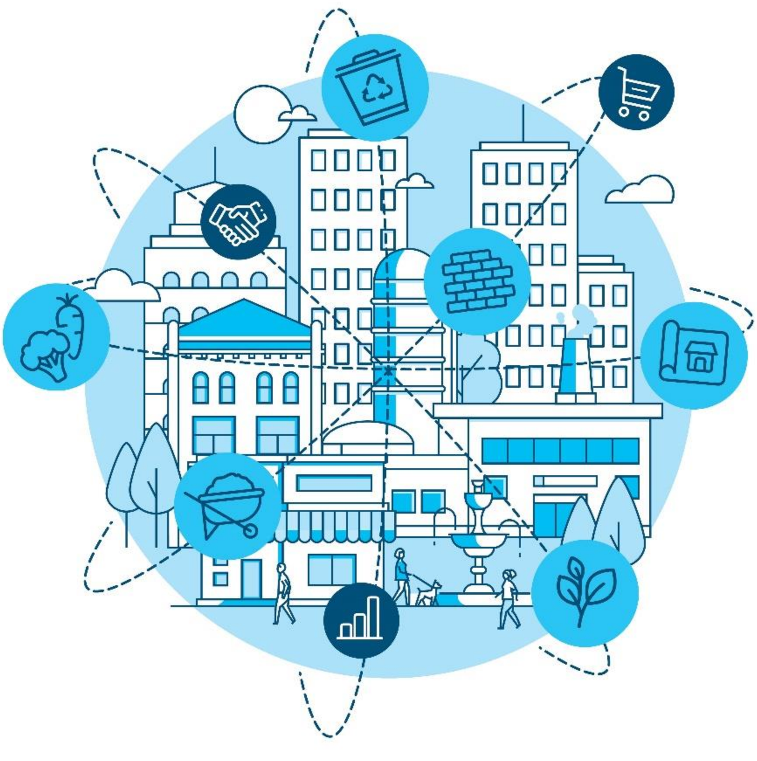
Guidelines for Sustainable Soil Management and Assessment of Soil Reuse Potential of Excavated Soils

Capital Region of Denmark, Municipality of Høje-Taastrup and Municipality of Roskilde, Denmark



Contents

Introduction

Ecosystem functions of natural soils include filtering and storage of rainwater, moderation of temperatures, CO2-storage, hosting of plants and organisms etc. These functions should be fully recognized and considered by urban planners, developers and builders as natural soils have a high environmental and economic value. Excavated soil is often treated as waste and disposed of at high costs even though excavated soils, if treated properly, may be used for a wide range of purposes of considerable value.

This guide describes how development projects can be adapted to minimize the impact on ecosystem functions in the soil and, if treated properly, how excavated soils may be used for a wide range of purposes with considerable value.

In the CityLoops-project three soil instruments have been developed:

- Instrument for prediction of soil production
- Roadmap for soil management
- Guidelines for sustainable soil management and assessment of potential for reuse of excavated soil

The instruments are based on general experience in a Danish context and on urban development projects in the Danish municipalities of Roskilde Kommune and Høje-Taastrup Kommune.

The guidelines presented here describe an overall approach to sustainable soil management and a description of potential ways of using soils frequently excavated in relation to urban development and construction works in Denmark. The guide is very “down to earth” and can be easily modified for use in other countries, by taking local geology, (geo)technical conditions and regulations etc. into account.

Overall approach

Rule no. 1: adapt development projects to reduce impact on ecosystem functions

When dealing with soil in urban development projects and construction, optimal sustainability is achieved by maintaining existing natural ecosystem functions.

To minimize environmental impact, it is important at an early stage of the project planning to consider how earthwork and construction may be adapted to avoid or reduce disturbing, excavation and relocating soil.

When planning urban development projects or construction works environmental impact can be reduced in several ways:

1. in tendering documents, construction clients can prioritize solutions with minimum soil impact/excavation.
2. access to geotechnical/geological information at an early stage will enable more accurate assessments and can be included in tendering documents.
3. evaluate if alternative location and footprint of buildings might help reduce volume of soil impacted/excavated.
4. evaluate if architecture of buildings might help reduce volume of soil to be excavated
5. choose foundation solutions which involve a minimum of soil works.
6. explore potential options for on-site or local soil reuse (landscaping, noise abatement, increased biodiversity, climate mitigation, liveability, infrastructure, or recreational uses etc.).
7. adapt development and construction plans to minimize soil excavation and generation of excess soil (e.g. go for small building footprint and locations where need for soil removal/excavation is minimal).
8. adapt development and construction plans to integrate and support local soil reuse (use options identified in "f" and see Table 1).
9. adapt development and construction plans to support interim soil storage/treatment.

Rule no 2: adapt project to maximize on-site reuse of excavated soil

If generation of excavated excess soil cannot be avoided, on-site soil reuse should be maximized. On-site soil reuse will reduce the environmental impact related to transport and ex-site dumping of soil. To maximize on-site soil reuse it may be useful to:

a) establish an overview of geology/soil types within development area.

b) evaluate what soil types will be generated due to construction works.

c) evaluate volume of different soil types to be generated.

d) assess geotechnical properties and potential uses of individual soil types.

e) identify how and where excavated soils can be used on-site (see Table 1).

f) assess if reuse potential of soils can be increased by using stabilizing agents (cement, lime etc., see Table 1).

g) consider potential for substituting mineral resources (gravel etc.) with excavated soils (see Table 1).

h) make sure different soil types are not mixed during excavation and storage (mixing may reduce options for reuse).

i) make sure soil quality is not degraded during excavation and storage (high water content/heavy rain may reduce options for reuse).

Rule no. 3: go for local reuse

If excavated soil cannot be used on-site, transport to distant sites should be avoided. To achieve this:

a) evaluate options for local reuse.

b) find out if near-by projects need soil for construction, landscaping, noise abatement, increased biodiversity, climate mitigation, liveability, infrastructural or recreational uses etc.

c) identify local facilities where soil can be stored or treated for future use, preferably as substitution for virgin raw materials.

Assessment of soil reuse potential

In Table 1, potential uses of soil types commonly found in Denmark are described.

In the table, the '+' and '-' symbols indicate whether a specific soil type is suitable for a particular application or not.

For some applications it is vital to determine the geotechnical properties of the soil prior to use, to ensure that geotechnical standards and requirements etc. are met.

When potential soil uses (and soil volumes) have been established it is possible to adapt existing development and construction plans to maximize local reuse of excavated soils, as well as determine which areas are available for local treatment or temporary storage of soil.

SOIL TYPE / APPLICATION	TOPSOIL	PEAT / GYTTJA	UNSUITABLE CLAY AND SILT Lime-free, w > 19-25 % Cv < 40 kPa	WELL-SORTED LAMINATED SAND/CLAY	CHALK-STABILISED CLAY w = 15-21 %	GLACIAL CLAY Lime content w < 15 %	SAND AND GRAVEL w = 15-21%	CEMENT STABILISED SOIL
RECREATIONAL AREAS	+	+	+	+	+	+	+	+
SUBBASE FOR LIGHTLY TRAFFICKED PATHS	-	-	-	+	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding and compaction	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding and compaction	+	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding and compaction
ROAD SUBBASE	-	-	-	+	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding, E-modulus, and compaction	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding, E-modulus, and compaction	+	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding, E-modulus, and compaction

SOIL TYPE APPLICATION	TOPSOIL	PEAT GYTTJA	SILT Lime-free, w > 19-25 % Cv < 40 kPa	WELL-SORTED LAMINATED SAND/CLAY	LIME-STABILISED CLAYEY SOILS w = 15-21 %	GLACIAL CLAY Lime content w < 15 %	SAND AND GRAVEL w = 15-21%	CEMENT STABILISED SANDY SOIL
EMBANKMENTS	(+) w < 25 % Max. 0.5 m layer thickness	-	-	+	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding, E-modulus, and compaction	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding, E-modulus, and compaction	+	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding, E-modulus, and compaction
BENEATH STRUCTURES	-	-	-	+ Requires strength-testing	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding, E-modulus, and compaction	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding, E-modulus, and compaction	+ Requires strength-testing	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding, E-modulus, and compaction

CLAYEY CONSTRUCTION MATERIAL rammed earth/compressed earth blocks	-	-	-	+ Requires strength-testing	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding, E-modulus, and compaction	+ **Pre-investigation**: soil strength, description, moisture content. **Control**: soil binding, E-modulus, and compaction	-	-

CityLoops is an EU-funded project focusing on construction and demolition waste (CDW), including soil, and bio-waste, where seven European cities are piloting solutions to be more circular.

Høje-Taastrup and Roskilde (Denmark), Mikkeli (Finland), Apeldoorn (the Netherlands), Bodø (Norway), Porto (Portugal) and Seville (Spain) are the seven cities implementing a series of demonstration actions on CDW and soil, and bio-waste, and developing and testing over 30 new tools and processes.

Alongside these, a sector-wide circularity assessment and an urban circularity assessment are to be carried out in each of the cities. The former, to optimise the demonstration activities, whereas the latter to enable cities to effectively integrate circularity into planning and decision making. Another two key aspects of CityLoops are stakeholder engagement and circular procurement.

CityLoops started in October 2019 and will run until September 2023.

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