# Improved Gabion Design for River Bank Protection and Flood Control in Nepal

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2023.12.22
Kathmandu, Nepal

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# Outline of Presentation

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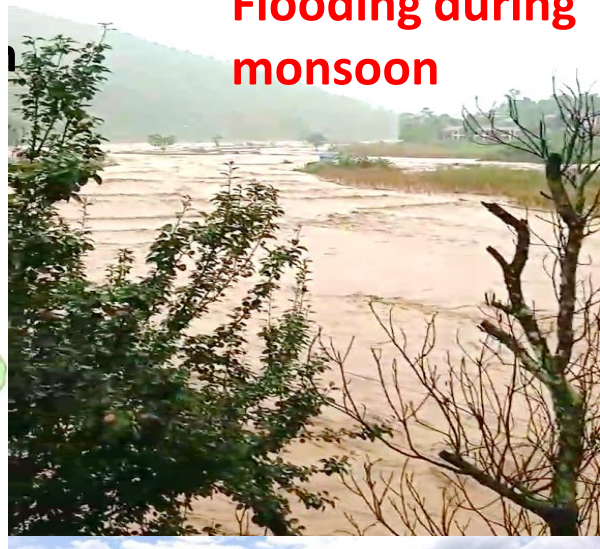
   - - Problems to address

2. Planning, Design and Construction Practices in Nepal and Japan

3. Gabion Design & Construction Methodology
   - - Site Geo-technical Situation
   - - Need of Japanese Methods
   - - Improved gabion design concept for Nepal
4. Result and Discussion

5. Conclusion

# Study Area Site Situation


- Paluntar, Gorkha, Nepal, Small Khar Khola river, Total 965 people, Total 215 HHs affected, agricultural lands, two bridges and roads.
- Few civil structures and embankments.
- The flow over topped bank and flooded. – infrastructures and Agri Land. Rain fall is 2,000 mm in the year of 2022.
- HFL 3m for 100 years, HFL 2m for 30 years for river width 18m.


# Problem to address

- The present problems in gabion of Nepal is less durable, damages fast and unstable. Few standard design and construction practices.
- No geotextile use, no foundation provided, only 100 cm height gabions, vertical type and lower slope type.
- The Khar Khola River is with few river embankments and heavy bank erosion and overflow.



# Gabion Design & Construction Practices

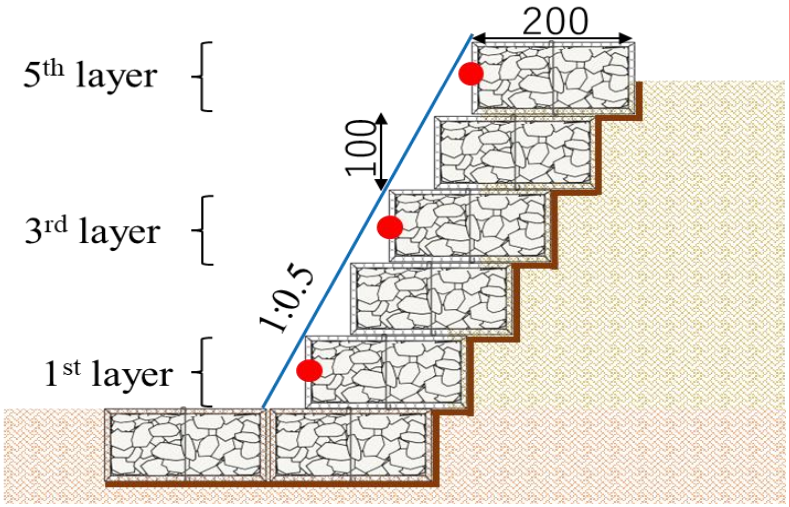
## Nepal


Gabion in Lohhore Khola, Dailekh by Public


Gabion in Chunkhu, Solu by local Gov


Sainamaina, Rupendehi by DWRI

## Japan




Typical Gabion design using in Japan

Gabion in Okudakhawa Kochi Japan

# Planning Design and Construction Practices of gabion in Japan & Nepal

| Parameters | Japan | Nepal |
|---|---|---|
| **Design and Planning** | Stringent standard Planning and Design procedures | Local practices dominant design |
| **Consideration of design parameters** | Hydrological, seismic, environmental & geo-technical Parameter. | Only Hydrological Parameters |
| **Geo-tech Topographic survey & RoW.** | Detailed geo-tech & topo survey and right of way for channel. | General topo survey considered. |
| **Construction process** | Rigorous construction process supervision of experts. | Follow the local practices |
| **Materials use** | High quality of construction materials; wire thickness, zinc coating, use of similar stone, geo-textile. Thickness- 2.64-16.00mm, H- 30 cm, 50cm, 100cm, Machine made. | Locally available materials, low quality of wire used 2.33-3.66mm, stone sizes varies, No geo-textile. H- 100 cm usual. |
| **Life span** | Durable up to 40-50 years | Durable up to 10 years |
| **Cost of construction** | Higher initial cost but overall life span cost is low. | Lower cost. |
| **Maintenance plan** | Clear maintenance plan | No plan |

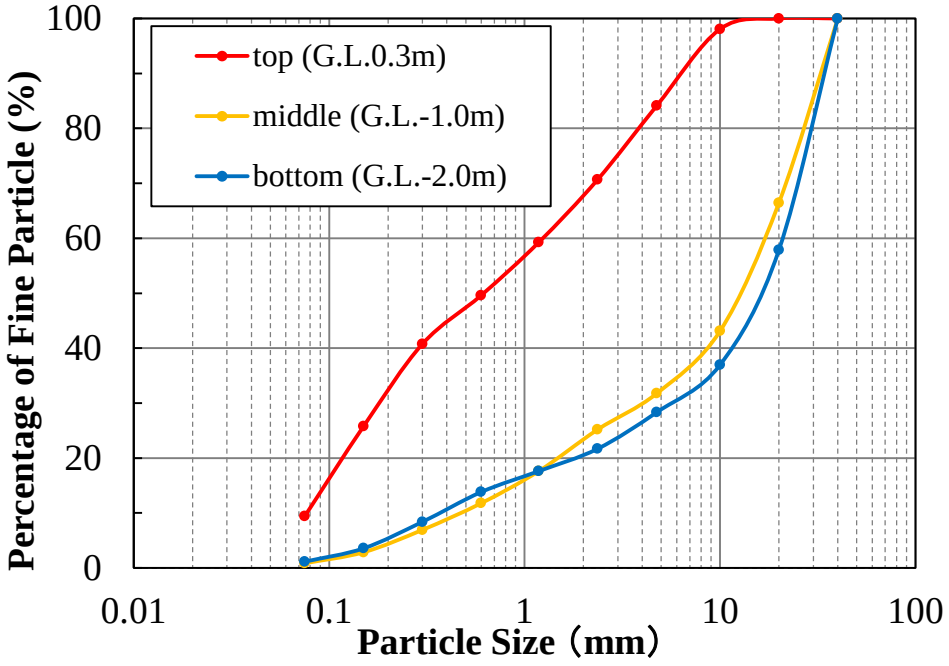
Gabion constructed Minaminotanigawa, Kochi, Japan

Gabion constructed at Sasaha Khola, Dhading, Nepal

Nepal prioritize cost-effectiveness and local materials, Japan emphasizes long-term resilience and stringent engineering standards.

# Gabion Design & Construction Methodology

# Site Geotechnical Condition





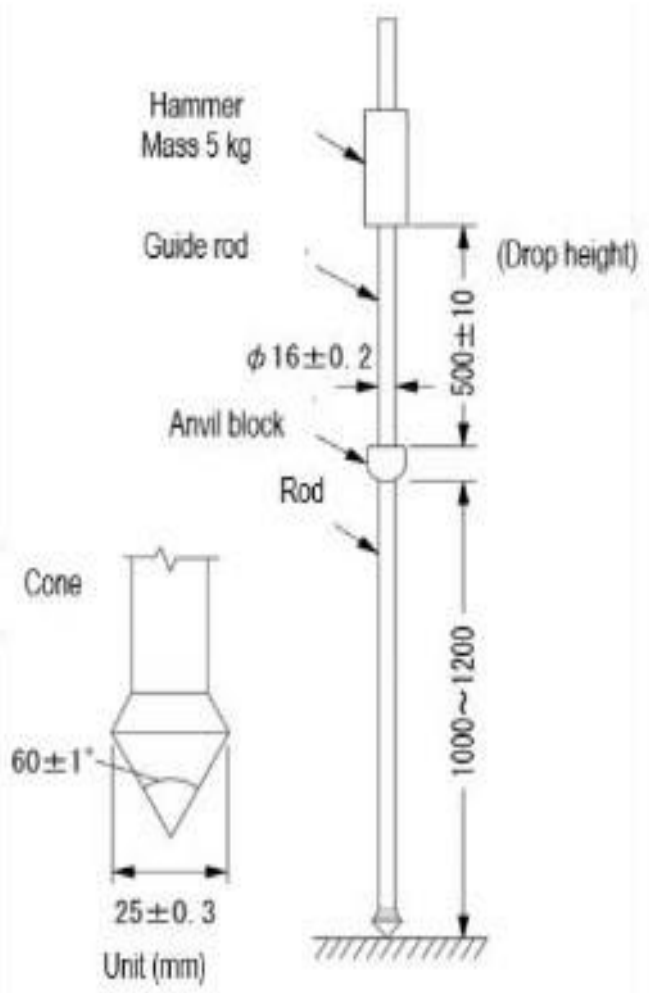
**Sample site location**

- Sample collected from site, sieve analysis.
- The top soil 9.4% of the fine particle, middle and bottom layer about 1% of fine particle.
- As per grain size, foundation soil is with about 80% gravel.

# Portable Dynamic Cone Penetration (PDCP ) Test

- Assess soil density, load-bearing capacity and shear strength
- Unit in Number of blow Nd
- Nd values 10cm erection of each.

PDCP Test in field




PDCP Equipment

# Site Geotechnical Condition

- PDCP test in the site.
- On the top layer (1.2m) the Nd< 10, hence softer soil.
- Depth below the middle layer (1.20m) Nd > 20 for both locations. Hence harder soil in middle and bottom layer.

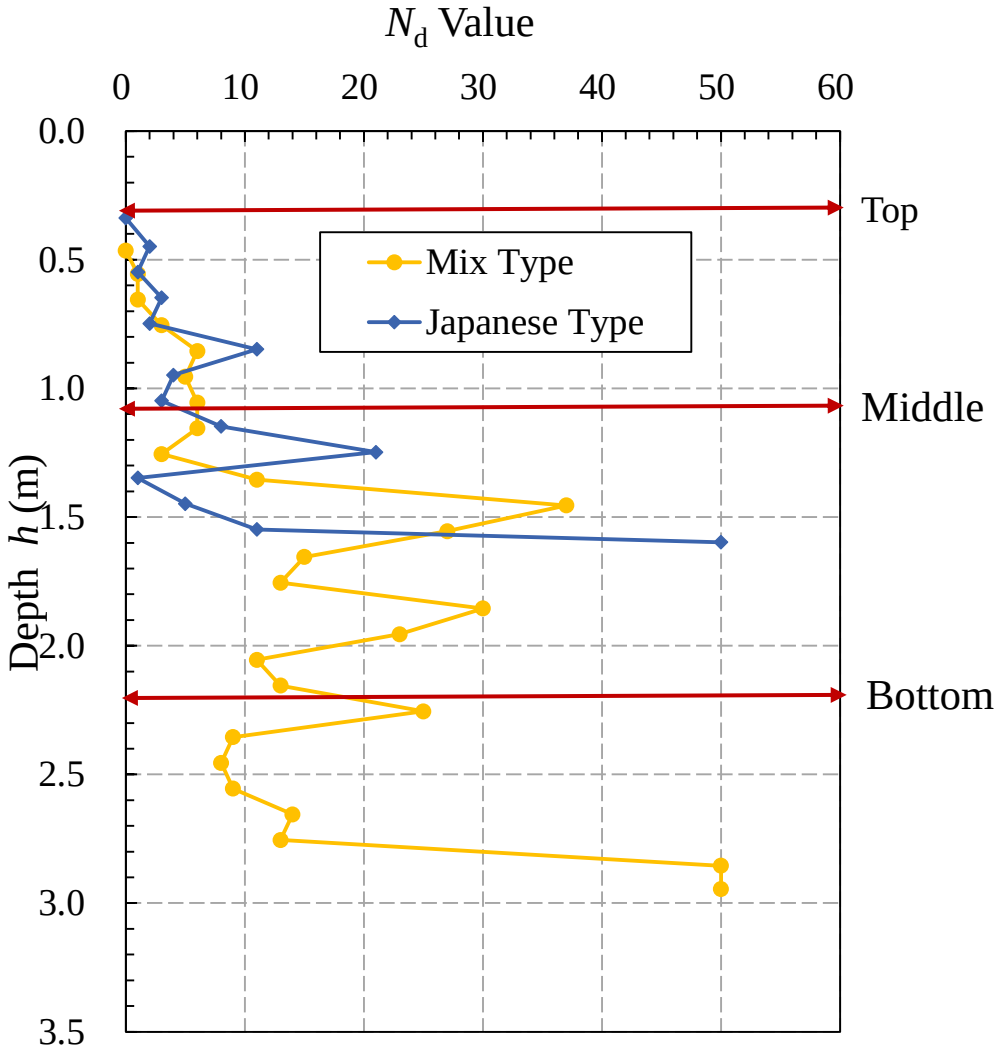



**Figure ：PDCP Test Result at Site**

*No treatment need for foundation soil*

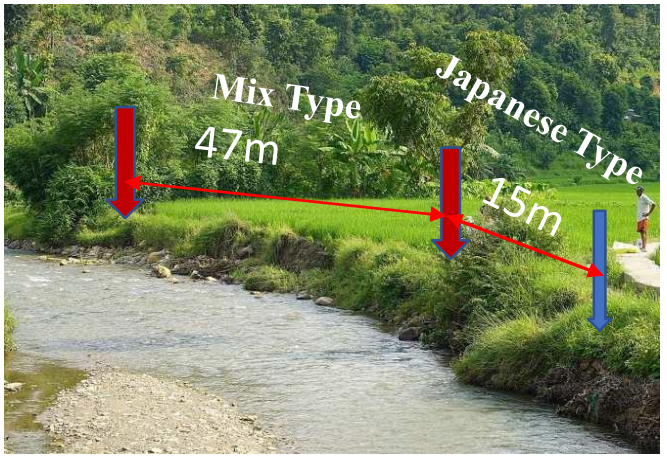
# Improved Gabion Design Concept

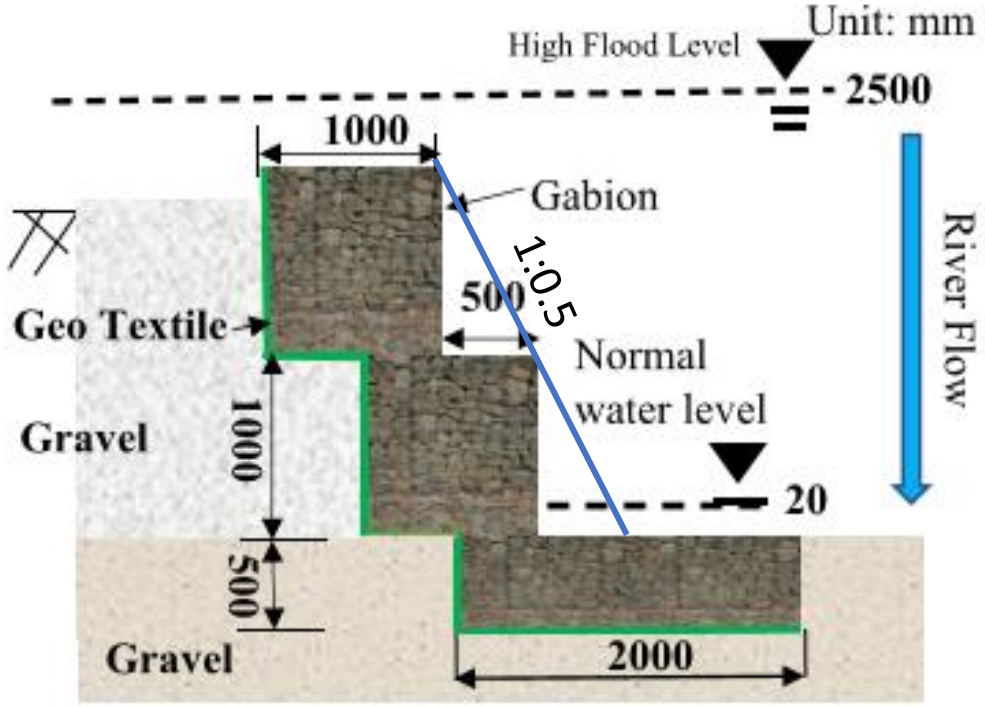
# Why Japanese Methods

- Long term resilient and stringent design and standard construction practices.
- Follow the Gabion Technical standard accredited by Government of JAPAN, JIS.
- Consider Seismic, Geo-technical, Environmental and Hydrological situation of the site.
- Good quality of construction materials.
- Long life span because of stability.
- Proper maintenance plan.
- Higher Initial cost but overall payback cost is low.

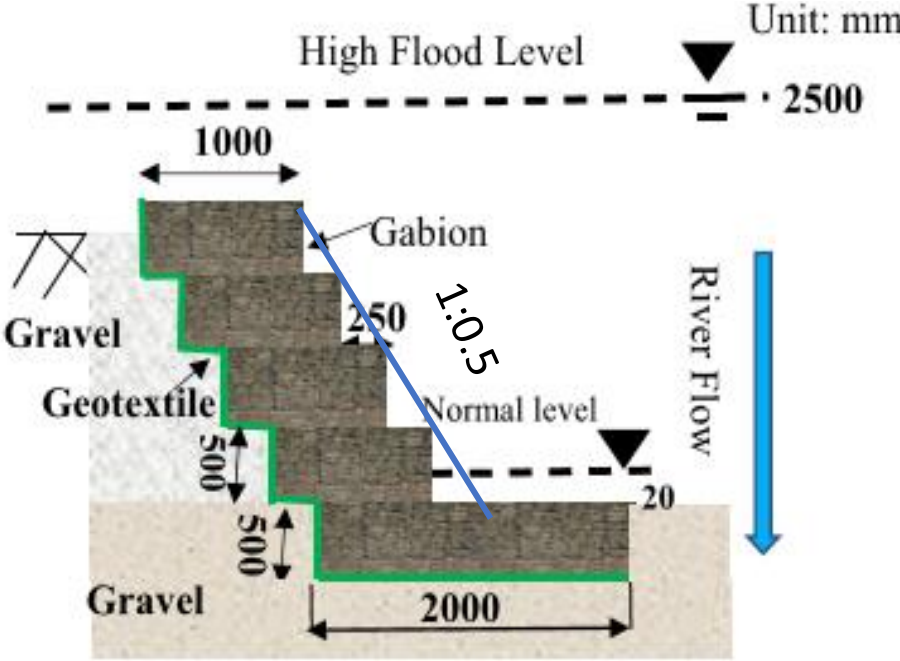
# Improved Gabion Design Concept

Site Selection → Finalization of design




**Japanese & Nepalese Mix Type Design**




**Japanese Type Design**

# Construction Process

1

Side wall cutting and foundation leveling

2

Foundation Layer laying

3

Foundation layer after construction

4

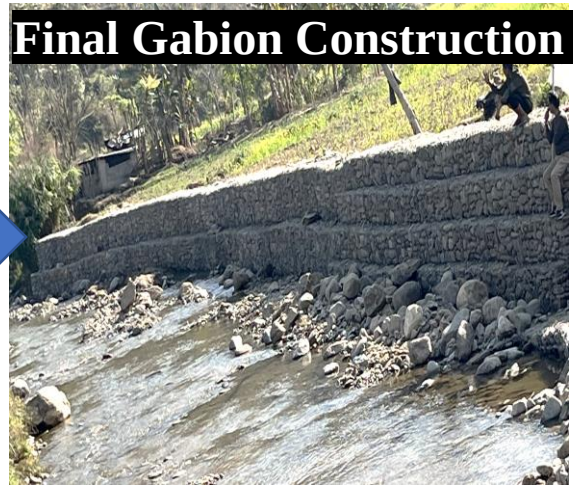
Geo-textile in the back

5

Laying layers one above another

6

Final Gabion Construction



# Result and discussion

# Adaptation of Japanese gabion practices in improved design

**Rigorous Engineering standard:**

- Detailed topo survey
- Soil Geo-technical Analysis
- Hydrological Analysis
- Series of discussion for finalization of design to adopt at local level.
- Follow available Engineering standard of Nepal

**Construction Materials:**

- Wire mesh quality- available wire mesh in Nepal Market, 3.66mm thickness.
- Stone sizes- Ø=20-25cm stone, more uniform, available in local area.

**Construction Process:**

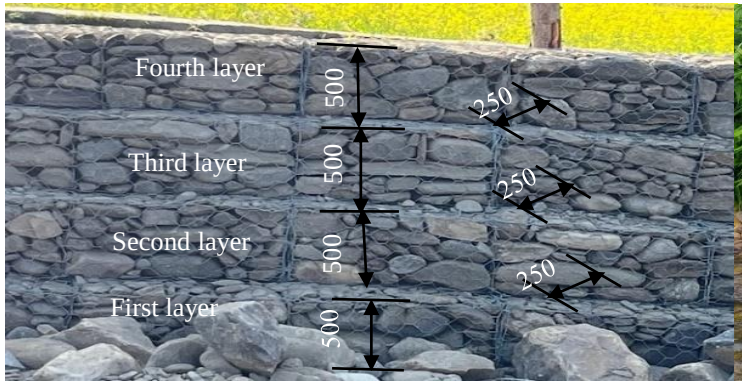
- Regular supervision by engineers
- Proper sizing and Placement
- Partial use of Machine for construction
- Follow the construction and safety guideline

**Maintenance Plan**

# Comparison between two types

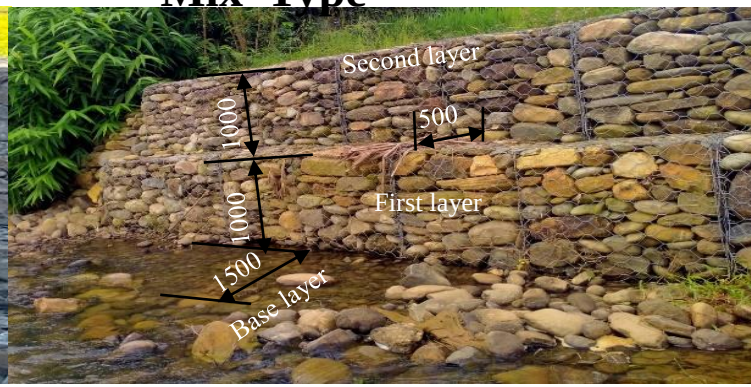
## Japanese Type

Unit: mm




## Nepalese & Japanese Mix Type

Unit: mm




| Parameters | Japanese Type | Mix Type |
|---|---|---|
| Planning and Design | New Standard Plan and Design | New Standard Plan and design |
| Construction Materials | Most of locally available Materials expect wire mesh. Partial machine for construction. | Locally available Materials. Partial Use of machine for construction. |
| Parameter of construction | Height, 50cm and front lap is 25cm. | Height,100cm and front lap ,50cm. |
| Use of Geo-textile | Uses Geo-textile | Uses Geo-textile. |
| Easiness | Need training for construction | No training needed |
| Stability | More stable than Mix type | Less stable than Japanese type |
| Cost of Construction | Costlier than mix type | Less costly then Japanese Type |
| Maintenance Plan | Clear Maintenance plan | Maintenance plan by community |

# Stability analysis gabion Revetment

## Field Level

- Monitoring of Horizontal and Vertical Deformation
- Regular Flow measurement

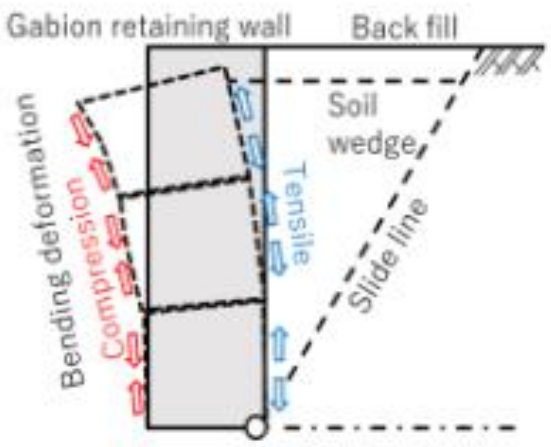
## Laboratory Experiment

- Consideration of Back Water Effect and Front Water Effect on gabions, with geo-textile and without geo-textile gabion, lunching apron without lunching apron and vertical and slope type gabions.

- Nepali style; Japane
- se style and Mix style.

**Stability Analysis**

small deformation 3cm mix type 37.5 meter section.




**Schematic diagram of gabion based retaining wall deformation**


**Horizontal deformation of gabion wall**

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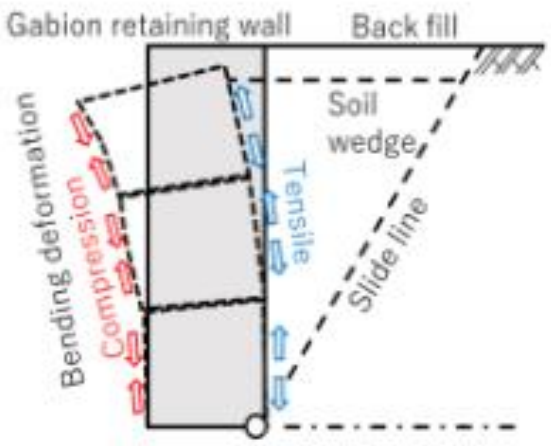


**Schematic diagram of gabion based retaining wall deformation**


**Horizontal deformation of gabion wall**

# Conclusion

- Overall, gabion technology is a cost effective and environmentally friendly solution for flood control and erosion control and widely used in many parts of Nepal and other developing countries.
- The improved gabion technology seen to be the most effective, economic, durable and adaptable for Nepal and similar context.

The further study will analyze the best possible gabion design, construction methodological options suitable for Nepal and similar context.

# Thank you for the attention

# Questions