



Technische Universität Berlin

Modelling Civil Engineered Systems

[WiSe 2025/26]

Individual Assignment I – Ontological Modeling
Retaining Wall

Prepared By

Name :	Md Nahidul Islam Mollah
ID :	TUB 0494297
Email :	mollah@campus.tu-berlin.de

Retaining walls are relatively rigid walls used for supporting soil laterally so that it can be retained at different levels on the two sides. It is designed to hold in place a mass of earth or the like, such as the edge of a terrace or excavation. The structure is built to prevent the lateral pressure of soil when there is a certain possibility of change in ground elevation that exceeds the angle of repose of the soil.

1.1 Ontology of a Retaining Wall System:

1.1.1 Purpose:

The ontology developed here for a retaining wall system includes key elements like Design option class, function class, load class, material class, retaining wall domain. The ontology has been created focusing on the structural design and geotechnical design aspects. Landslide mitigation, improving drainage systems, erosion control are particularly the main purpose of this Retaining wall ontology.

1.1.2 Scope:

The areas where landslides occur frequently, soil erosion needed to be controlled, improving drainage system is necessary, the concept of this Retaining wall ontology models could be implemented. The ontology model helps to make the overall structure coherent and complete.

1.1.3 Intended End Users:

The people who are involves with planning, design, analysis, construction, infrastructure development as Civil Engineers, Geotechnical Engineers, Structural Engineers, Project Managers, Urban Planners.

1.1.4 Intended Use:

To enhance the parametric models for retaining wall design, this ontology intended to be used. Particularly, it will help structural analysis under different load conditions, soil pressure, hydrostatic pressure and dynamic forces. Additionally, the model improves design process under worst conditions, provides guidelines for construction and analysis of the Retaining wall structure.

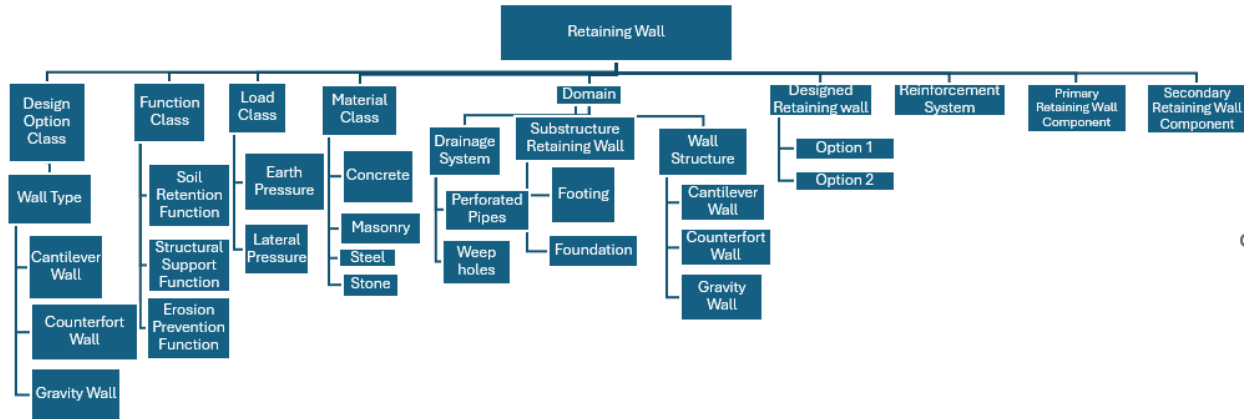


Figure 1.1: Hierarchy of the Retaining Wall

1.2 Physical Components of Retaining Wall:

1.2.1.1 Substructure

Wall Base or Substructure Retaining wall: This is the Foundation that supports the whole wall structure.

Wall Structure: The vertical part of the structure that resists pressure.

Reinforcement System: To strengthen the structure rebar, steel are used.

Drainage System: To prevent the water flow building up behind the structure.

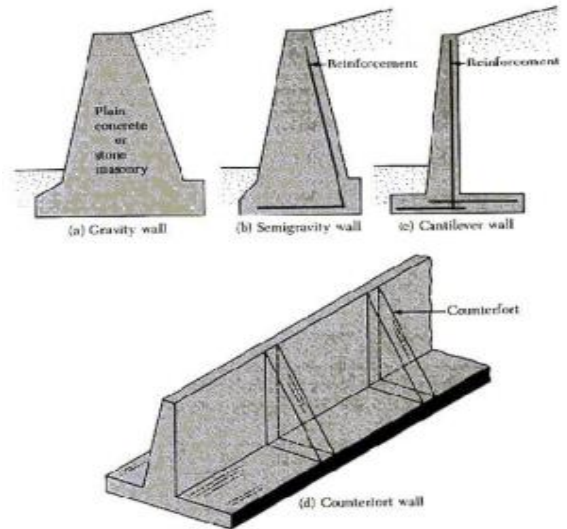


Figure 1.2: Concrete Retaining Wall

1.2.2.1 Superstructure

Foundation

Footing

1.2.2 Main Material:

Concrete, Steel, Masonry, Stone

1.3 Functions of Retaining wall:

There are many functions of building a retaining wall. Such as -

Structural Support: It helps prevent soil displacements, particularly the areas where landslides occur frequently.

Create sloped areas functional: Retaining wall makes the slope areas flatten so that soil or water do not flow downside. It also helps pedestrians to give access to a sloped area.

Improve Drainage: To facilitate the flow of water in certain areas retaining wall can be used. It is beneficial when the slope is near the body of water. Additionally, in certain areas, it is important to manage the water flow to mitigate the flood risk.

Control Erosion: The common and main purpose of building retaining walls is to prevent or hold back soil.

1.4 Key Axioms in the Retaining Wall Ontology:

Intersection: Retaining Wall \cap Concrete material \cap Soil Retention Function \cap Foundation

Union: Retaining Wall \cup Gravity Wall

Existential Restriction:

hasWallStructure some GravityWall

hasFunction some SoilRetentionFunction

hasSubstructure some Foundation

Universal Restriction: has Material only Concrete Material

At least Restriction: has Substructure min 1 Foundation

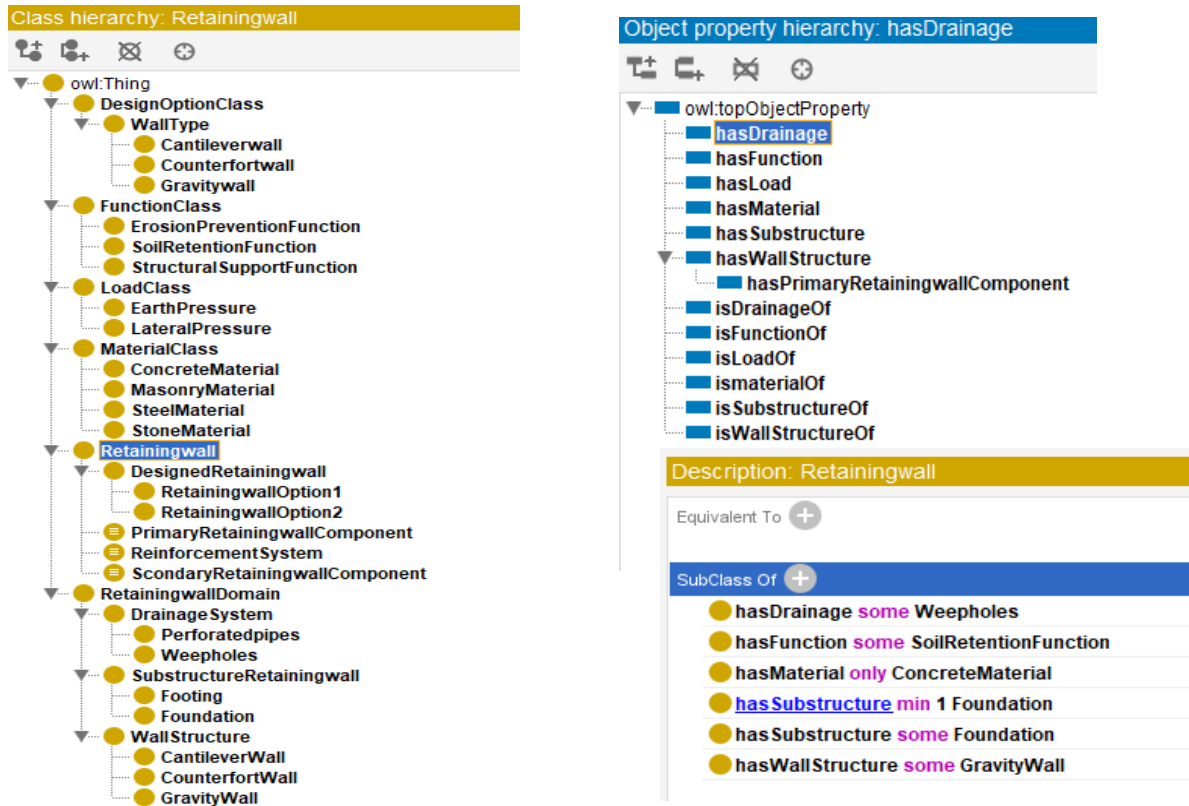


Figure 1.3: Class hierarchy, Object property hierarchy and description (subclass of) of Retaining Wall.

Property	Domain	Ranges
hasFunction	Retaining Wall	Function Class
isFunctionOf	Function Class	Retaining Wall
hasLoad	Retaining Wall	Load Class
isLoadOf	Load Class	Retaining Wall
hasMaterial	Retaining Wall	Material Class
isMaterialOf	Material Class	Retaining Wall
hasSubstructure	Retaining Wall	Substructure Retaining Wall
isSubstructureOf	Substructure Retaining Wall	Retaining Wall

Table 1.1: Domain and Ranges of the Properties.

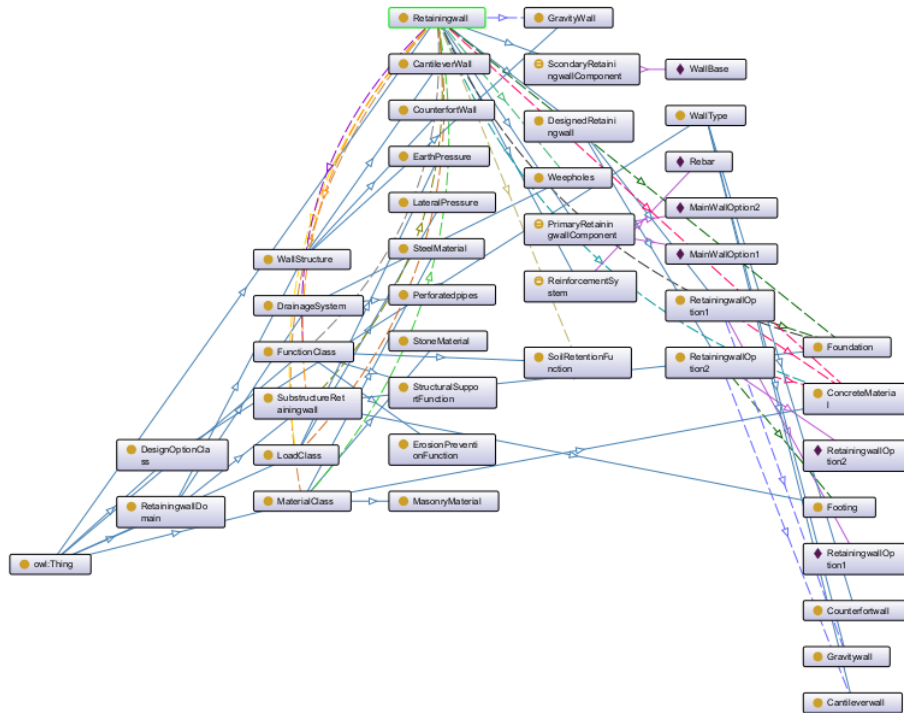


Figure 1.4: Onto graph of the Retaining Wall (generated by Protégé Software)

1.5 Engineering Examples:

Scenario 1: Because of heavy rainfall Flood takes place easily in Dhaka, Bangladesh. As a result, on an urgent basis we need to construct a retaining wall along the Buriganga River to protect the residential area and infrastructure from flooding. The retaining wall must withstand the higher water pressure during monsoon seasons and must prevent soil erosion.

The Ontology helps-

For erosion prevention, the Soil Retention Function (under Function Class) prevent erosion along riverbanks of Buriganga River, mitigate the impact of the flood. Concrete or Masonry Material (under Material Class) can be used due to their durability. As the water pressure is higher, Reinforcement System can provide stability. For water management system, allow the excess water flow without damaging the wall there is Drainage System.

The Ontology Works-

hasFunction some SoilRetentionFunction is to prevent soil erosion, provide protection against flooding.

hasMaterial some ConcreteMaterial is used for the wall, which is tough against flood water.

hasSubstructure some Foundation, is used for deep foundation to resist water pressure.

hasDrainageSystem some Weepholes, drainage system is essential to divert the water.

Scenario 2: Dhaka is one of the most over populated city of the world. Dhaka is experiencing rapid urban growth, highways and road expansions are necessary to facilitate the increasing population and traffic. A road construction project requires retaining wall to stabilize the soil where road embankments needed to be reinforced.

The Ontology Helps-

Depending on the design, the ontology defines Retaining wall as Gravity wall or Cantilever wall. To support embankments against soil erosion, Concrete Material is used due to its strength and durability. Additionally, a Drainage System that helps stop water from building up and putting pressure behind the wall, which could weaken its structure.

The Ontology Works-

hasFunction some SoilRetentionFunction prevent the soil erosion along the embankment of the highway.

hasMaterial some ConcreteMaterial, the wall is constructed using concrete.

hasSubstructure some Foundation will support the weight of the Highway and prevent shifting.

hasWallStructure some GravityWall, wall can be a gravity wall because of the type of the soil.

Scenario 3: Sylhet is one of the land slide prone areas of Bangladesh. The landslide often damage roads, tea garden, residential area. In hilly areas the wall must be designed to withstand lateral earth pressure, dynamic loads because of rainfall induced soil problem.

The Ontology Helps-

The main function of the Retaining Wall is to prevent soil movement which fits the SoilRetentionFunction class.

Depending on the availability the material can be ConcreteMaterial or MasonryMaterial.

The Wall Structure could be either CantileverWall or CounterfortWall.

To improve tensile strength and structural stability, the ontology refers ReinforcementSystem.

DrainageSystem ensures the subsurface water is properly drained.

The Ontology Works-

hasFunction some SoilRetentionFunction, this helps to prevent landslides and retain slope of soil.
hasMaterial some ConcreteMaterial, for achieving strength and durability it ensures the wall is built with concrete.

hasSubstructure some Foundation, for hilly terrain it requires a deep foundation.

hasWallStructure some CantileverWall, To manage water pressure behind the wall it includes weep holes and perforated pipes.

References:

https://www.concretenetwork.com/concrete/poured_concrete_retaining_walls/four_types.htm

https://link.springer.com/chapter/10.1007/978-3-031-69228-4_2

https://lged.portal.gov.bd/sites/default/files/files/lged.portal.gov.bd/page/5b47e2c4_c80c_485f_af5f_e280d08c2e18/2023-06-18-06-25-55d1d1ada2b179bc7cf879c60c659326.pdf

https://en.wikipedia.org/wiki/Retaining_wall)