西南交通大学
Southwest Jiaotong University

边坡落石灾害及其防治

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西南交通大学


LIVE
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2013/08/31
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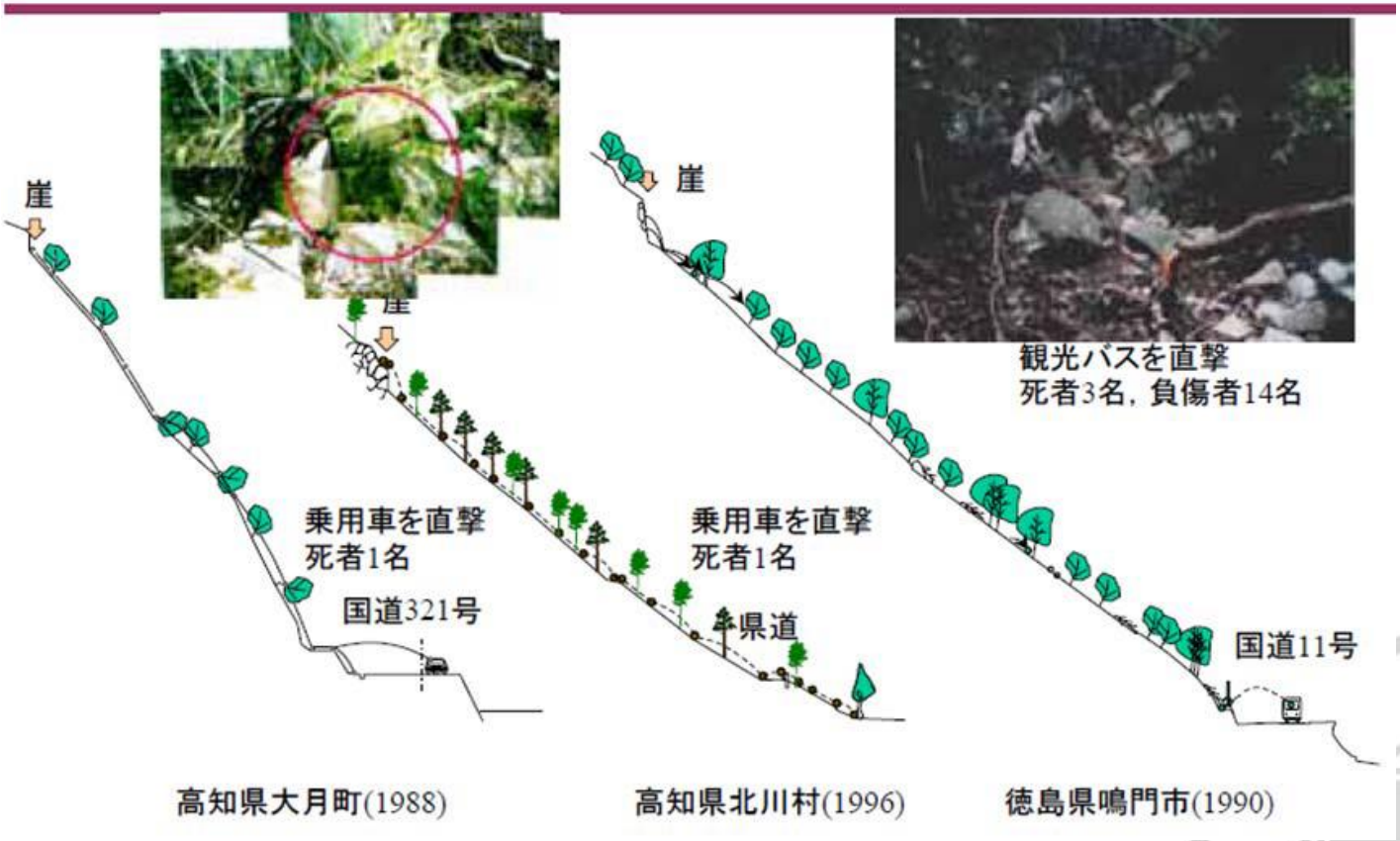
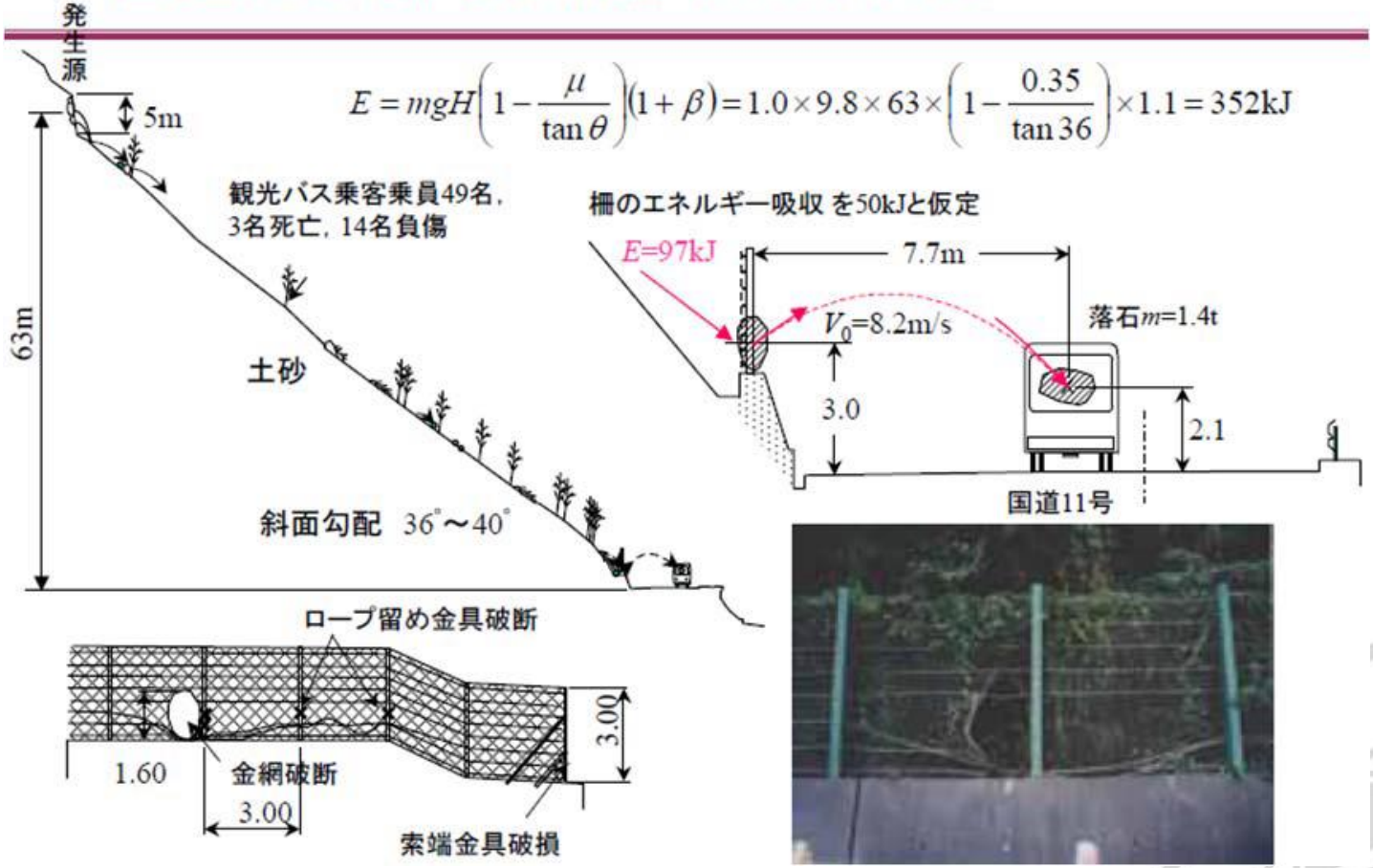
Collapse and falling stone are frequent geological hazards.

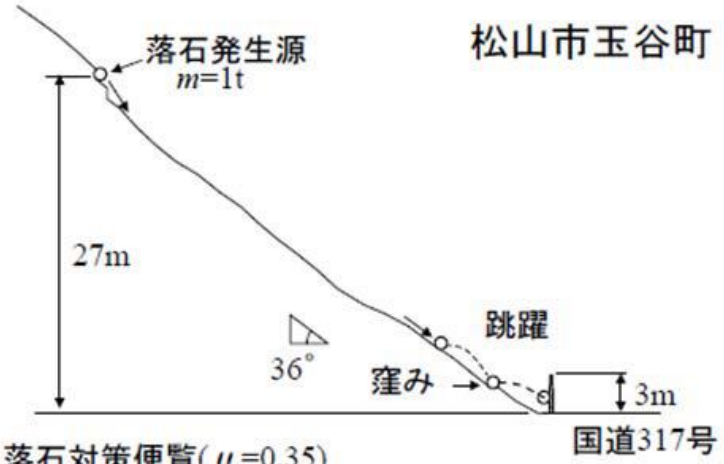
四国の落石発生源の多くは崖部(1)



国道11号鳴門市北灘 1990年10月



国道317号芸予地震による落石2001年



落石対策便覧(μ=0.35)

$$E = mgH\left(1-\frac{\mu}{\tan\theta}\right)(1+\beta)$$

$$=1.0\times9.8\times27\times\left(1-\frac{0.35}{\tan 36}\right)\times1.1=151\text{kJ}$$

防護柵の可能吸収エネルギー50kJ<151kJ

- 落石の速度，エネルギーを過大評価？
- 等価摩擦係数0.35は適切？

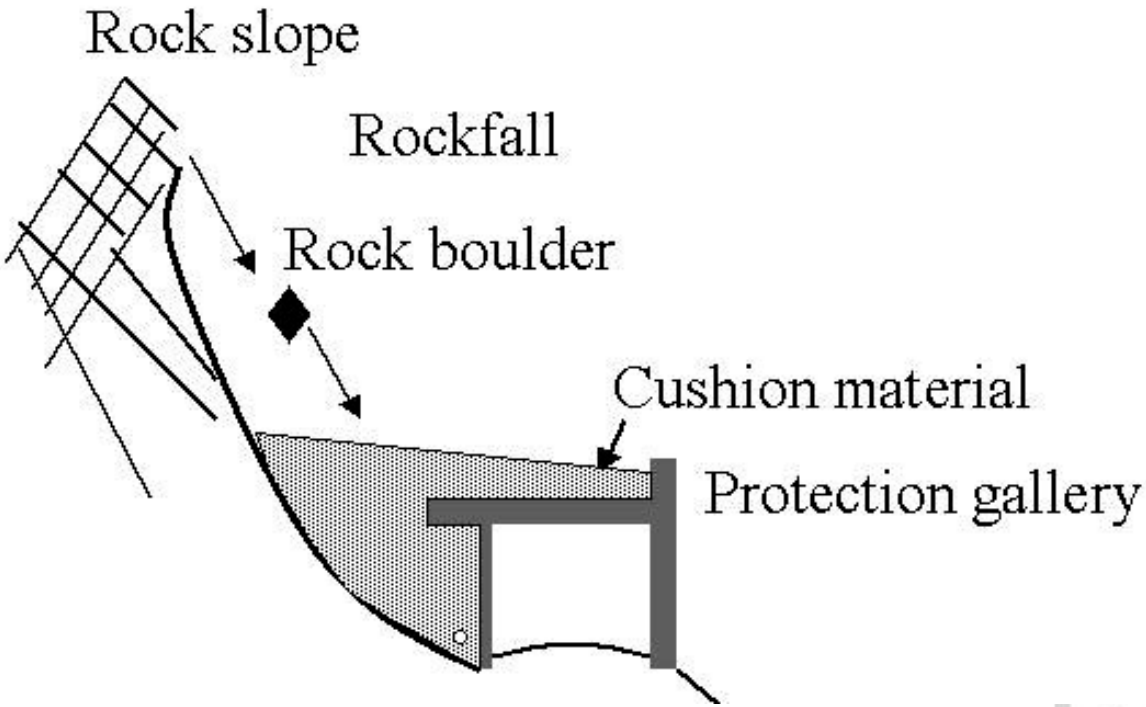
Faling Rock Protection

rockfall shelters or reinforced concrete retaining walls

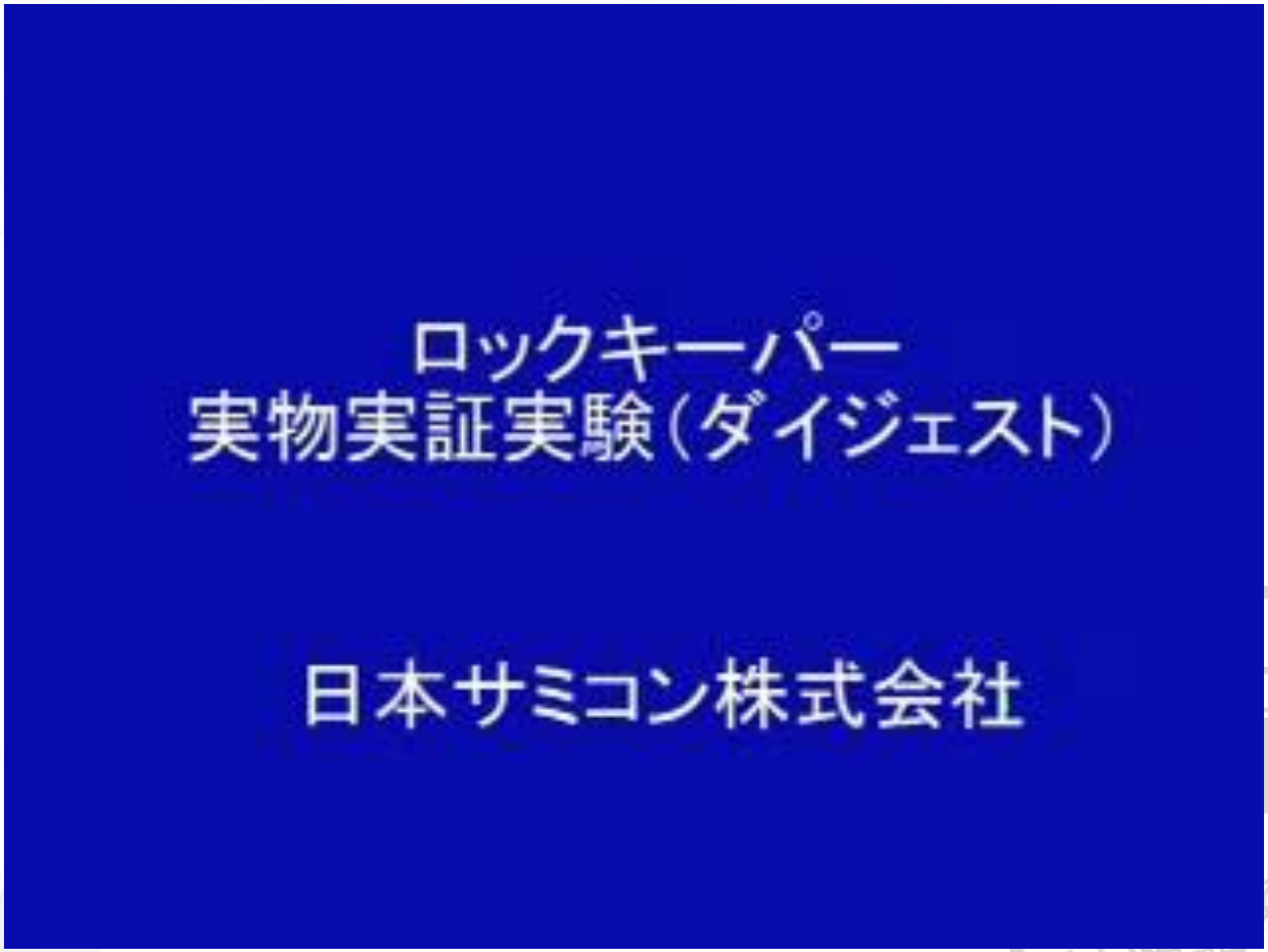
rockfall shelter

retaining wall

Rockfall shelters are usually concrete structures covered on the roof by an absorbing material such as soil backfill used as a shock absorbing cushion.



Impact Test of Falling Rocks on The Rockfall Shelters



Taroko Gorge of Taiwan

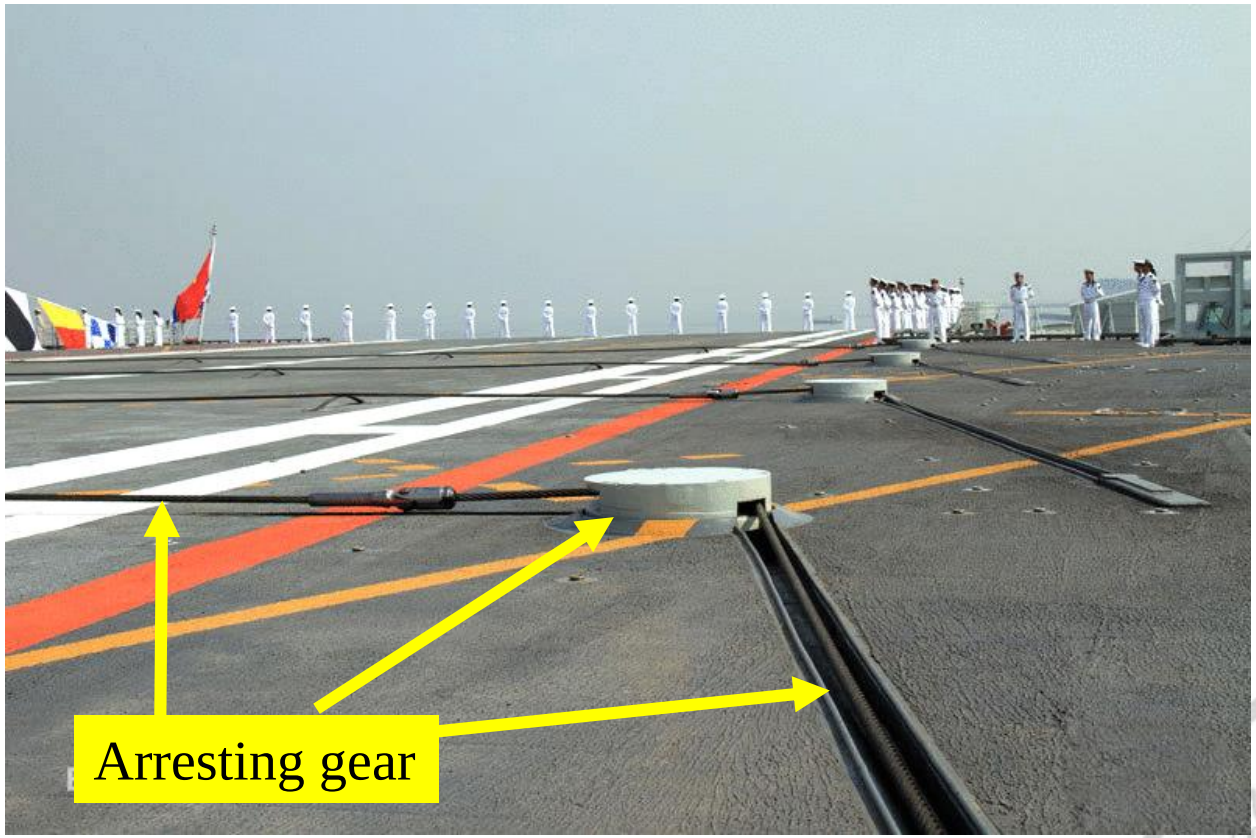
Safety and Preparation

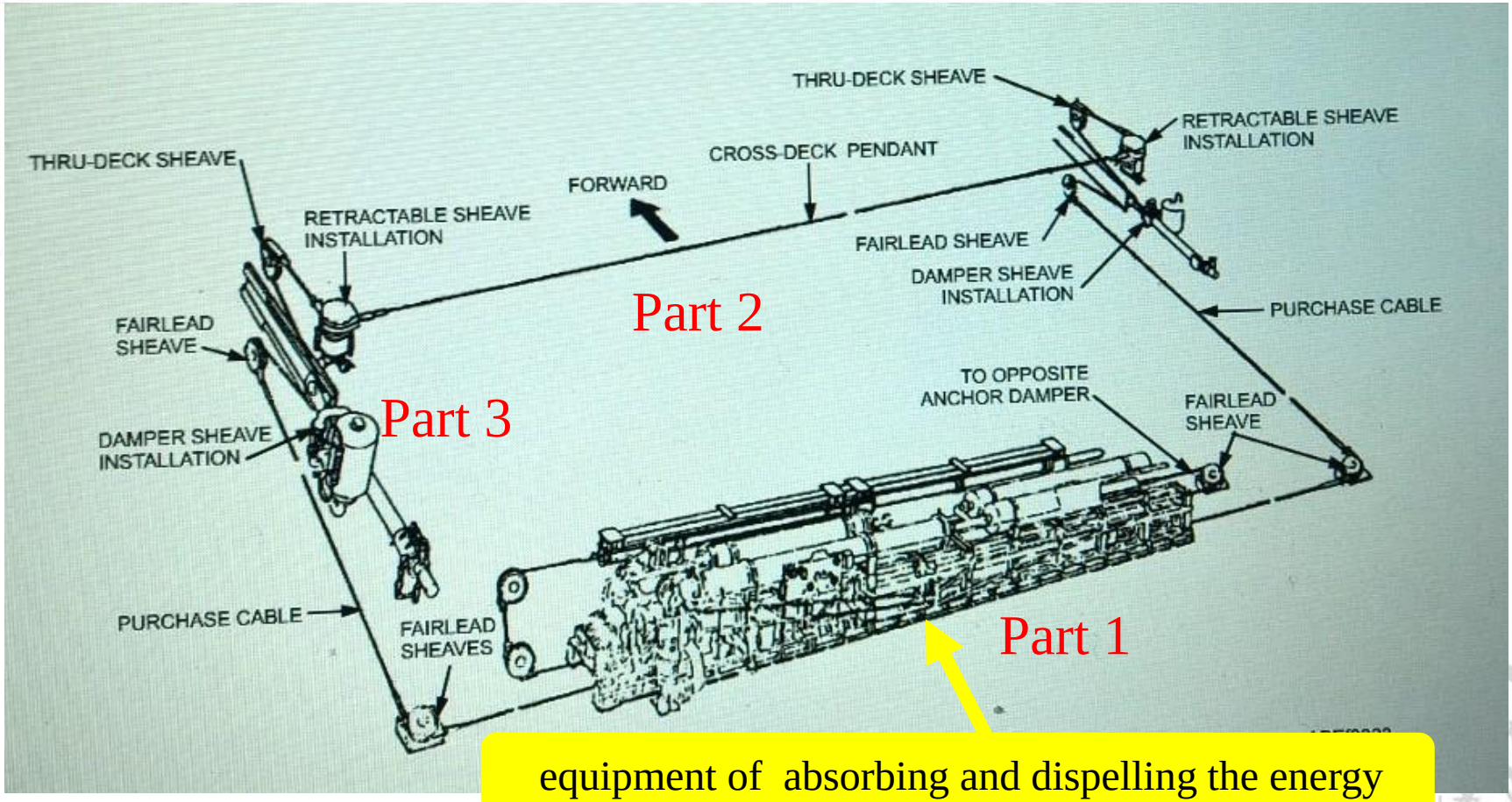
Rockfall Shelters of Taroko Gorge

An Effective Way to Intercept Falling Rocks—Net Barrier


RT

Aircraft Carrier

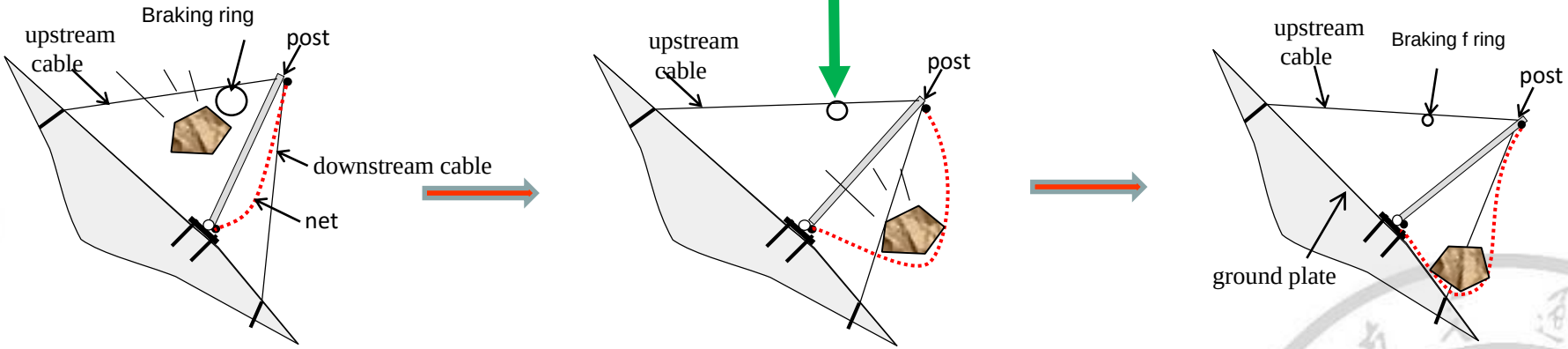




equipment of absorbing and dispelling the energy

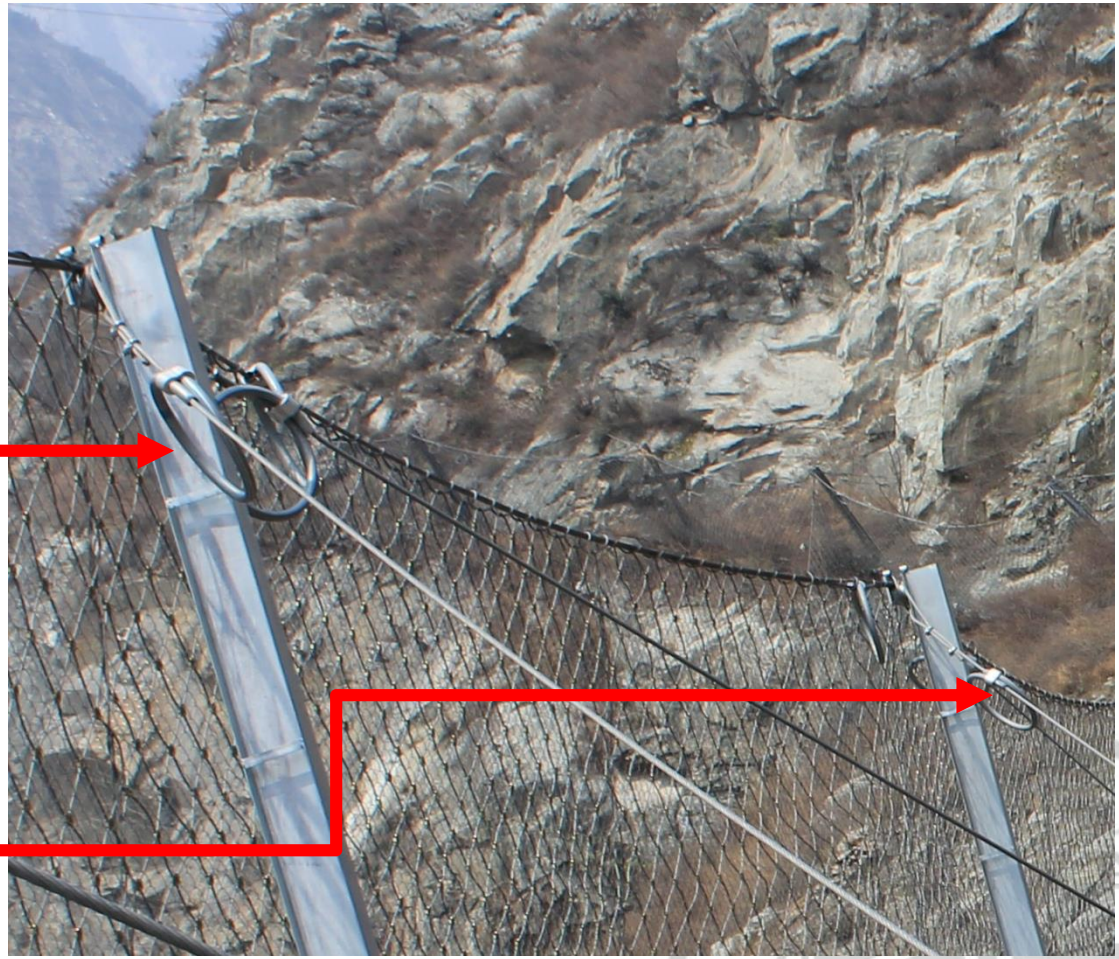
The Deformation Process of Net Barrier

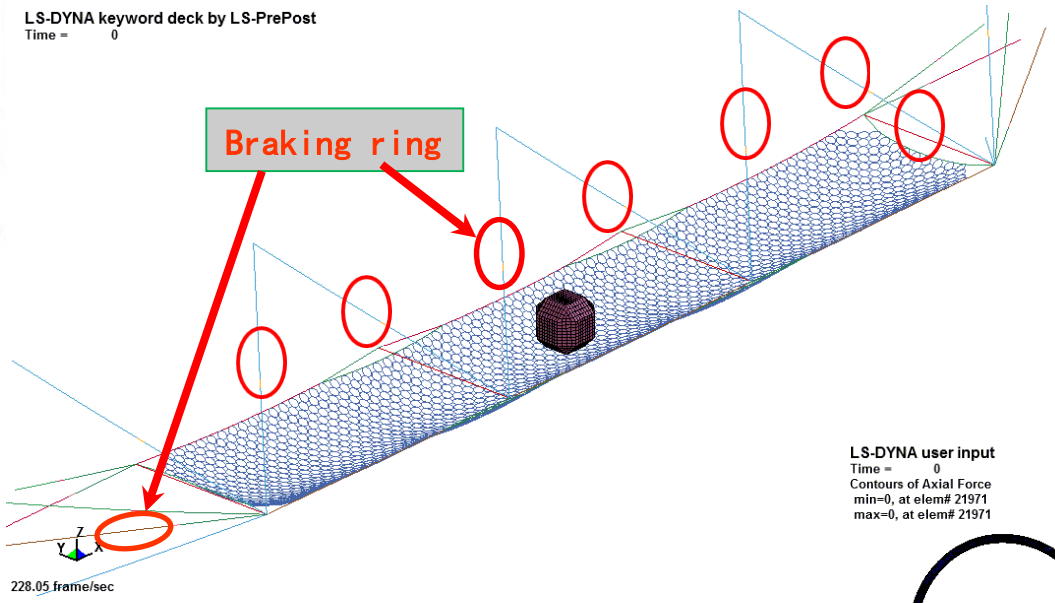
Braking ring: device of absorbing and dispelling the energy

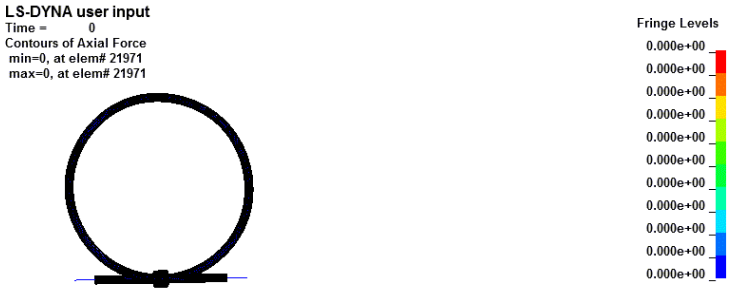


net

Braking ring

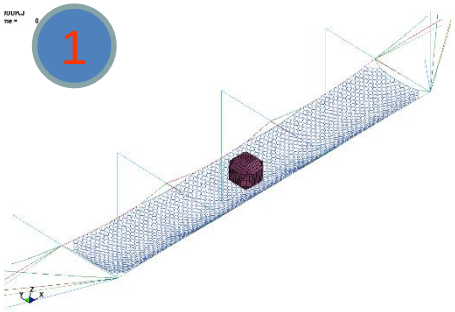




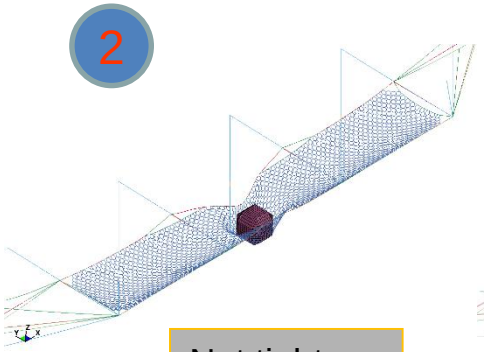


Numerical simulation

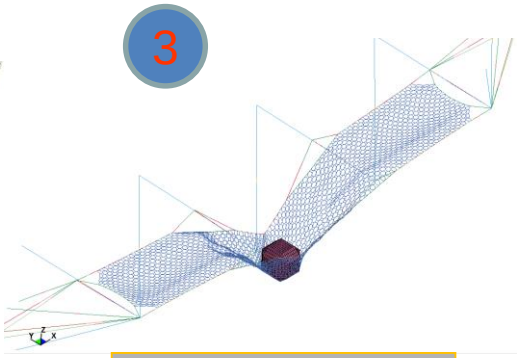
The Deformation Process of Net Barrier



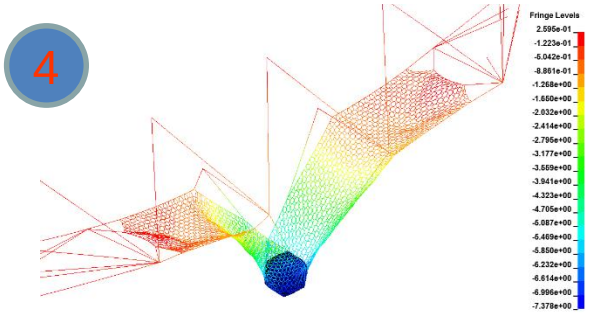
Initial contact



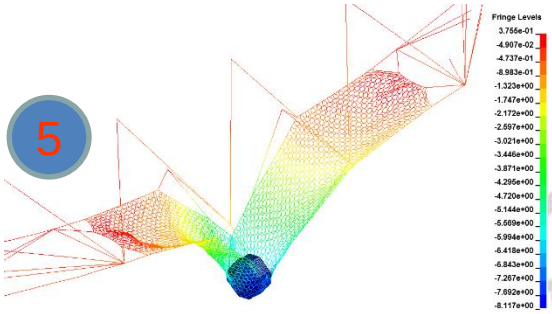
Net tightens



rings begin to work

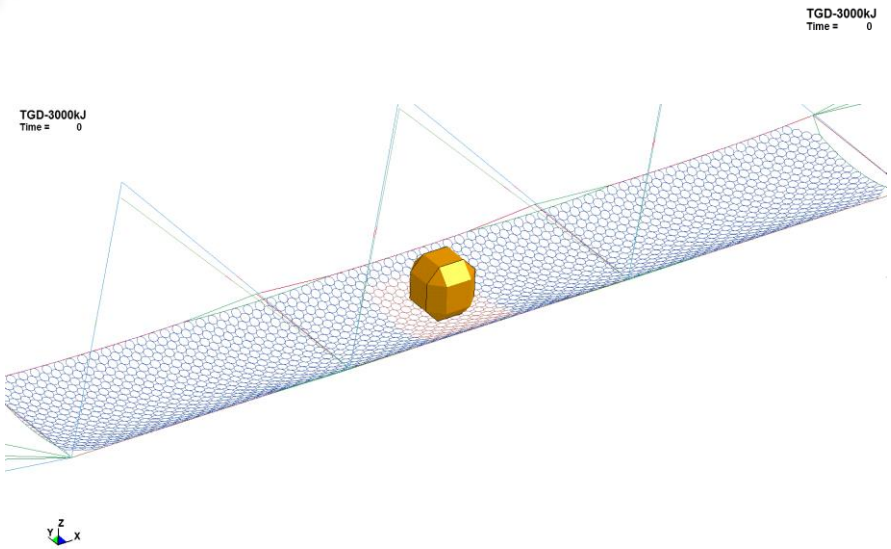


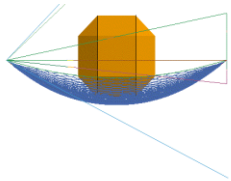
Large deformation

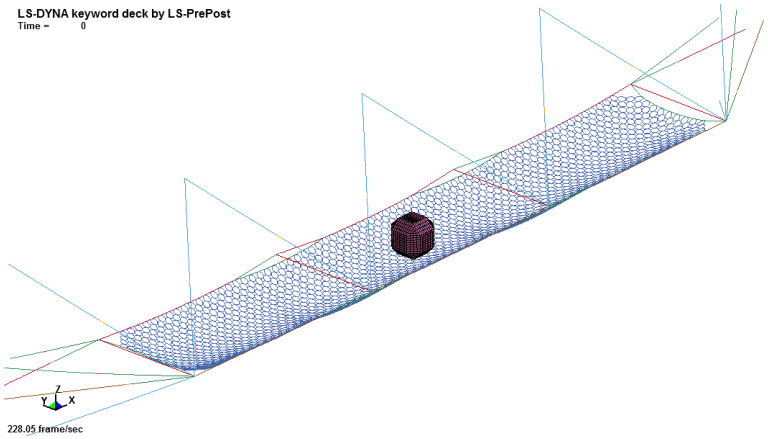


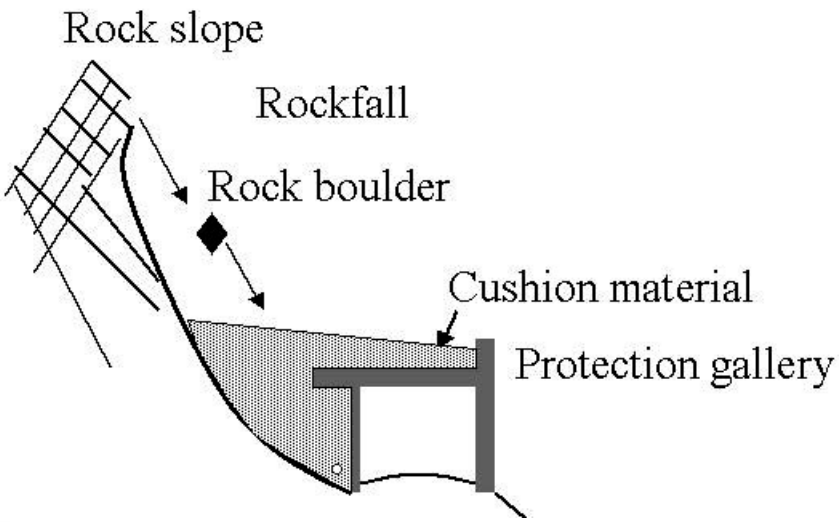
maximum deformation

The working mechanism of net barrier --reducing the impact of fall rock on the net by constant deforming , absorbing and dispelling impact energy with braking rings.



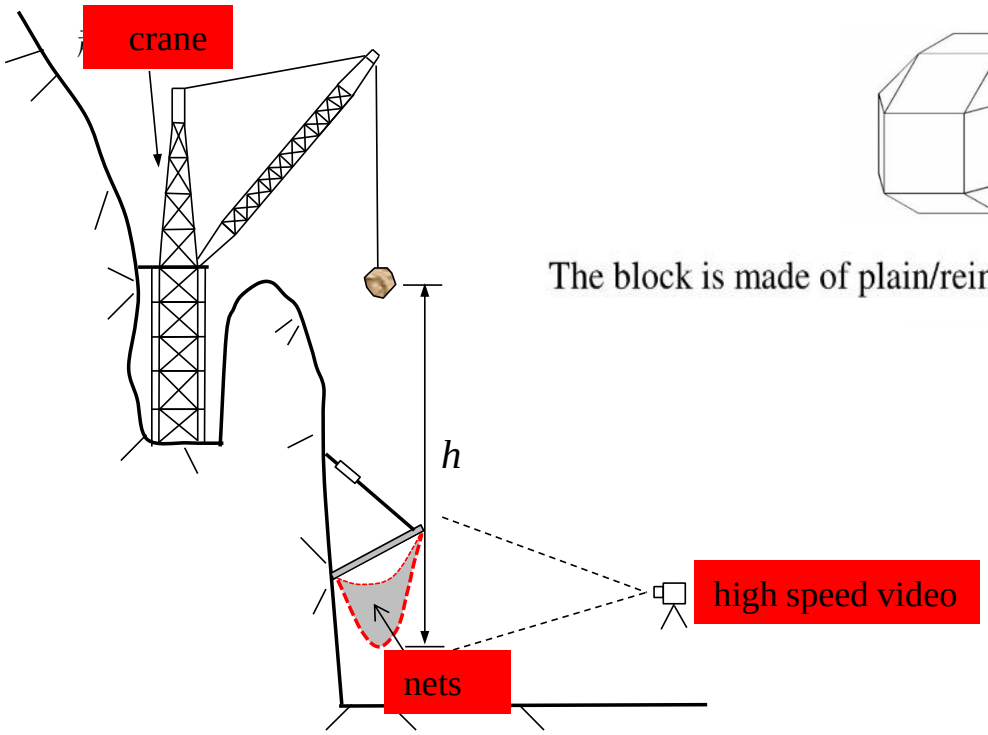


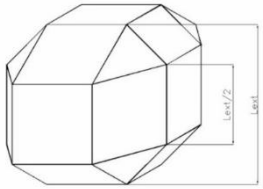

LS-DYNA keyword deck by LS-PrePost
Time = 0
228.05 frame/sec


Rock slope
Rockfall
Rock boulder
Cushion material
Protection gallery


少林寺

Field Rockfall Test Site

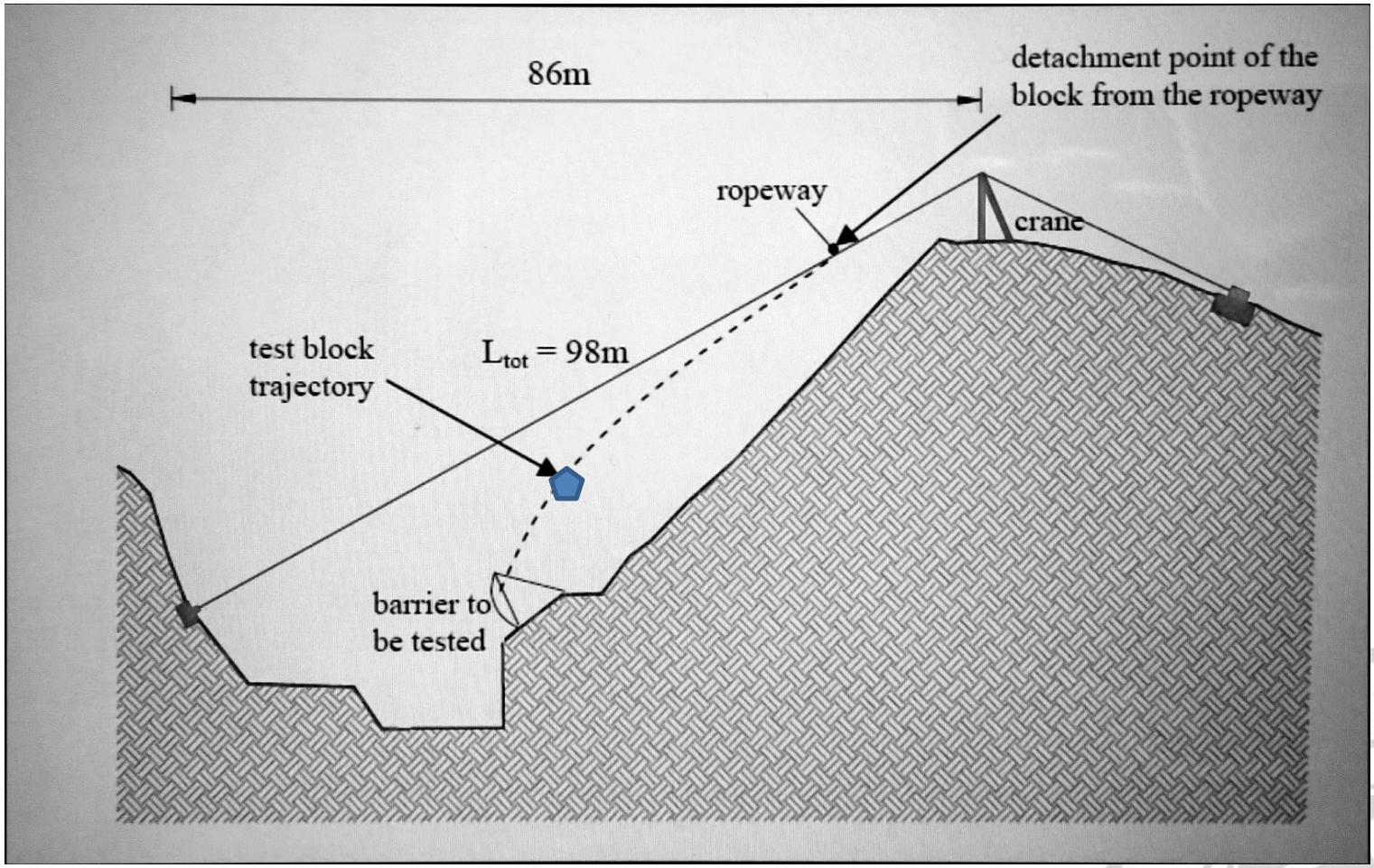




The block is made of plain/reinforced concrete and its shape is a polyhedra

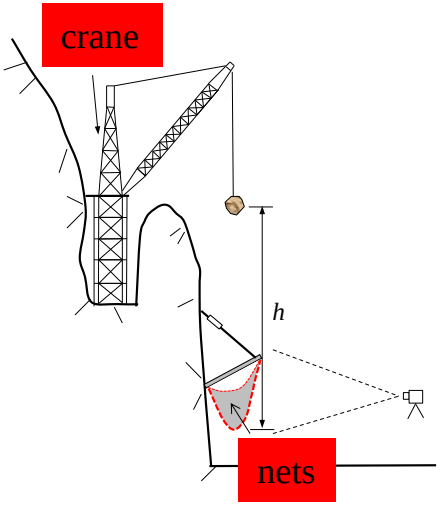
Vertical test site

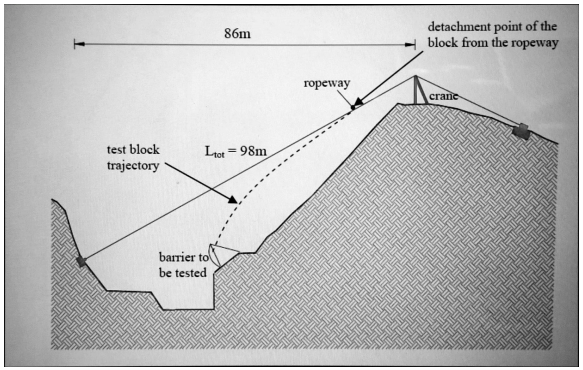
Field Rockfall Test Site



Inclined test site


195
落石注意



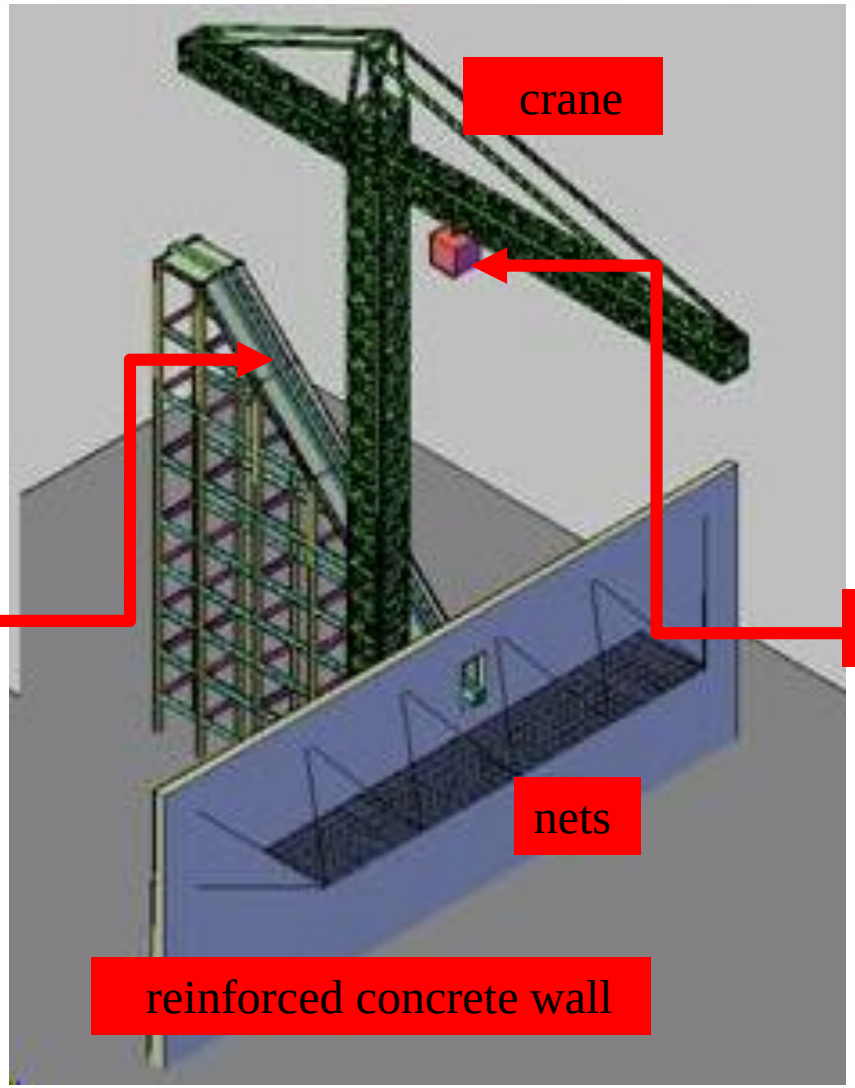


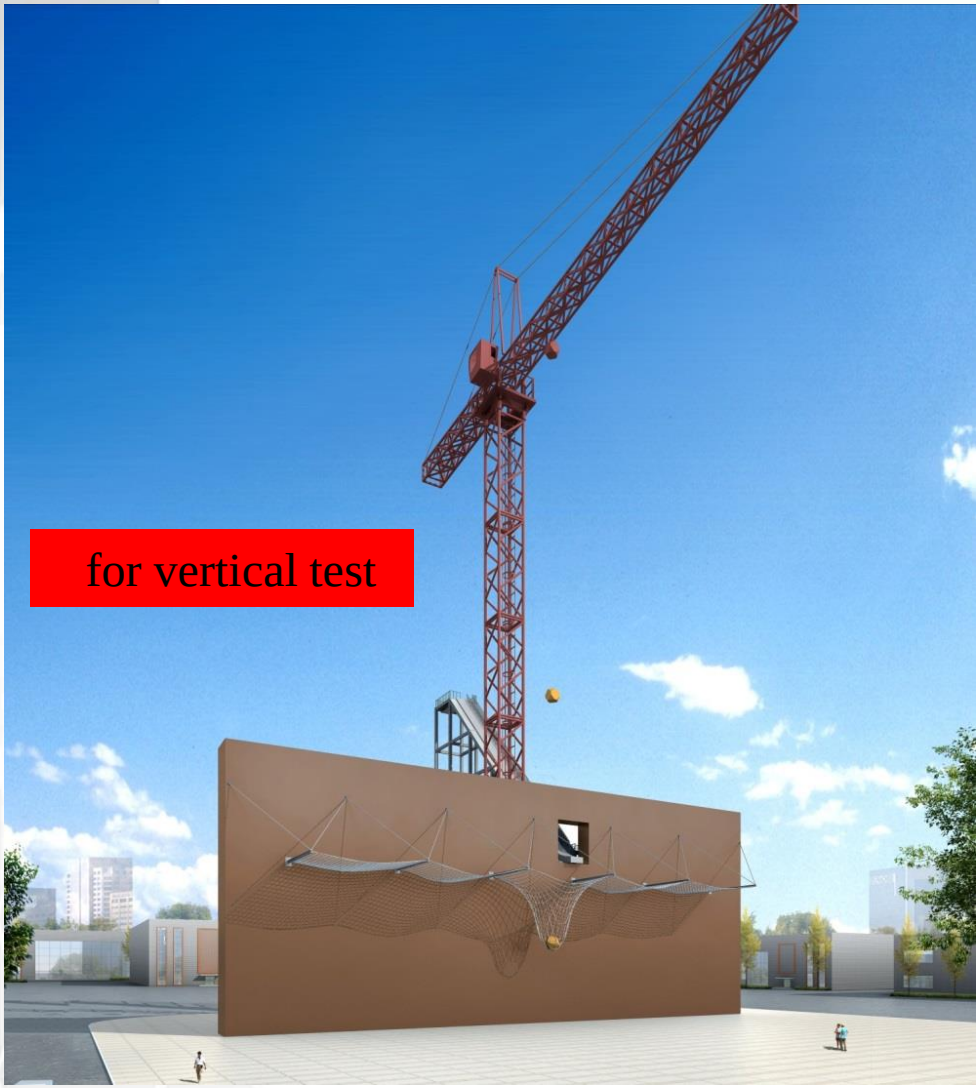
The advantages of field rockfall test :

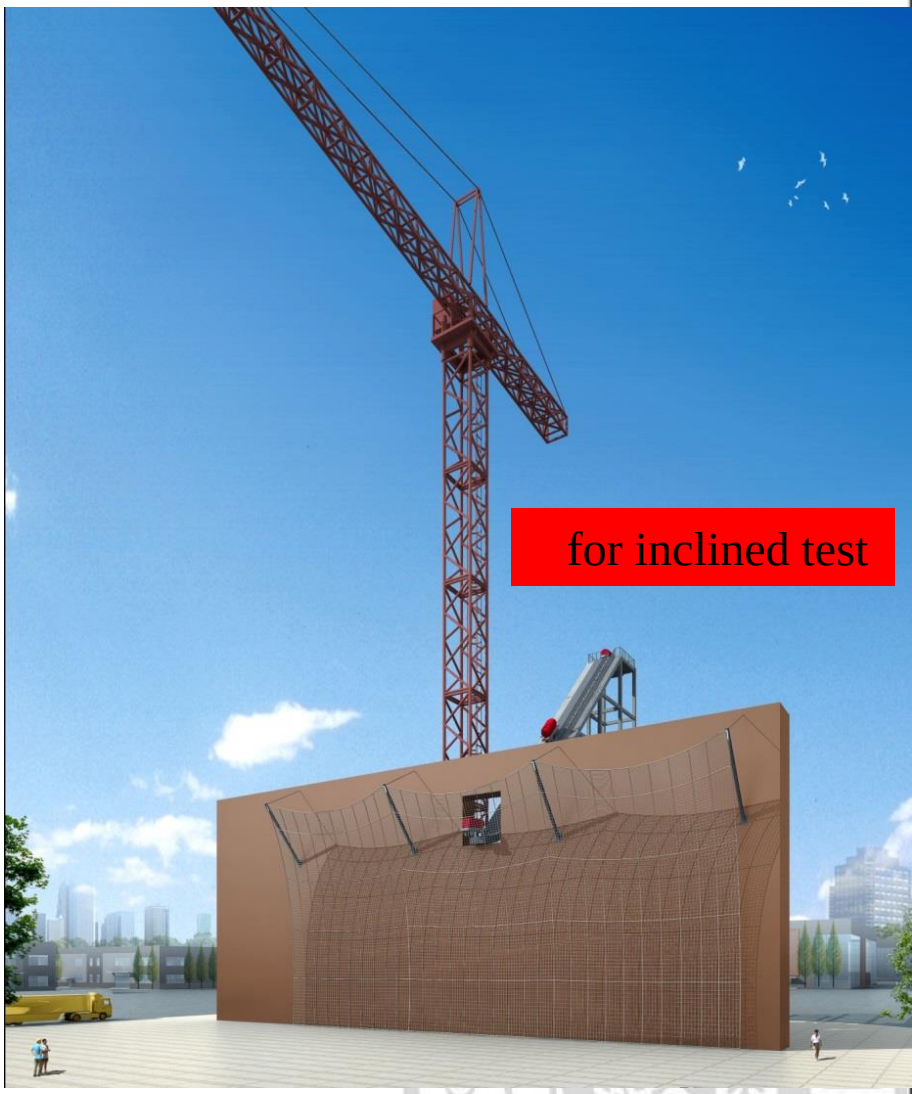
1. site conditions (such as slopes and cliffs)
2. lower construction cost.

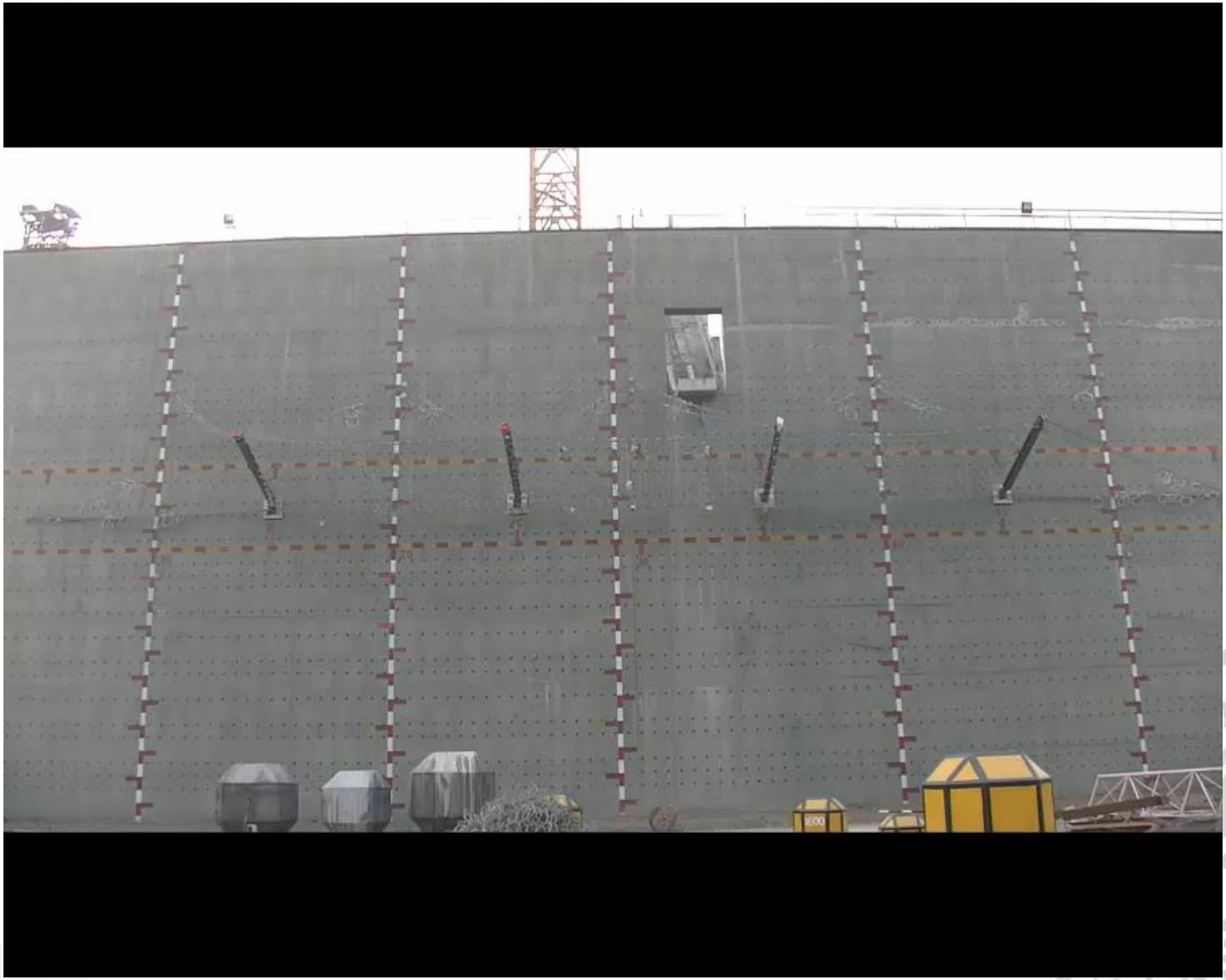
The disadvantages of field rockfall test :

1. the test site often locates in exurban or mountainous areas and is not easy to arrive.
2. the equipment maintenance and management would be difficult.
3. the ground condition limits the design and construction of test facilities and it's difficult to achieve the ideal condition.


crane
for inclined test
for vertical test
nets
reinforced concrete wall


for vertical test


for inclined test



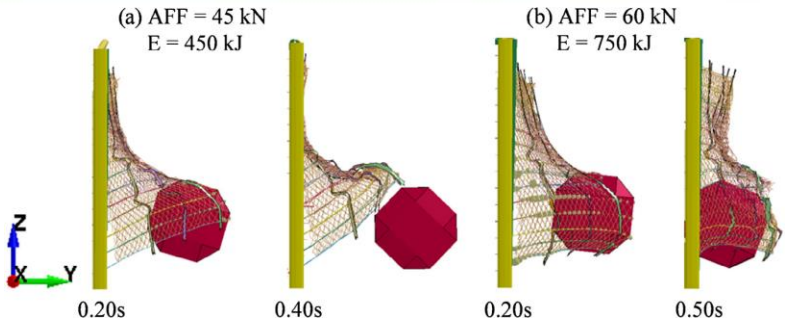
Debris Flow Barriers

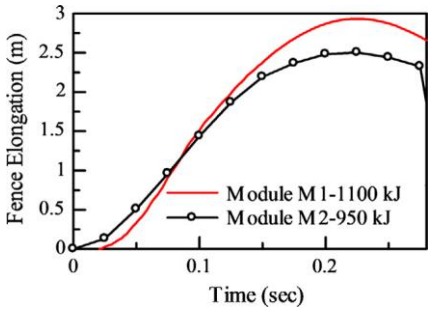
Debris flow event Aobandani, Japan 1998

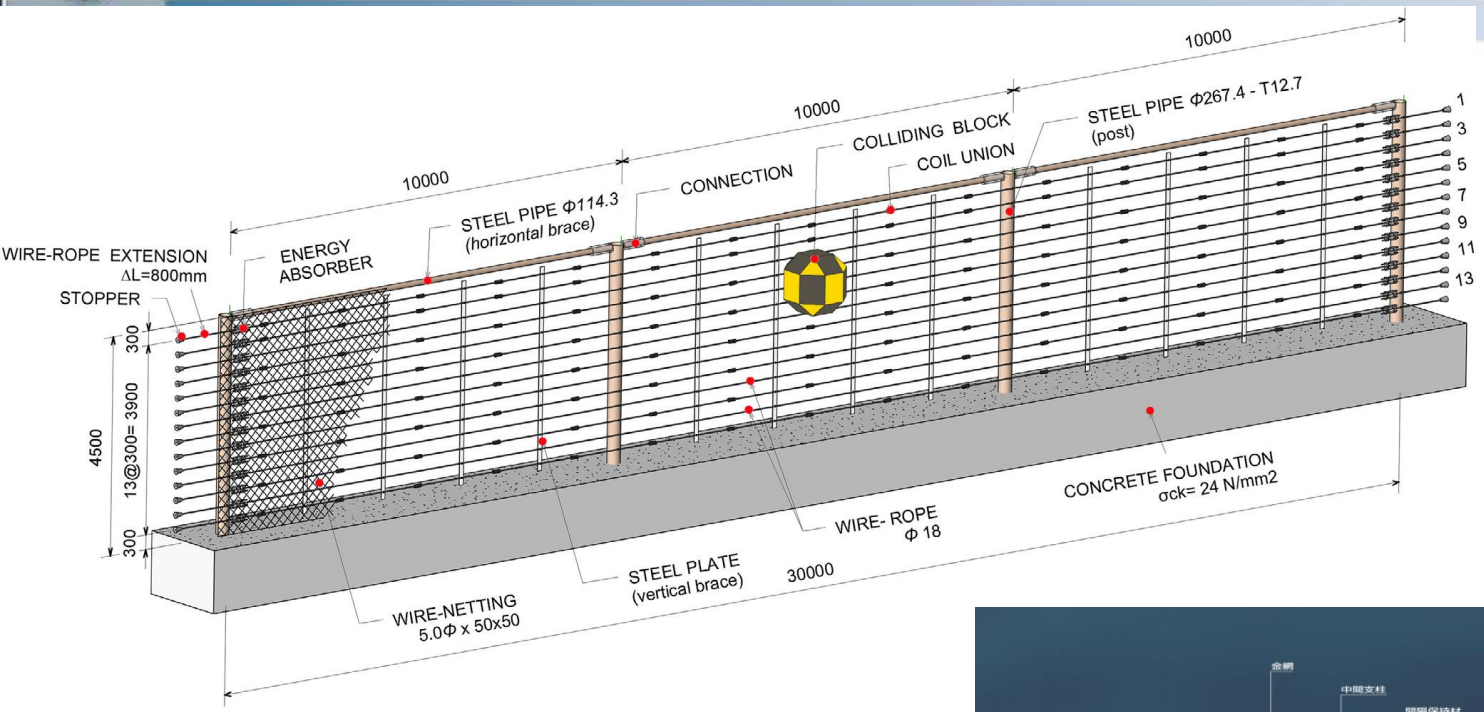
Debris flow event Seewalchen, Austria 2000

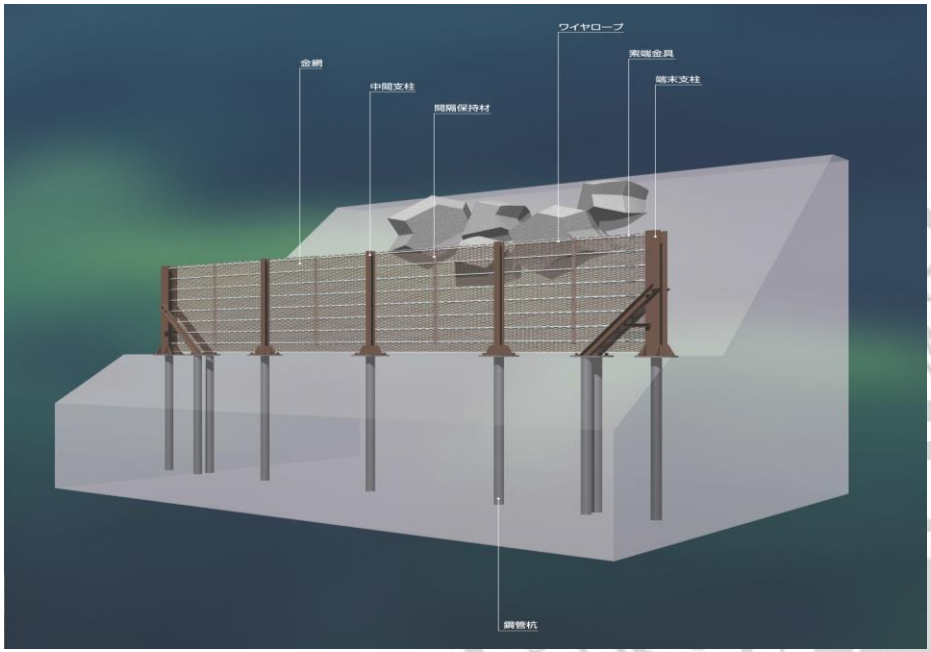
Snow Slide Event Hayato, Japan 2001

Wire-Rope Rockfall Protective Fence


(a) AFF = 45 kN
E = 450 kJ
(b) AFF = 60 kN
E = 750 kJ
Z
X
Y
0.20s
0.40s
0.20s
0.50s

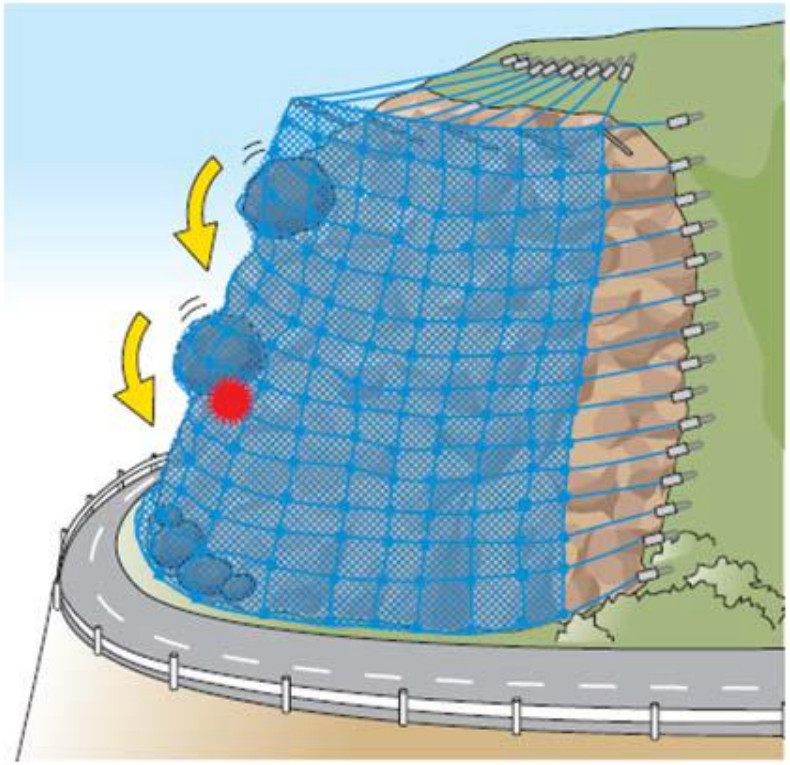

Fence Elongation (m)
Time (sec)
Module M1-1100 kJ
Module M2-950 kJ
0
0.5
1
1.5
2
2.5
3
0
0.1
0.2


10000
10000
10000
STEEL PIPE Φ267.4 - T12.7
(post)
COLLIDING BLOCK
COIL UNION
CONNECTION
STEEL PIPE Φ114.3
(horizontal brace)
ENERGY
ABSORBER
WIRE-ROPE EXTENSION
ΔL=800mm
STOPPER
1
3
5
7
9
11
13
300
13@300= 3900
300
4500
WIRE-NETTING
5.0Φ x 50x50
STEEL PLATE
(vertical brace)
30000
WIRE- ROPE
Φ 18
CONCRETE FOUNDATION
σck= 24 N/mm2


ワイヤロープ
金網
索端金具
中間支柱
端末支柱
間隔保持材
鋼管杭

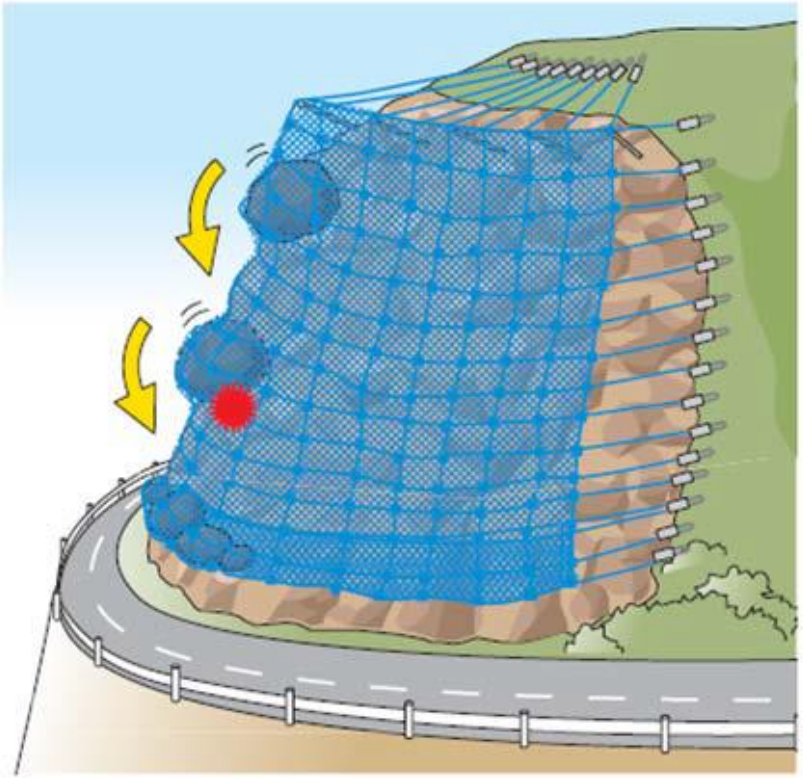
ポケット式RCネット工法 【岩塊が落下した場合】

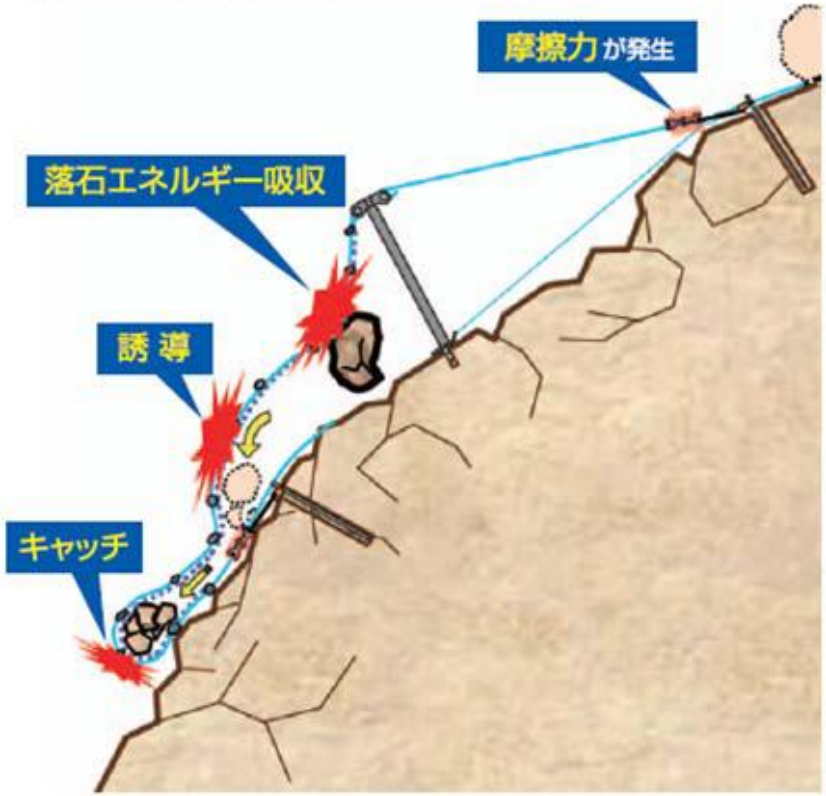
- 岩塊が斜面から剥離し落下すると想定します。
- 落下しRCネットに衝突した岩塊は、端緩衝金具とワイヤロープとの摩擦により落石エネルギーを吸収されます。
- 更にRCネットと地山に挟まれながら下端部まで導かれます。



ポケットキャッチ式RCネット工法 【岩塊が落下した場合】

- 岩塊が斜面から剥離し落下すると想定します。
- 落下しRCネットに衝突した岩塊は、端緩衝金具とワイヤロープとの摩擦により落石エネルギーを吸収されます。
- 更にRCネットと地山に挟まれながら下端部まで導かれます。崩壊した岩塊の撤去も可能です。

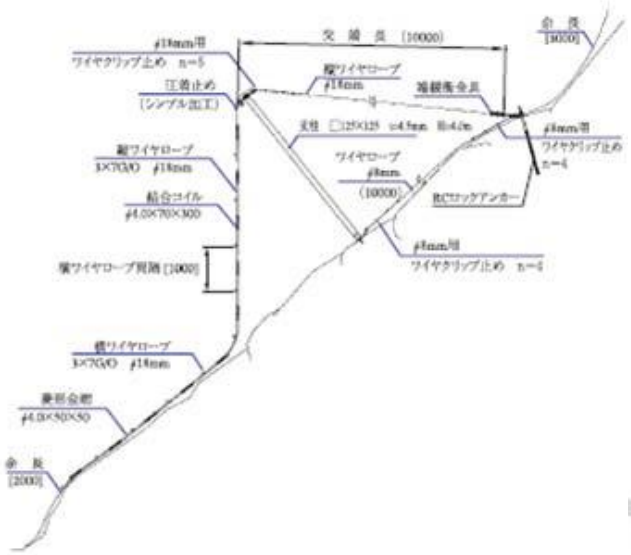




3-1（公）道路工事（防災）

発注者 岡山県備中県民局 高梁支局

横断図例



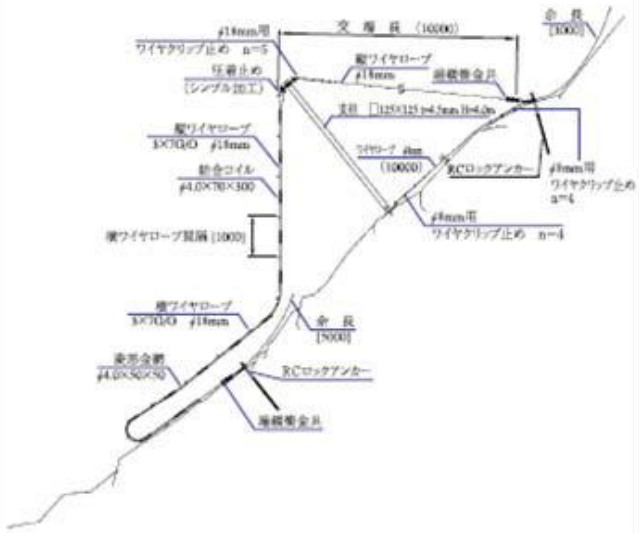
型　　式／ポケット式	
岩 塊 重 量／64.3kN	
落石エネルギー／2,530kJ	
面　　積／1,811㎡	

主要地方道佐渡一周線離島地域連携（県道防災）工事

発注者　新潟県佐渡地域振興局

ポケットキャッチ式RCネット工法

横断図例



型　　式	／ポケットキャッチ式
岩塊重量	／48.0kN
落石エネルギー	／1,795kJ
面　　積	／360㎡

THANKS