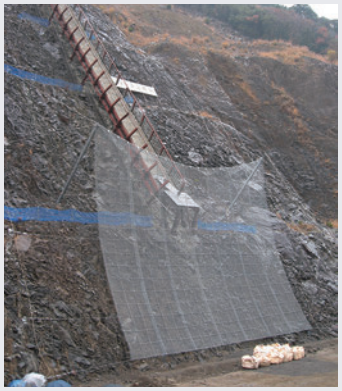
	Model CN-5.0ZA (G, TF)-30
Wire net	5.0ϕ×50×50
Top horizontal rope	7×7 30ϕ
Vertical/horizontal ropes	3×7 18ϕ
Vertical/horizontal reinforcing ropes	3×7 14ϕ
CN strut (with ladder)	H-200×200×8×12, 2-M33×1200
Strut suspension rope	7×7 30ϕ
Strut side stay rope	3×7 18ϕ
Anchor fitting	25t×450×450, 4-M33×1350
TR Cement Jaw Anchor	M33×1200
FR anchor	FRC290 7×7 30ϕ 8.5m
Saddle (for FR anchor)	16×600×1000
Root anchor	114.3ϕ×4.5×1800
Rigging screw	Nominal 36
Turnbuckle J&E	M24×350
Turnbuckle E&E for Strut connection	M24×350
Wire grip	F30-32
Thimble	A-34
Winding grip	For 18ϕ For 14ϕ
Suspension fitting	For 30ϕ
Cross grip	4.5t×60×75
Coupling coil	4.0ϕ×70×300

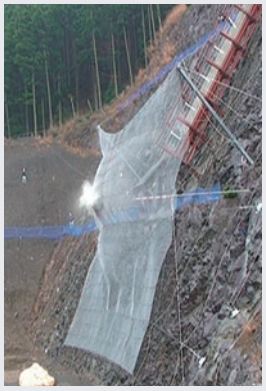
Note: All parts are galvanized. For standard versions (ZA), the wire nets, wire ropes, and winding grips, which are low in plating coating weight, are plated with a highly durable alloy of zinc and 10% aluminum. For TF versions, members with a plating coating weight of 550 g/m² or more (HDZ-55) are applied with powder coating baking.

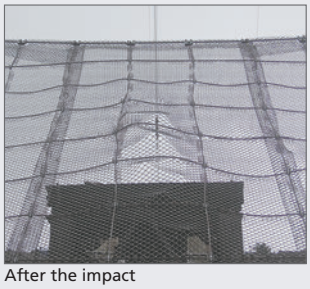
Full scale weight impact tests

Model CN-5.0ZA

The test confirms that a descending horn-shaped concrete plumb bob(10kN) from the upper chute with revolving movement (plumb bob energy 389kJ) collided with the Curtain net construction and it catches the plumb bob without being penetrated.



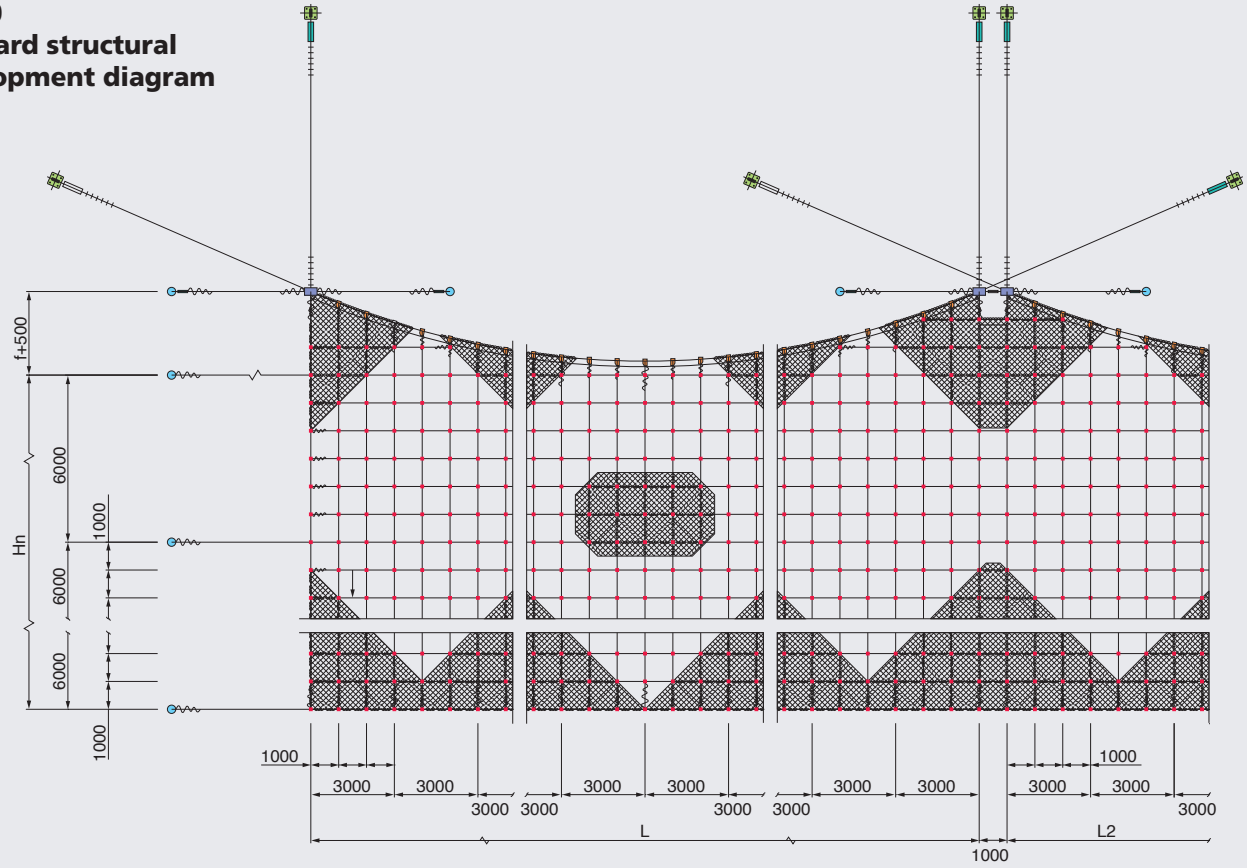




After the impact

Structure of Curtain Net

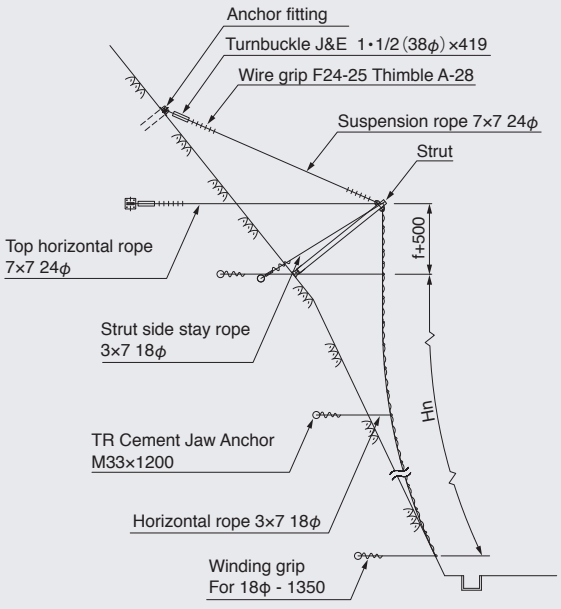
CN-5.0
Standard structural development diagram



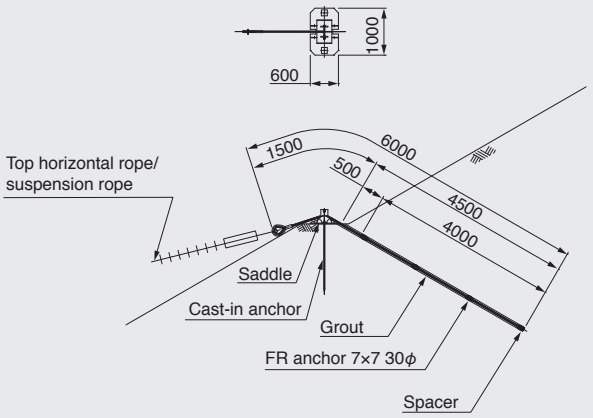
Parts list

Part name	Symbol
Wire net	
Top horizontal rope	
Vertical rope	
Horizontal rope	
Vertical reinforcing rope	
Horizontal reinforcing rope	
Strut	
Strut suspension rope	
Strut side stay rope	

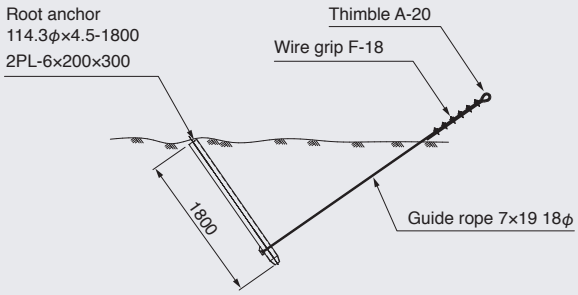
Part name	Symbol
SymbolAnchor fitting	
TR Cement Jaw Anchor	
Turnbuckle	
Wire grip	
Winding grip	
Suspension fitting	
Cross grip	
Coupling coil	



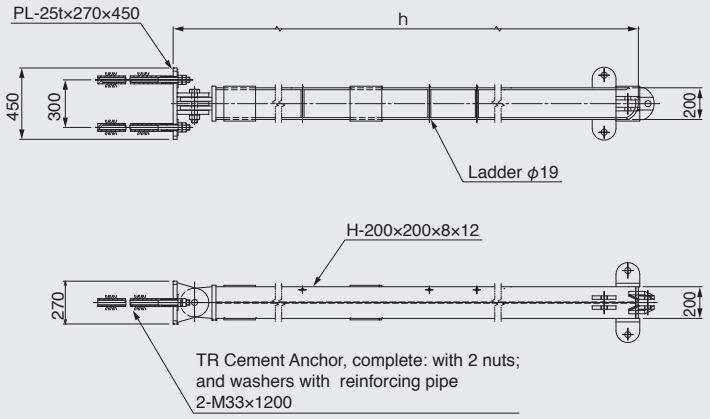
FR anchor FRC-190



Root anchor



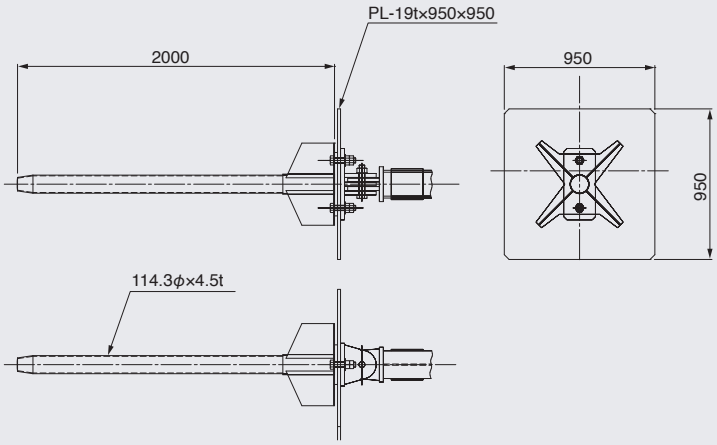
Strut



Strut height

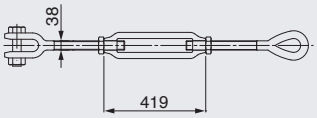
h(m)
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0

Underground cast-in anchor for strut foundation

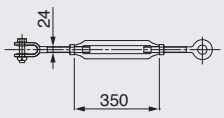


Turnbuckle

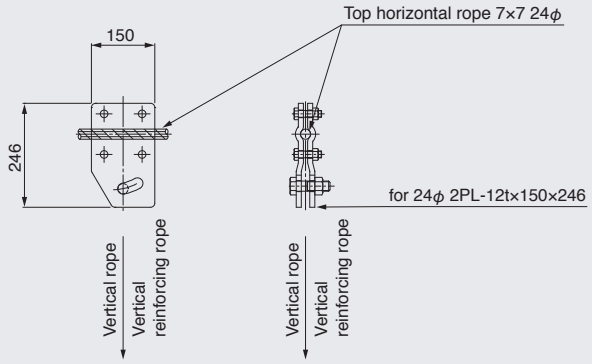
J&E 1·1/2(38ϕ)×419



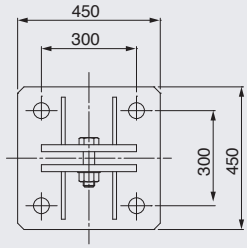
J&E M24×350

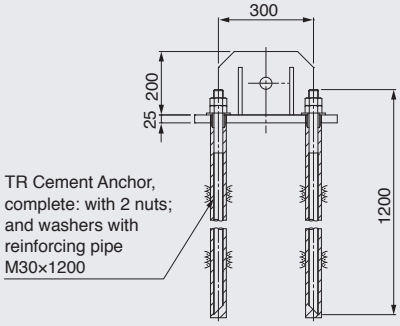


Suspension fitting

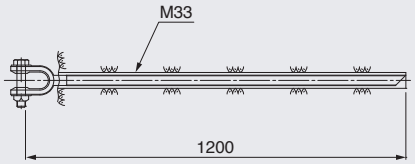


Anchor fitting





TR Cement Jaw Anchor



Note: Separate specifications apply if snow load is taken into consideration.

CURTAIN NET SUPER

These models comprise a rhombus wire net of 5.0ϕ element wires plated with a zinc-aluminum alloy. Two models are the standard: Model CNS-S (ZA) with two top horizontal ropes of 7x7 ZA/0 30ϕ, and Model CNS-M (ZA) with horizontal ropes of 7x7 ZA/0 24ϕ. In addition, the model using wire nets, wire ropes, winding grips, and coupling coils, all plated with a zinc-aluminum alloy, is Model G and the one applied with Toff-coating is Model TF.

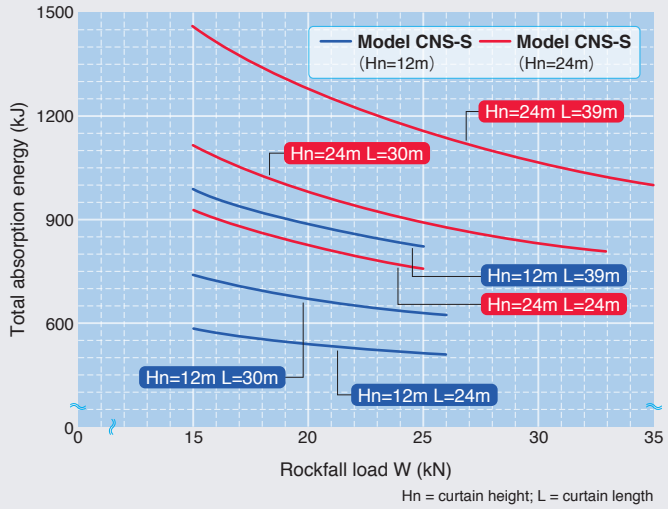
Model CNS-S (ZA, G, TF)

Model

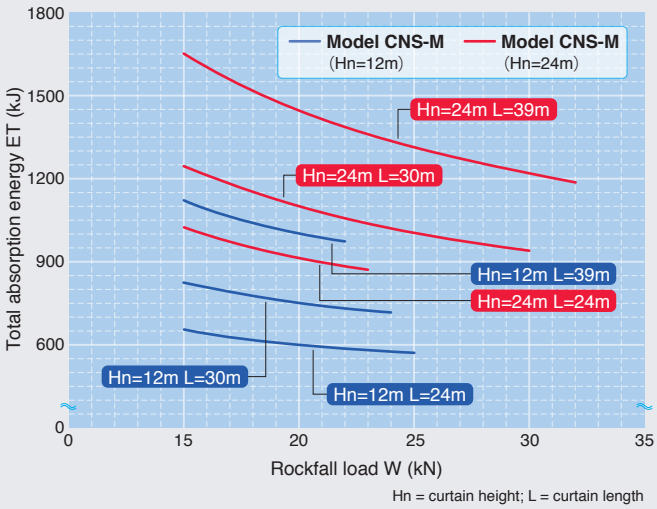
	Model CNS-S (ZA, G, TF)
Wire net	5.0ϕ×50×50
Top horizontal rope	7×7 30ϕ
Vertical/horizontal ropes	3×7 18ϕ
Vertical/horizontal reinforcing ropes	3×7 14ϕ
CNS strut (with ladder)	H-250×250×9×14, 4-M33×1200
Strut suspension rope	7×7 30ϕ
Strut side stay rope	3×7 18ϕ
Anchor fitting	for 30ϕ 25×450×450, 4-M33×1350
TR E Anchor	38ϕ×1200
FR anchor	FRC-290 7×7 30ϕ 8.5m
Saddle (for FR anchor)	16×600×1000
Root anchor	114.3ϕ×4.5×1800
Rigging screw	Nominal 36
Turnbuckle J&E	M24×350
Joint rope, with both ends worked for Toyolock	3×7 18ϕ
Wire grip	F30-32
Thimble	A-34
Winding grip	for 18ϕ for 14ϕ
Suspension fitting	for 2×30ϕ
Cross grip	4.5 t ×60×75
Coupling coil	4.0ϕ×70×300
Coupling coil (for top rope)	4.0ϕ×100×300

Note: All parts are galvanized. For standard versions (ZA), the wire nets, wire ropes, and winding grips, which are low in plating coating weight, are plated with a highly durable alloy of zinc and 10% aluminum. For TF versions, members with a plating coating weight of 550 g/m² or more (HDZ-55) are applied with powder coating baking.

Selection Chart



Hn = curtain height; L = curtain length



Hn = curtain height; L = curtain length

Model CNS-M (ZA, G, TF)

Model

	Model CNS-M (ZA, G, TF)
Wire net	5.0ϕ×50×50
Top horizontal rope	7×7 30ϕ
Vertical rope	3×7 18ϕ
Horizontal rope	7×7 24ϕ
Vertical/horizontal reinforcing ropes	3×7 14ϕ
CNS strut (with ladder)	H-250×250×9×14, 4-M33×1200
Strut suspension rope	7×7 30ϕ
Strut side stay rope	3×7 18ϕ
Anchor fitting (for suspension/top horizontal ropes)	for 30ϕ 25×450×450, 4-M33×1350
Anchor fitting (for horizontal rope)	25×450×450, 4-M30×1200
TR E Anchor	38ϕ×1200
FR anchor (for suspension/top horizontal ropes)	FRC-290 7×7 30ϕ 8.5m
Saddle (for FR anchor)	16×600×1000
FR anchor (for horizontal rope)	FRC-190 7×7 30ϕ 6.0m
Saddle (for FR anchor)	16×600×1000
Root anchor	114.3ϕ×4.5×1800
Rigging screw	Nominal 36
Turnbuckle J&E	M24×350
Joint rope, with both ends worked for Toyolock	3×7 18ϕ
Wire grip (for suspension/top horizontal ropes)	F30-32
Thimble (for suspension/top horizontal ropes)	A-34
Wire grip (for horizontal rope)	F24-25
Thimble (for horizontal rope)	A-28
Winding grip	for 18ϕ for 14ϕ
Suspension fitting	for 2×30ϕ
Cross grip	4.5 t ×60×75
Coupling coil	4.0ϕ×70×300
Coupling coil (for top rope)	4.0ϕ×100×300

Note: All parts are galvanized. For standard versions (ZA), the wire nets, wire ropes, and winding grips, which are low in plating coating weight, are plated with a highly durable alloy of zinc and 10% aluminum. For TF versions, members with a plating coating weight of 550 g/m² or more (HDZ-55) are applied with powder coating baking.

Full scale weight impact tests

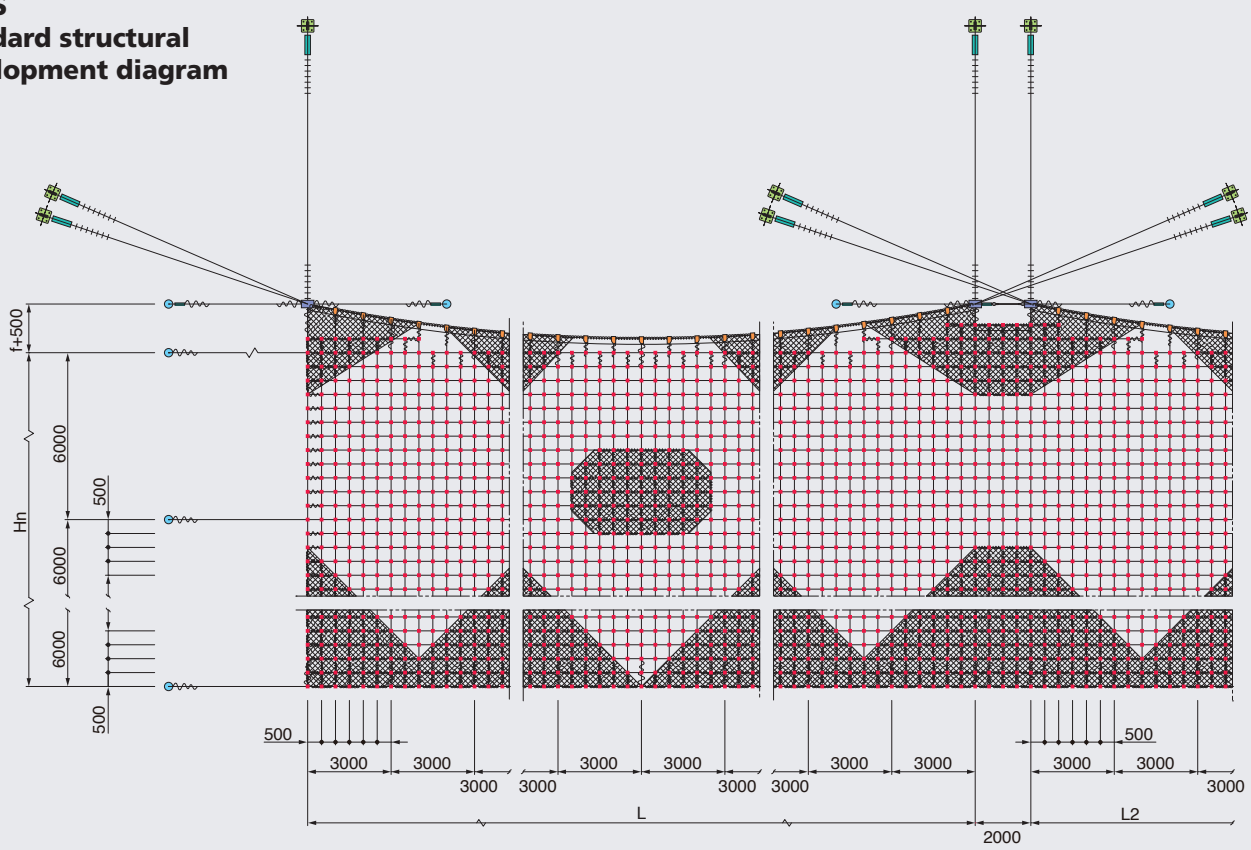
Model CNS-S

The test confirms that a descending horn-shaped concrete plumb bob (20kN) from the upper chute with revolving movement (plumb bob energy 803kJ) collided with the Curtain net construction and it catches the plumb bob without being penetrated.

After the impact

Structure of Curtain Net Super

CNS-S
Standard structural development diagram

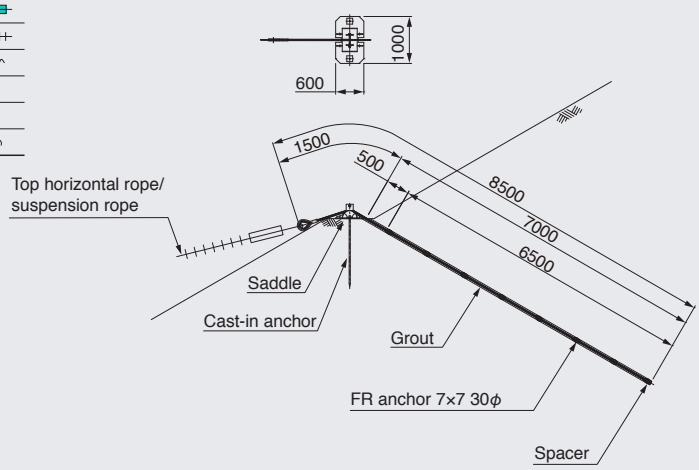


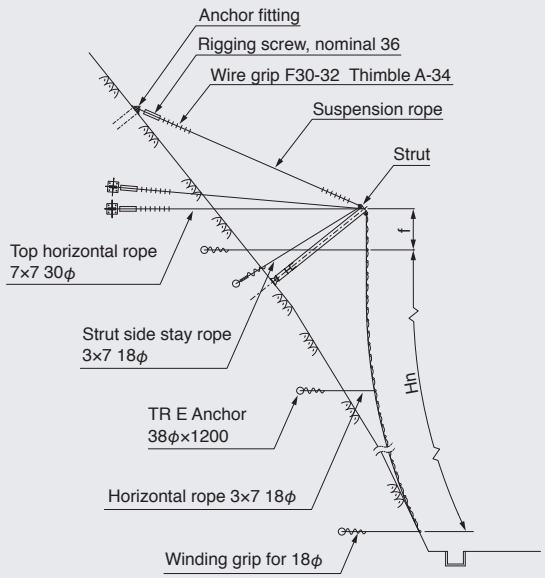
Parts list

Part name	Symbol
Wire net	
Top horizontal rope	—
Vertical rope	|
Horizontal rope	—
Vertical reinforcing rope	|
Horizontal reinforcing rope	—
Strut	
Strut suspension rope	|
Strut side stay rope	—

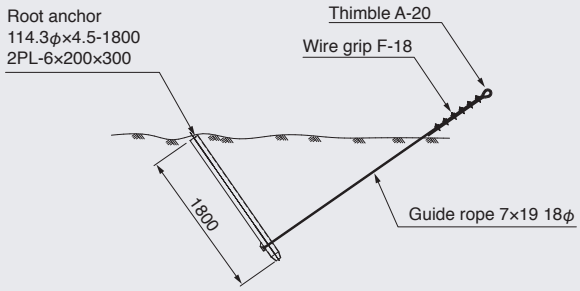
Part name	Symbol
Anchor fitting	
TR E Anchor	
Turnbuckle	
Wire grip	
Winding grip	
Suspension fitting	
Cross grip	
Coupling coil	

FR anchor FRC-290

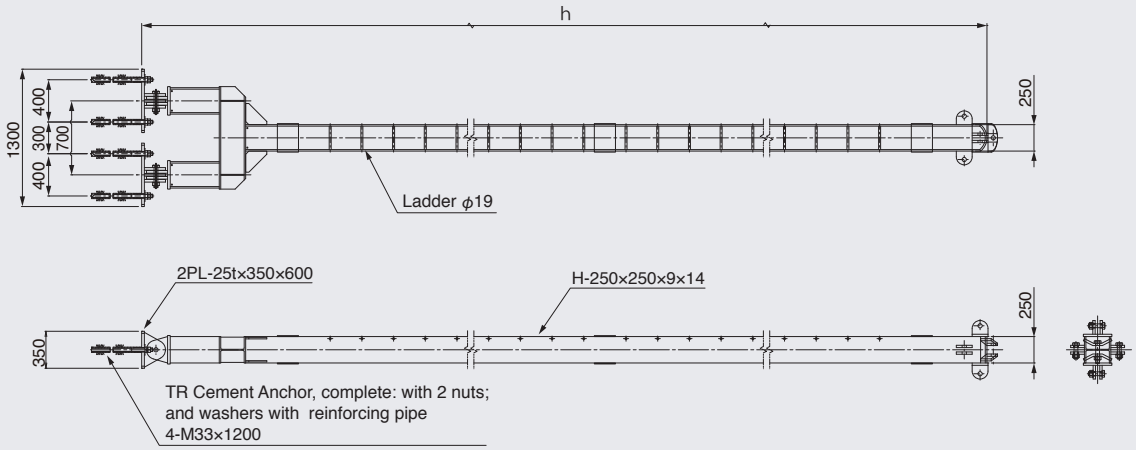




Root anchor



Strut

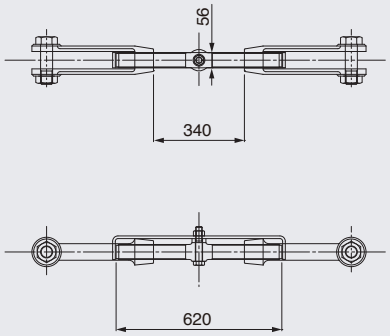


Strut height

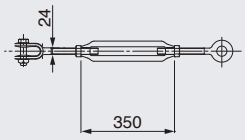
h (m)
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0

Turnbuckle

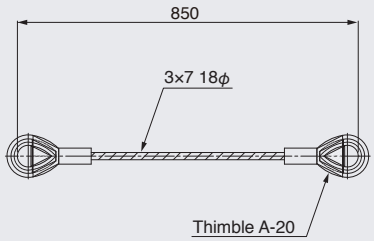
Rigging screw, nominal 36



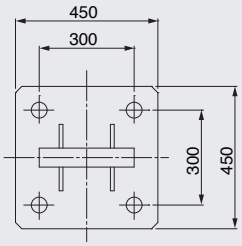
J&E M24×350

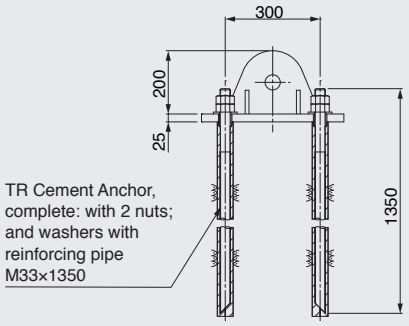


Joining rope for strut connection

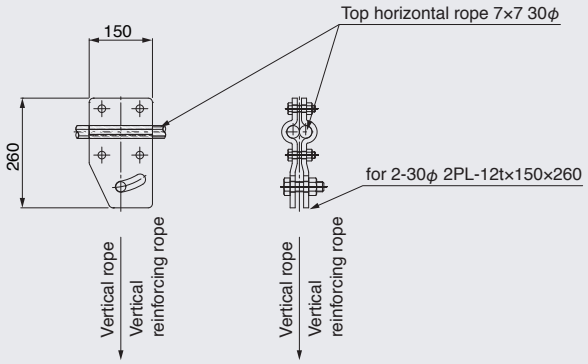


Anchor fitting

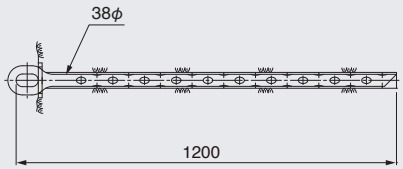




Suspension fitting



TR E Anchor



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