

**Rotterdam roof park: A multifunctional structure of shared use
Defining four spatial dimensions of multifunctionality**

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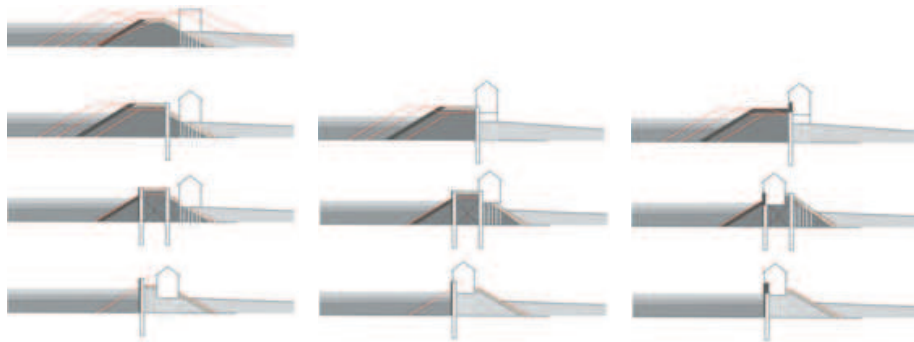
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Figure 1 (below). Various examples with different degrees of spatial integration.

Figure 2 (below). Cross section of Rotterdam Roof Park.



Spatial optimization

Dike improvements in the urban context

Multi-functional zone

Structural integration

Building is part of the supportive structure of the flood defense

Bi-structural or multi-structural

Functional integration

Building is part of the water retaining structure of the flood defense

Multi-structural water retaining

Peter van Veelen, Mark Voorendt, Chris van der Zwet

ROTTERDAM ROOF PARK: A MULTIFUNCTIONAL STRUCTURE OF SHARED USE

DEFINING FOUR SPATIAL DIMENSIONS OF MULTIFUNCTIONALITY

In the context of urban planning, concepts of multiple land-use refer to situations where the existing space is more intensively used (Habiforum, cited in Hooimeijer et al, 2001). This can be achieved by morphological integration of functions (stacking of multiple functions in one building or construction), by mixed space use (multiple functions in a certain defined area) and by temporal shared-use of the same space.

The degree of spatial integration we use is based upon a classification by Ellen (2011) and adapted by Van Veelen (2013), who distinguishes four spatial dimensions of multifunctionality. These dimensions are used for evaluating the degree of spatial and functional integration, with slightly adapted terminology (see also Figure 3):

1. Shared use

A flood defence structure is (temporarily) used by another function, without any adjustments to its basic structure. It is, generally well possible to use the flood defence for infrastructure, recreation and agricultural uses, as long as the functioning of the flood defence is not impeded.

2. Spatial optimisation

The basic shape of the flood defence is adapted to create space for other structures. These structures are technically spoken not part of flood defence structure. Spatial optimisation is found in many places in the highly urbanised areas of the Dutch delta. The most compact and spatially optimal shape is obtained if a vertical retaining wall is applied which replaces a dike slope or berm, leaving space for, e.g., housing.

3. Structural integration

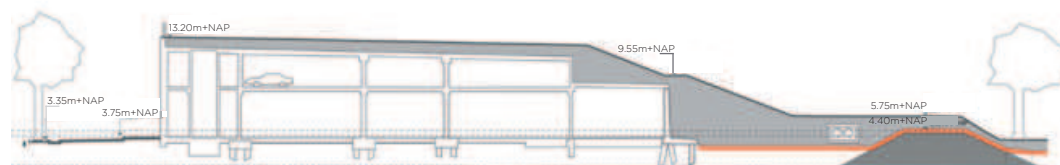
An object is built on, in or under the flood defence structure, but does not directly retain water. The concept of structural integration is used in situations where the current dike is over dimensioned (super dike) or many times stronger than necessary (concept 'unbreachable' dike).

4. Functional integration

The water-retaining element of the flood defence also functions as a part of the structure with another function (the 'object'). Although this concept is technically feasible, it is hard to find realised examples of full integration. There are some historically evolved situations in which the dike is part of a medieval city wall (e.g., in Kampen) or a row of old buildings (e.g., in Dordrecht).

- If the flood defence shape is adapted to allow more spatial compactness, the situation is categorised as 'spatial optimization'.
- If the object, or part of it, fulfils a structural role in the flood defence structure, it is evaluated as 'structural integration'.
- If this structural role is retaining water, the category is called 'functional integration'.

The Roof Park complex itself does not contain structural elements that are part of the flood defence. The additional soil layer on top of the dike is not considered to contribute to the retaining height because the Water board regards the existing profile as the flood defence. This dike profile has not been adapted to make space for other functions. The Roof Park therefore is classified as 'shared use'.



design water level 2100 (85m sea level rise) +4.35m NAP
design water level +3.90m NAP
NAP 0.0m

The determination of the degree of integration starts with identifying the composing elements of a flood defence structure.

- As a first step it should be determined whether an element has a water-retaining function or influences the strength and stability of the flood defence structure as a whole.
- If this is not the case, the integration is categorised as 'shared use', as long as the basic shape of the flood defence is not altered.

This text is an adapted version of part of the chapter 'Design challenges of multifunctional flood defences. A comparative approach to assess spatial and structural integration' published in Flowscapes (2008). All authors contributed equally to this chapter.