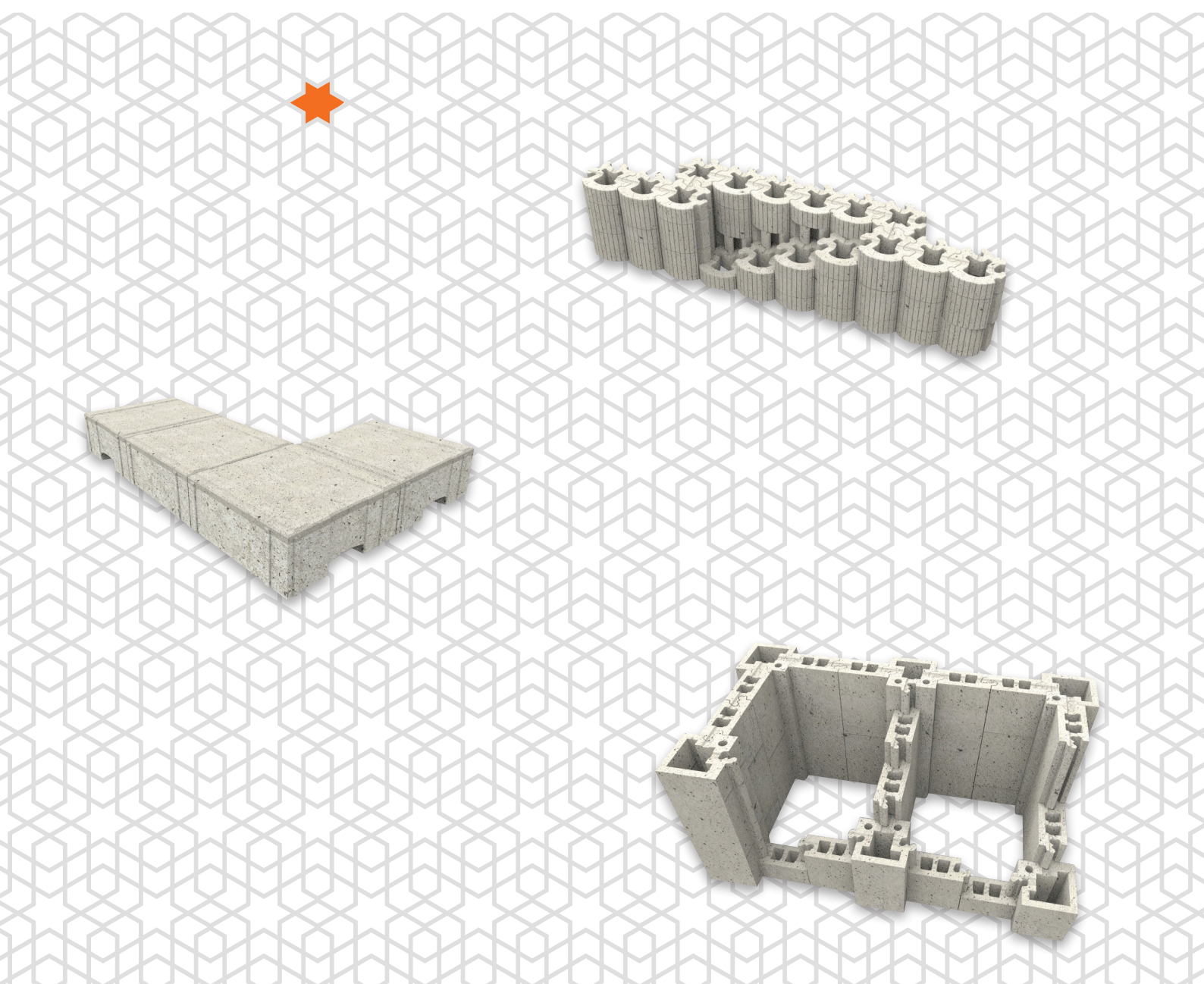


# Natural Disaster Recovery and Prevention System



## Sustainable water cycle in Urban areas



# Countermeasures against natural Disaster Caused by Climate Change

## The biggest crisis in mankind in the 21<sup>st</sup> Century

Recently, climate change is causing floods, landslides, typhoons, droughts one after another around the world and the damage is so enormous that it has a significant effect on the nation's economy. Moreover, the frequency of occurrence is continuously increasing and casualties and damages of property are being highlighted as severe problems. Thus, a proactive countermeasure is required.



- 1 Loss of embankment caused by flood and its recovery
- 2 Prevention and recovery of landslide
- 3 Urban flooding issue by torrential rain
- 4 Loss of coastal sand dunes caused by coastal erosion

## 3D interlocking Retaining Wall Block

### Current status of existing technology

- Mankind is faced with the dangers of natural disaster such as landslide, flood, earthquake and others due to climate change
- Limitation of prevailing technology: Riverside or hillside embankment susceptible to collapse due to the weak binding force between the blocks

### Solution of this technology

- All the blocks are connected as one uni-body like structure through three-dimensional binding mechanism which fundamentally prevents the cause of collapse



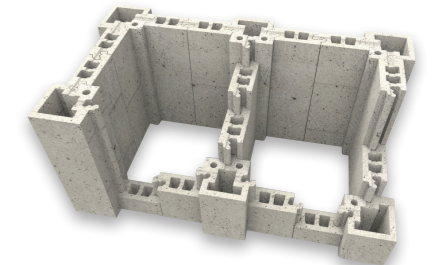
## Assembly-type of Block for Construction

### Current status of existing technology

- Damages such as collapse of buildings due to earthquakes and floods → A lot of casualties and property damage
- Can only be structured by a person equipped with technology, requires a lot of construction cost and time

### Solution of this technology

- Buildings are constructed easily through binding of blocks  
Doesn't require mortar and the public can construct their own houses easily and quickly
- Earthquake-resistant design



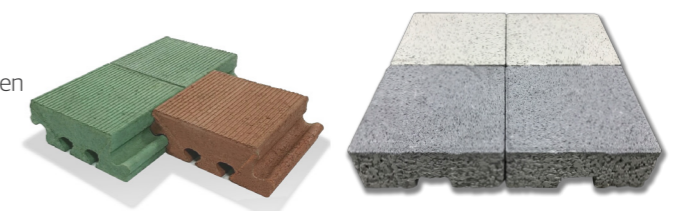
## Water permeable Hole Block with Gaps

### Current status of existing technology

- Typical water permeable blocks in the market lose its water permeability within 6 months due to clogged pores.

### Solution of this technology

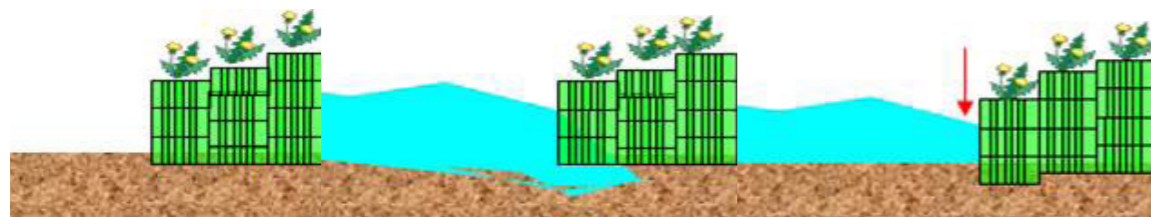
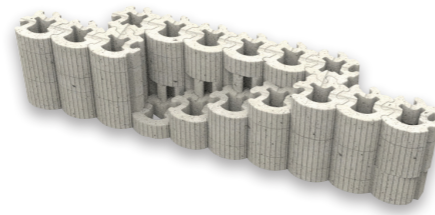
- Water permeable hole block with gaps applied for new concept of technology equipped with exceptional permeable sustainability for the water circulation of the city.
- Long-term water permeable sustainability through the gaps between the blocks and the hollow space at the bottom of the block



# 3D Interlocking Retaining Wall Block

## 3D interlocking retaining wall block to prevent natural disasters such as landslides and floods

- All blocks are strongly interconnected to each other acting as one whole structure, securing safety in any circumstances  
All blocks are interconnected and cross-linked to each other using half size and full size blocks forming a uni-body like structure without the use of any mortar.
- Stability can be secured as blocks can slide down individually even if the foundation collapses or in case of differential settlement of foundation.



### Product image



Finishing full size block



Standard full size block



Curved full size block



Finishing half size block



Standard half size block

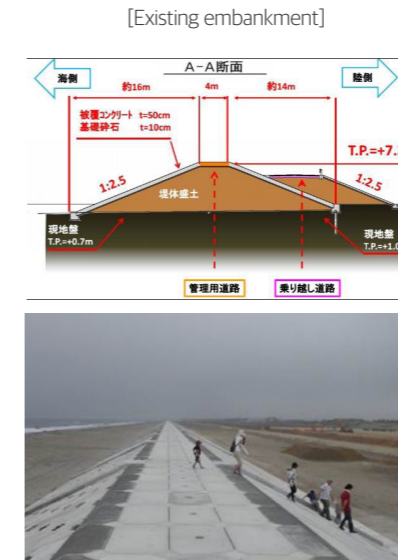


Curved half size block

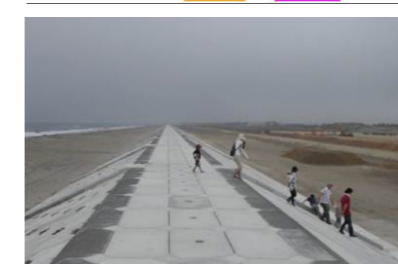
### Product specification

		(Finishing, Standard, Curved type) Specification	Weight(kg)
Small size	Full size block	250 × 250 × 200	13
	Half size block	250 × 250 × 100	6.5
Medium size	Full size block	550 × 550 × 400	130
	Half size block	550 × 550 × 200	65

## Innovative, economical, safe and environmental friendly technology compared to the existing engineering construction method



[embankment applied with new technology]



Required length of area is reduced from 45 meter to 5 meter.  
Construction period is reduced by below 1/5 of conventional method  
Project cost is reduced by below 1/10 of conventional method  
Desolate landscape/environmental aspects → As plants can grow through hollow space of block, finished construction view provides a beautiful scenery and blends with its surrounding environment

## The Installation is very fast and it can be applied in areas where the existing engineering technique cannot be applied



Can be installed without foundation prepping work so that overall construction time can be reduced



It can be installed with human labor only in the areas inaccessible by equipment



Products above medium-size can be installed extremely quickly by using equipment



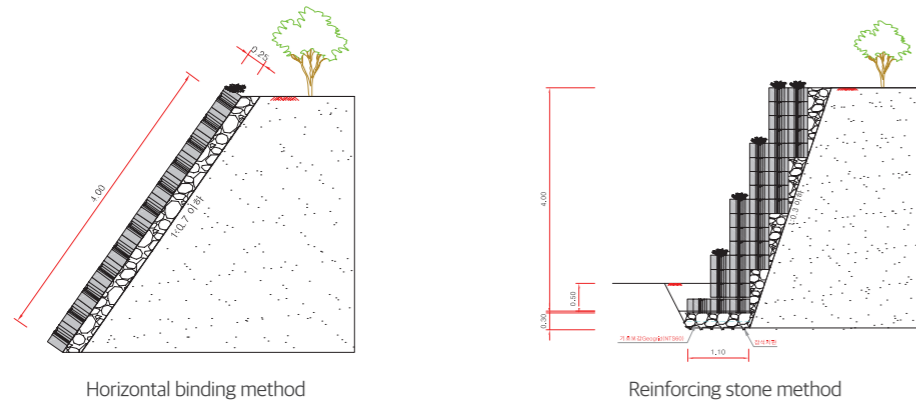
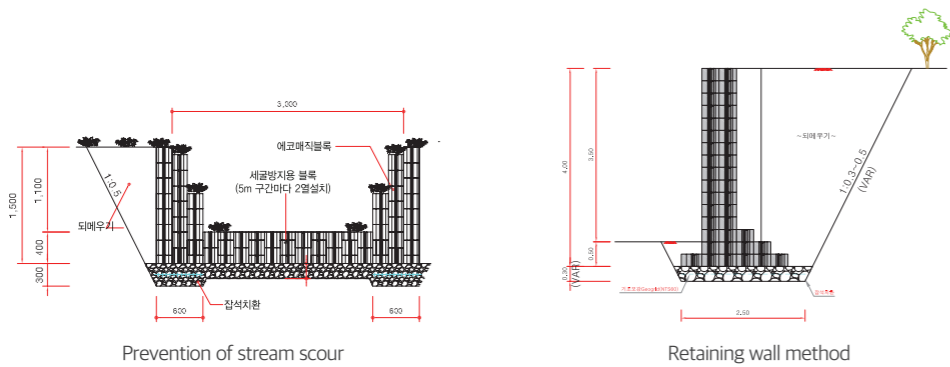
**Prevents coastal erosion, prevents sand loss**

The only engineering technique that can be applied to regions where foundation works cannot be feasible

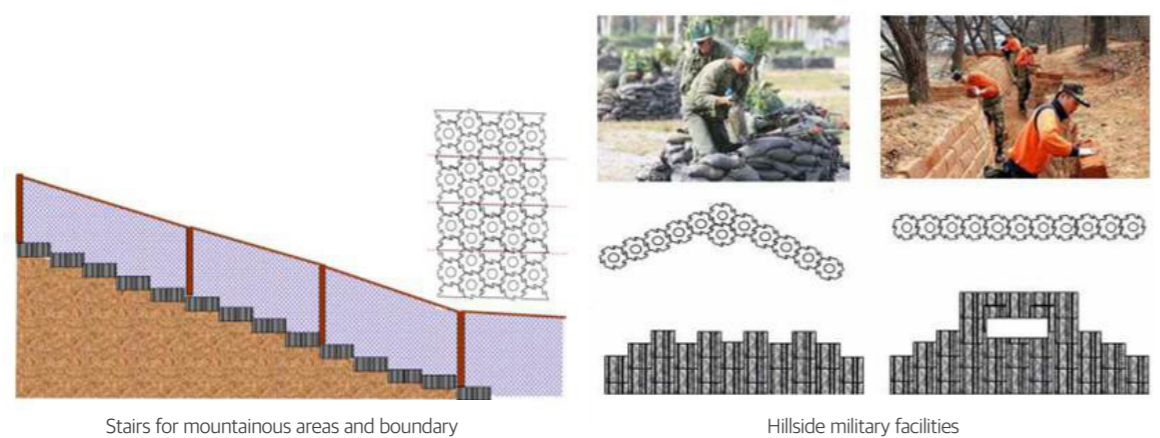
# 3D Interlocking Retaining Wall Block

## Section with retaining wall block

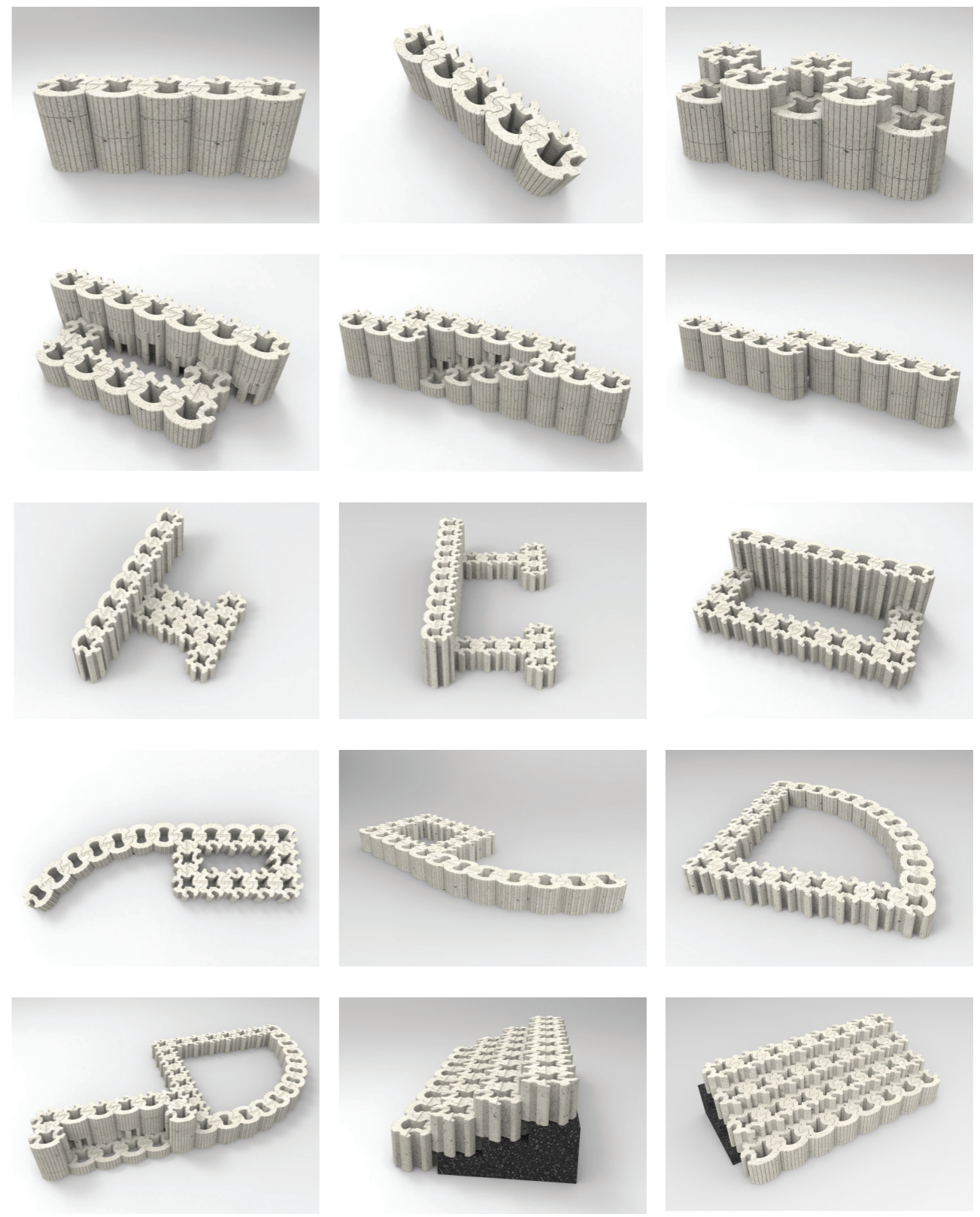
- Various cross sections can be materialized so it can be applied to various types of construction sites (stream, waterway, revetment, mountainous areas, embankment, coast and others)
- Can be installed in various types such as retaining wall method, reinforcing stone method, detachable method, and prevention of river scouring and others



## Stairs for mountainous areas and boundary establishment, hillside military facilities



## Various forms of assembly style can be applied per each application requirement



# 3D Interlocking Retaining Wall Block

## Case study of retaining wall block

### ■ Hill slope

- 1 Yangju City Gyeonggi-do
- 2 Yeongam-gun Jeollanam-do



- 3 Jangheung-gun Jeollanam-do
- 4 Jirisan National Park



- 5 Odaesan National Park
- 6 Boseong-gun Jeollanam-do



- 7 Miryang City Gyeongsangnam-do
- 8 Gwangyang City Jeollanam-do



- 9 Goheung-gun Jeollanam-do
- 10 Gwangyang City Jeollanam-do



### ■ Streamslope

- 11 Gurye-gun Jeollanam-do
- 12 Andong City Gyeongsangbuk-do



- 13 Paju City Gyeonggi-do
- 14 Busan City Gyeongsangnam-do



- 15 Gurye-gun Jeollanam-do
- 16 Yeongam-gun Jeollanam-do



### ■ Others (Prevention of coastal erosion etc.)

- 17 Pohang City Gyeongsangbuk-do
- 18 Suwon City Gyeonggi-do



- 19 Geoje City Gyeongsangnam-do
- 20 Cheonan City Chungcheongnam-do



## Assembly-type of Block for Construction

### Current status of existing block

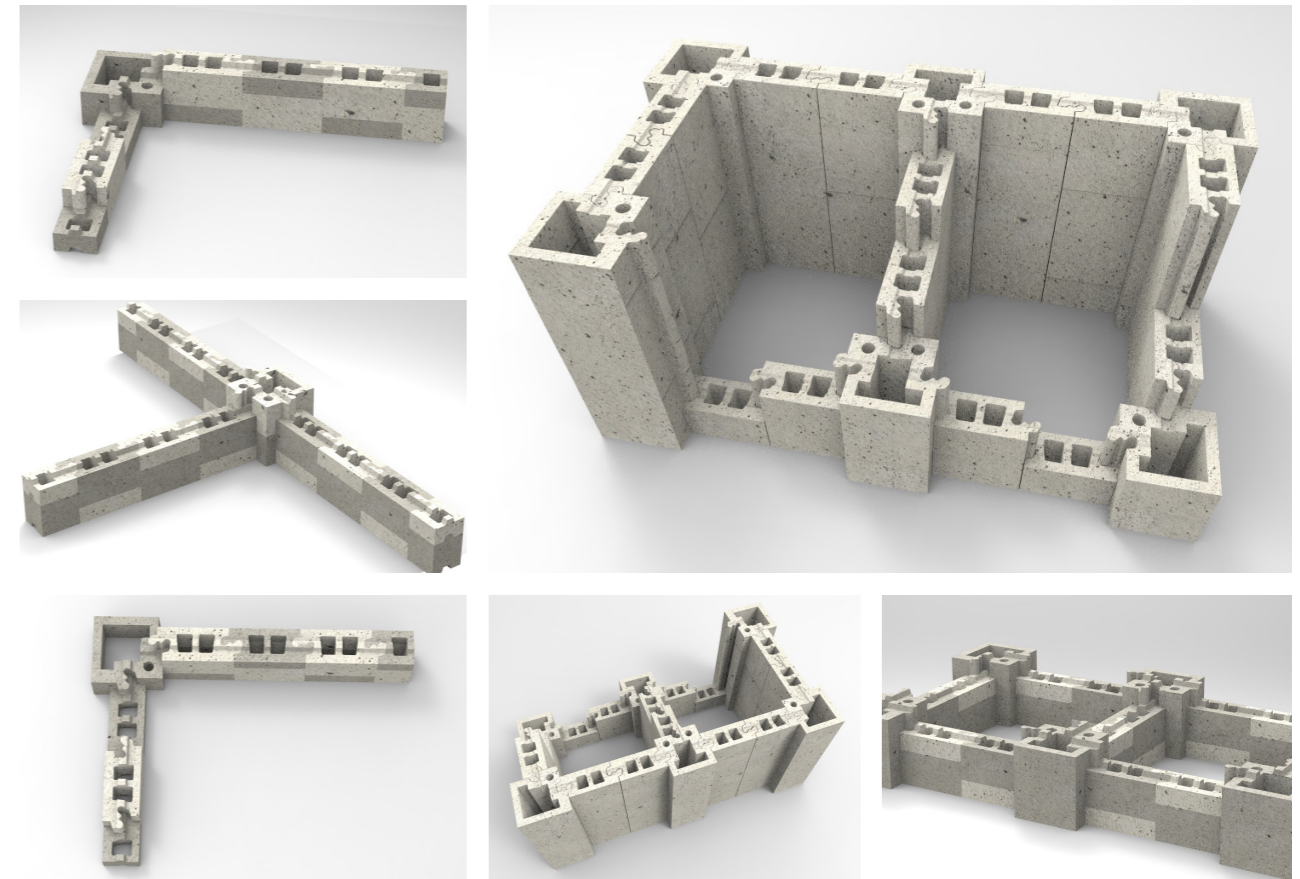
- Natural disasters such as earthquakes around the world causes damages such as collapse of building walls and others.
- Numerous events of damages on the outer walls of buildings other structures are being caused by natural disaster like earthquakes around world. For the conventional work, overall construction cost is high as it requires special engineers to be hired. As it involves curing the mortar used, adequate construction time needs to be planned in advance. However, the use of interlocking prefabricated construction blocks can save a lot of construction cost and time as it can be installed without engineers and does not require the use of mortar for block-block binding. It can be also widely used in many different applications as not only for the outer building wall use, but also for the inside of building.



### Examples of product applications



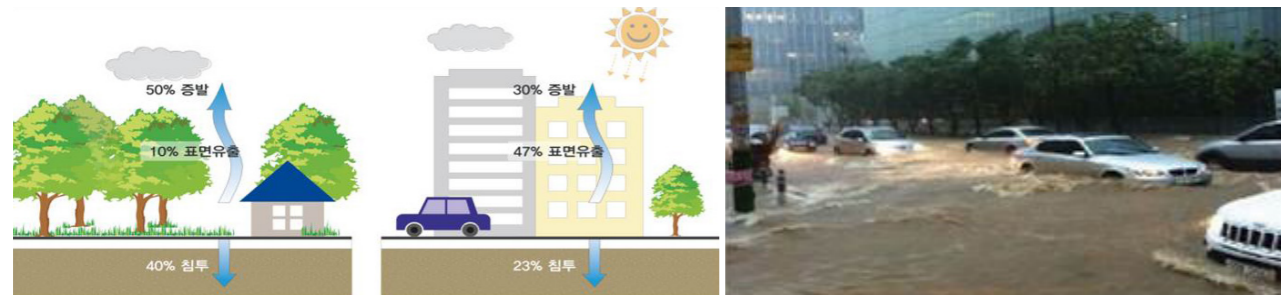
### Example of binding Cross-sectional image



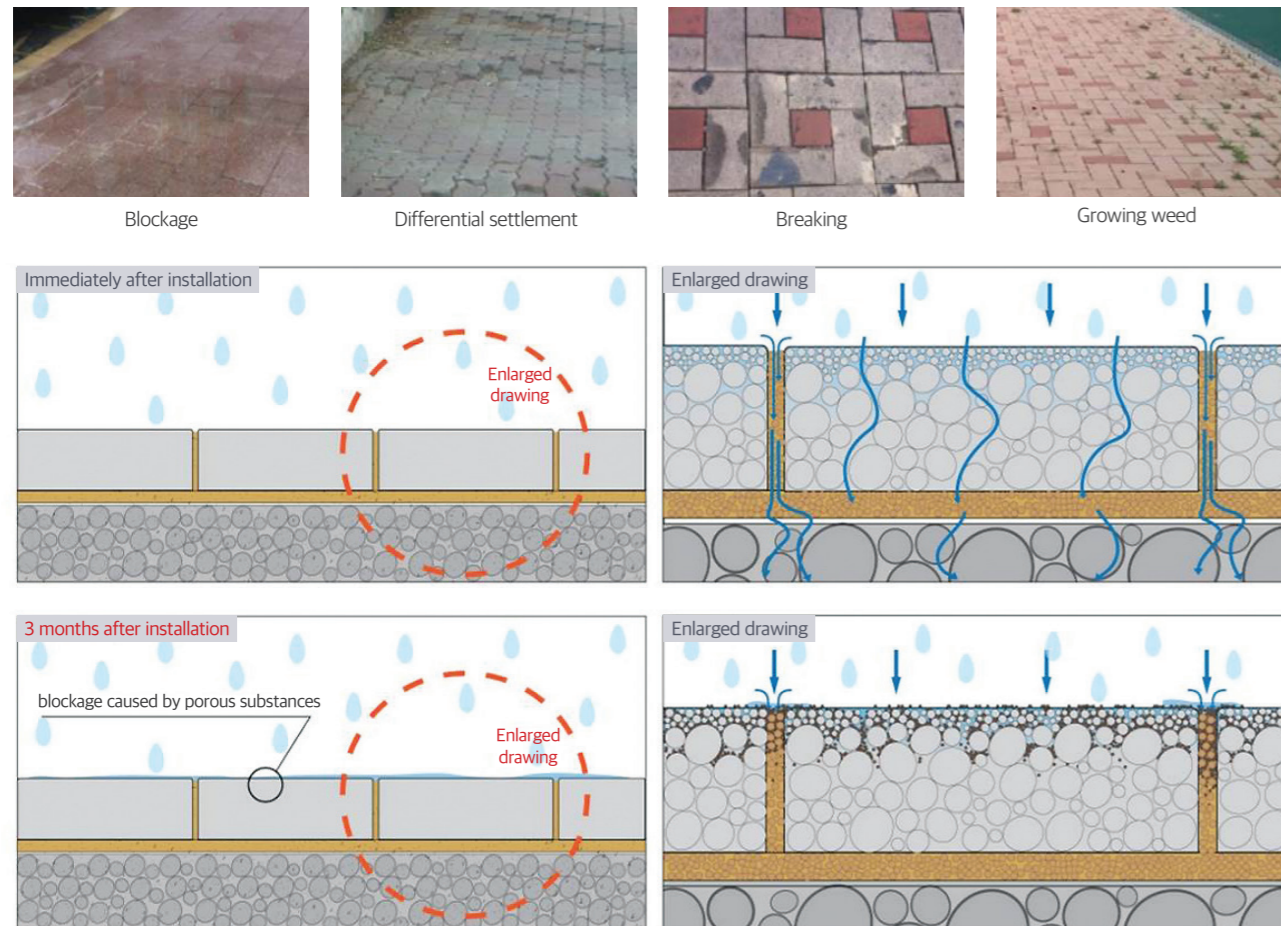
# Water Permeable Hole Block with Gaps

## Phenomenon caused by urban water circulation problem

- Submersion of lowlands
- Urban heat island phenomenon
- Tropical night phenomenon
- Decline of ground water
- Urban ecological breakdown
- Deterioration of water quality by non-point pollution



## Problems of existing blocks



Pores become clogged by foreign substances

## Case study of initiatives related to permeable block in Korea

- Ministry of Land, Infrastructure and Transport
  - Enforcement regulation of the “National Land Planning and Utilization Act”
  - It specifies that the pavement works of all facilities such as pedestrian road, bicycle road, parking lot, square, school, hospital and park should be in a **“structure in which rainwater can penetrate well”**.
- Ministry of Environment
  - Environmental Impact Assessment Method (guideline for applying LID)
  - Guideline on Biotops Area Ratio
    - When permeable blocks that do not cause blockage are used, 40% of the pavement area is acknowledged as green land
  - Guideline on non-point pollution control
- Ordinance of Seoul City, Daejeon City
  - Only products that have qualified the durability test of permeability performance can be used
  - After installation of permeable blocks, its sustainable permeability must be maintained and tested every 2 years

제33조(투수성능 지속성 확보) ① 시장은 빗물침투시설의 성능유지를 위한 투수성능 지속성 검증시험(이하 “검증시험”이라 한다)의 기준을 마련하고 기술개발을 위하여 노력하여야 한다.

② 시장구청장은 빗물침투시설을 설치하려는 경우 제1항에 의한 검증시험을 실시하는 공인기관으로부터 시험을 통과하거나 인증을 받은 시설 또는 이에 준하는 자격을 갖춘 제품을 우선적으로 설치하여야 한다.

③ 빗물침투시설의 성능유지를 위하여 구청장은 매 2년마다 현장 침투능시험을 시행하고 투수능력이 유지되도록 관리하여야 한다.

If the permeability falls below the standard (0.1mm/sec) value after at least 2 years from the installation of permeable block, the relevant local government has to be responsible

Case study of ordinance for Seoul City's rainwater management

**환경영향 평가 기준**  
2013. 7. 17

**도시개발의 환경영향평가시 LID기법 적용 매뉴얼**

나. 투수블럭

1) 시장개요

하중이 크지 않은 도로에 불투수성 포장 대신 빗물이 땅으로 침투될 수 있도록 투수성 블록을 설치하여 자연의 물순환 기능을 회복할 수 있도록 하는 방법

2) 설치시 고려 사항

① 반드시 투수능력이 지속적으로 유지되어야 하며, 이를 위해 투수성능의 지속성에 관한 시험성적서 등을 제시하여야 함

② 공단박원에 대한 유지관리 방안으로 잔류청소 등의 대안이 제시되고 있으나, 현실적인 적용의 한계가 있으므로 별도의 유지관리 없이도 일정 기간 동안 일정 기준 이상의 투수능력이 유지될 수 있어야 함

It must be a structure that doesn't become clogged and 2 years after construction, necessary measures may be taken if the permeability isn't maintained

The Ministry of Environment's guideline on the application of LID when assessing environmental impact

# Water Permeable Hole Block with Gaps

## Test method of verifying the sustainability of permeability performance

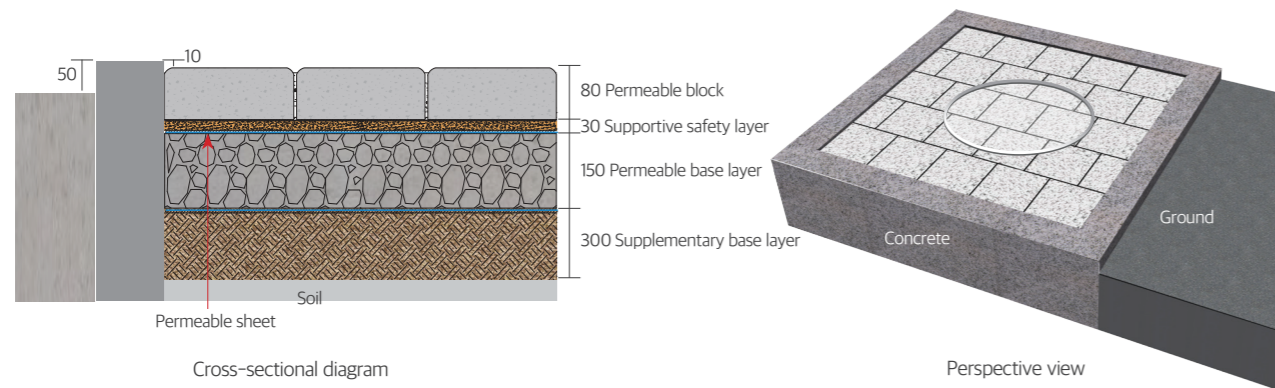
What is a verification test on the sustainability of permeability performance at site?

- Paving blocks that have received Grade 1 in the existing verification test of sustainability of permeability get clogged after 3~6 months so a verification test of sustainability of permeability performance at site is proposed
- After installing the blocks equivalent to the actual installation site according to the specification of permeable block, impurity is added (amount of impurity that has built up on the pavement surface over the past 5 years based on Seoul City standard) for the pollution simulation, the permeability is measured by using a test method for onsite permeability

Amount of impurity following sample types

Sample type	Rectangular sample		
	Block size	10cm x 20cm	20cm x 20cm
Weight of impurity (g)	12	24	55

Permeability test as per Site installation based on specification → Impurity inserted → Pollution, site infiltration etc.



## Grade of verification test on the sustainability of permeability performance at the site of water permeable hole block with gaps

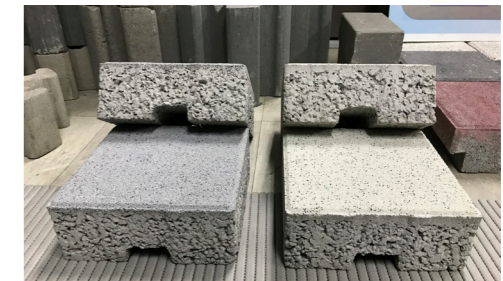
Item	Grade 1	Grade 2	Grade 3	Grade 4	No grade
permeability coefficient mm/sec	<b>1.0 above</b>	0.5 above 1.0 below	0.1 above 0.5 below	0.05 above 0.1below	0.05below

- After polluting simulation using perspective impurities of over 5 years, the measurement of permeability coefficient has to be above 1.0mm/sec to receive Grade 1.
- Currently, the permeability coefficient of permeable block stipulated in the K.S. (Korean Standard) regulation is more than 0.1mm/sec (KS F 4419: Concrete Interlocking Block for Side Walk and Road)

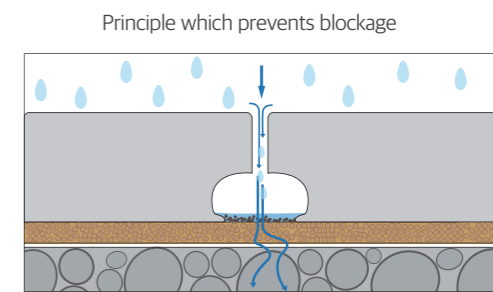
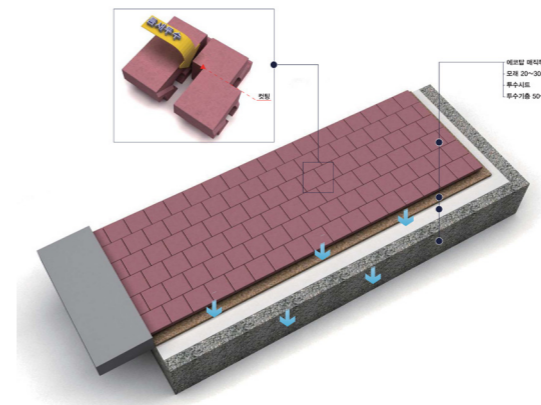
## Introduction of permeable block products



Permeability can continuously be maintained through the gaps between the blocks and the hollow space under the block



Consists of popular blocks focused on features and high-end permeable block with enhanced design



Differential Settlement	<b>Clearance pitcher Hall block</b>	<b>Existing porous permeable block</b>
Permeability (stagnant water)	<b>the block secures water storage space</b>	<b>aggregate foreign substance</b>



Water permeable hole block with gaps that contributes to the soil ecology

Report on the result of monitoring and analysis of test conducted on Seoul City's permeable road pavement (block) & report on Seoul City's 「Identifying test installation of environment-friendly permeable block pavement and improvements」 outsourcing



# Water Permeable Hole Block with Gaps

## Case study of permeable block installation

### ■ Square/park pavement



2014.04  
Jijeong Elementary School in Wonju City



2014.04  
Environment Office in Wonju City

### ■ Side walk and road pavement



2014.02  
Angang-eup Gyeongju City Gyeongsangbuk-do



2013.03  
Bundang-gu Seongnam City Gyeonggi-do



2014.04  
Culture Center at Suncheon City Jeollanam-do



2013.11  
Seokgwang Elementary School in Seoul City



2014.06  
Gwangyang City, Jeollanam-do



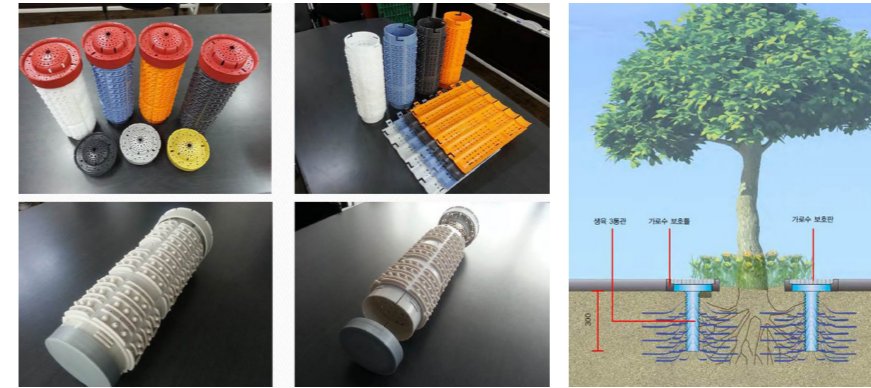
2015.05  
Yongin City Gyeonggi-do

## Patents registered in various countries for the retaining wall block / permeable block / block for construction



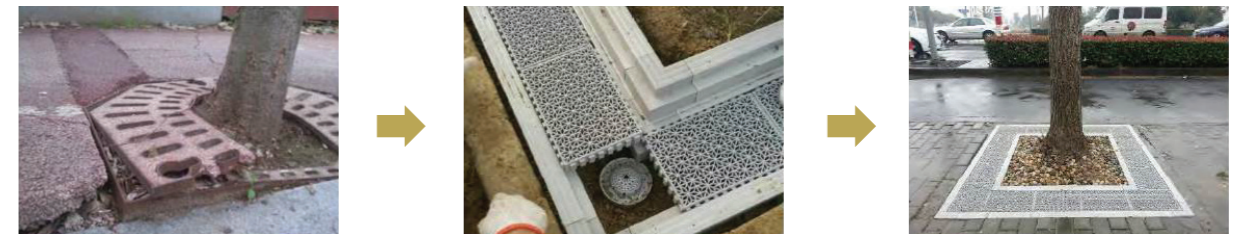
Overseas patent and design registration completed in USA, Japan, China, Brazil, India, Indonesia, Vietnam, Peru, Paraguay, Turkey, Europe, Thailand, Peru, Argentina

# 3-in-1 (water, nutrients, air) Tree Life Support System



Installed together with permeable pavement, this system enhances the penetration ability of rainwater while supplying water, nutrient and air to street trees and plants in the city

## Case study



Convenient nutrient supply



There is a big difference in the degree of growth and development after installation

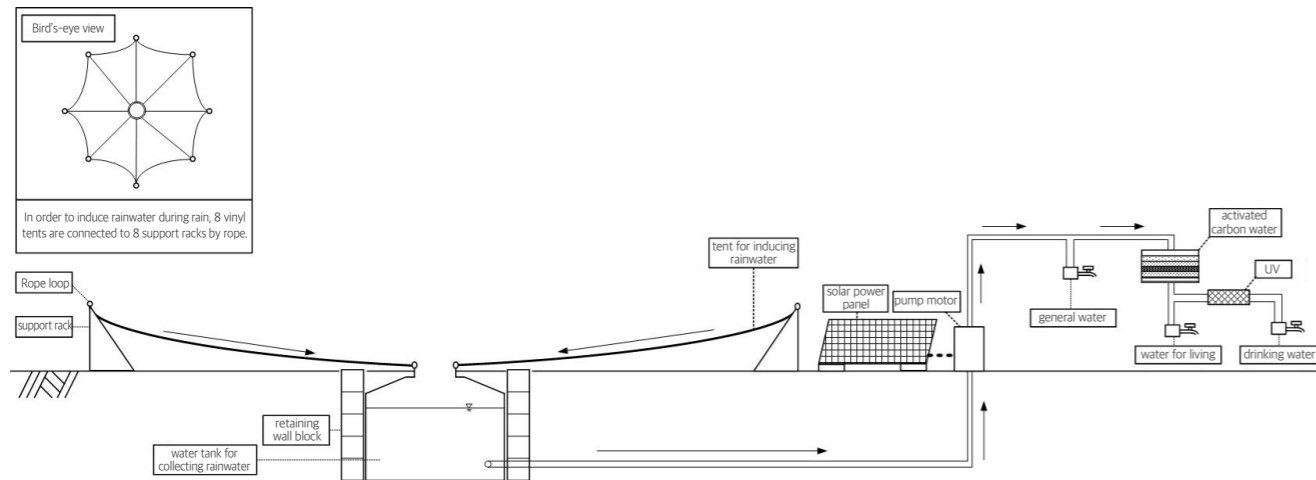


Watering the plants directly onto the flower bed wastes water but by watering the plants through rainwater inlet, water can easily be supplied

# System Using Rainwater

## Essential technology for solving the lack of water around the world

- Catchment surface is stored neatly and only opened during rainfall to collect clean rainwater
- Once the valve is opened by using solar power, motor operates automatically
- Can be used depending on the purpose such as general water, water for living, drinking water and others
- Usage amount for 1~5 household can be secured depending on the area of catchment surface and size of water tank
- Clean, economic and stably secures water resources

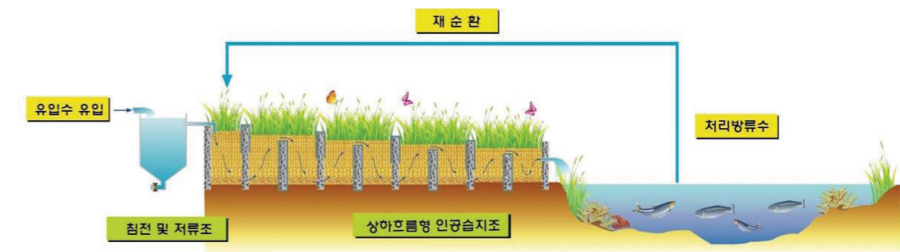
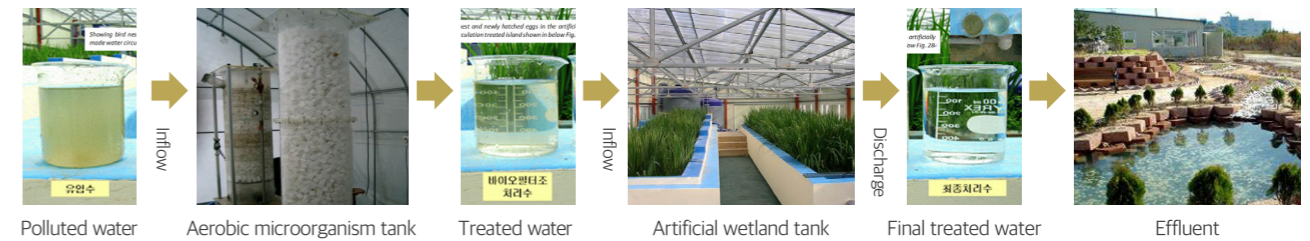


Collects rainwater to be used for various purposes such as flower bed and others

# Natural Purification System

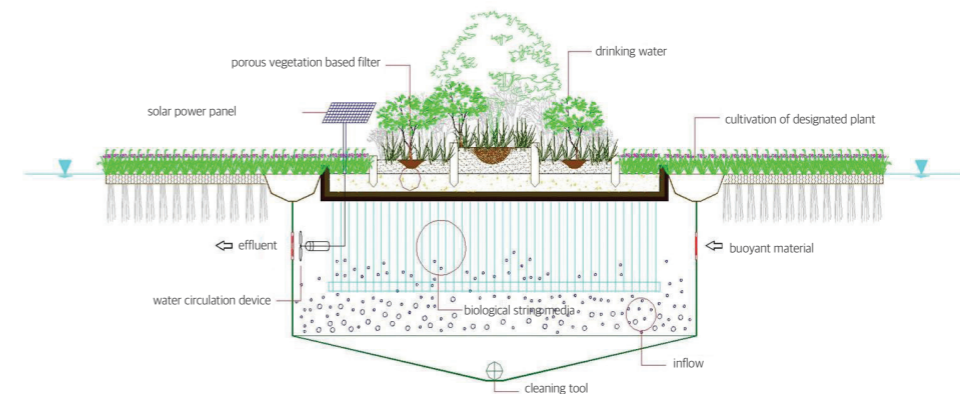
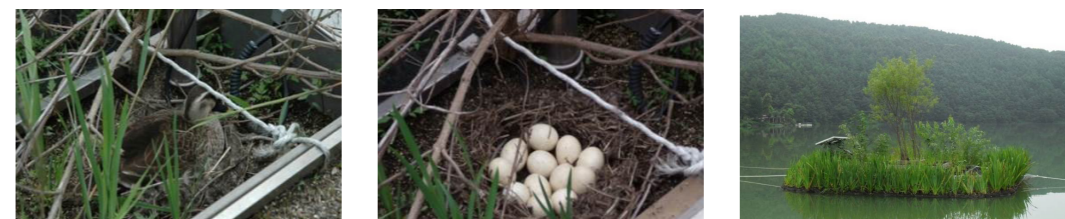
## Highly efficient artificial wetland

- Naturally purifies and treats daily life wastewater from 50~100 households
- Highly efficient natural treatment technique



## Plant island for purifying ecology

- Daily rainwater can be treated by using small-scale solar power based on natural purification technique
- Suppresses algal bloom with water circulation using solar power
- Utilized as plant habitat (reservoir, dam's water quality purification)





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