About WEDC

The Water, Engineering and Development Centre is one of the world's leading education and research institutes for developing knowledge and capacity in water and sanitation for sustainable development and emergency relief.

We are committed to the provision of effective, evidence-based and appropriate solutions for the improvement of basic infrastructure and essential services for people living in low- and middle-income countries. With over 45 years of experience, we offer expert advice and quality learning opportunities for sector professionals.

Founded in 1971, WEDC is based in the School of Civil and Building Engineering at Loughborough University, one of the top UK universities. Being a part of a leading university gives us a recognised platform of independence and quality.

What makes us stand out from the crowd is our outreach to practitioners. We use our knowledge base and our applied research work to develop the capacity of individuals and organizations throughout the world, promoting the integration of social, technical, economic, institutional and environmental activities as foundations for sustainable development.

Visit our website to find out more about our postgraduate and professional development programmes (MSc, Diplomas and postgraduate certificates available at the University or by distance learning); **our research; our advisory services; our international conferences; and our extensive range of information resources which are free to download from our knowledge base.**

http://wedc.lboro.ac.uk

Water, Engineering and Development Centre
School of Civil and Building Engineering
Loughborough University
Leicestershire LE11 3TU UK

T: + 44 (0) 1509 222885
E: wedc@lboro.ac.uk
W: wedc.lboro.ac.uk

Linkedin: WEDC UK
Twitter: wedcuk
YouTube: wedclboro

WEDC Developing knowledge and capacity in water and sanitation

GUIDE 24

Latrine pit excavation and linings

The need for a latrine pit lining depends upon the type of latrine under construction and the condition of the soil. Septic tanks and aqua privies, for example, require watertight compartments so their pits are always lined. For a pit latrine, however, it is only necessary to line the pit if there is a possibility that it will collapse during its life span.

Contents

This guide examines the methods and materials for lining a pit and the soil conditions that determine which options are most appropriate.

wedc.lboro.ac.uk/knowledge

Loughborough University

© WEDC, Loughborough University, 2014

Author: Bob Reed Quality assurance: Brian Reed and Rebecca Scott

Edited and illustrated by Rod Shaw

Designed and produced by WEDC Publications

This guide is one of a series of published learning resources which are available for purchase in print or available to download free of charge from the WEDC Knowledge Base. Any part of this publication, including the illustrations (except items taken from other publications where WEDC does not hold copyright) may be copied, reproduced or adapted to meet local needs, without permission from the author/s or publisher, provided the parts reproduced are distributed free, or at cost and not for commercial ends and the source is fully acknowledged. Please send copies of any materials in which text or illustrations have been used to WEDC at the address given below.

Published by WEDC, Loughborough University

ISBN 978 1 84380 174 0

This is one of a series of WEDC guides on sanitation. For a comprehensive list of all published guides, please visit: http://wedc.lu/1mlHcnD

Also available in French, translated by SOLIDARITÉS INTERNATIONAL

Water, Engineering and Development Centre
School of Civil and Building Engineering
Loughborough University
Leicestershire LE11 3TU UK

T: + 44 (0) 1509 222885
E: wedc@lboro.ac.uk
W: wedc.lboro.ac.uk

Linkedin: WEDC UK
Twitter: wedcuk
YouTube: wedclboro

Learn with WEDC

Learn with one of the top, award-winning universities of excellence in the UK and partake in a quality learning experience.

Gain a recognised, respected, independent and validated qualification.

WEDC offers you a wide variety of learning opportunities in all aspects of water and environmental management, water and waste engineering and infrastructure in emergencies.

You can learn in different ways and at different levels. Come to WEDC or study at home or at your place of work.

Choose from one of our postgraduate programmes and study towards a Postgraduate Certificate, Diploma or Master of Science (MSc). Study by research towards a PhD.

Alternatively, tailor-make a programme from our wide range of stand-alone modules to suit your particular professional development requirements.

Or you may prefer to invite us to collaborate with you to devise a programme especially for your staff.

Go straight to details about one of our learning opportunities.

Postgraduate programmes

- Infrastructure in Emergencies
- Water and Environmental Management
- Water and Waste Engineering

Other courses and programmes

- Special courses for groups
- Professional development
- PhDs
- Online courses

Pit excavation

Pits are usually dug by hand. Great care must be taken to protect the workers from pit collapse. When soils are loose or likely to collapse the pit walls must have temporary supports until a lining can be constructed. There must always be one person at the surface and at the top of the excavation to help in case of an accident.

Shallow pits

In most cases, pits up to 1.5m in depth can be fully excavated and then lined from the base (Figures 1 & 2). If the soil is very loose, the sides of the excavation should be sloped (wider at the top than at the base) to prevent them collapsing into the hole whilst the lining is being constructed.

Deep pits

Unlined pits

Even pits in firm, self-supporting soils must be lined for the top 0.5m - 1.0m. Construct as follows:

Figure 1. Lining from the base

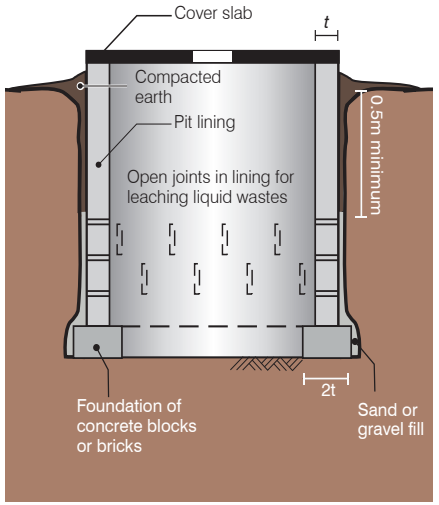


Figure 2. Details of the construction of a shallow pit with lining

- Excavate and line the top of the hole. Remember that the lining must extend by about 10cm above the ground to prevent surface water entering the pit.
- Excavate the rest of the pit within the lining (Figure 3). This section of the hole cannot be as wide as the inside of the lining as the bottom of the lining requires a foundation.

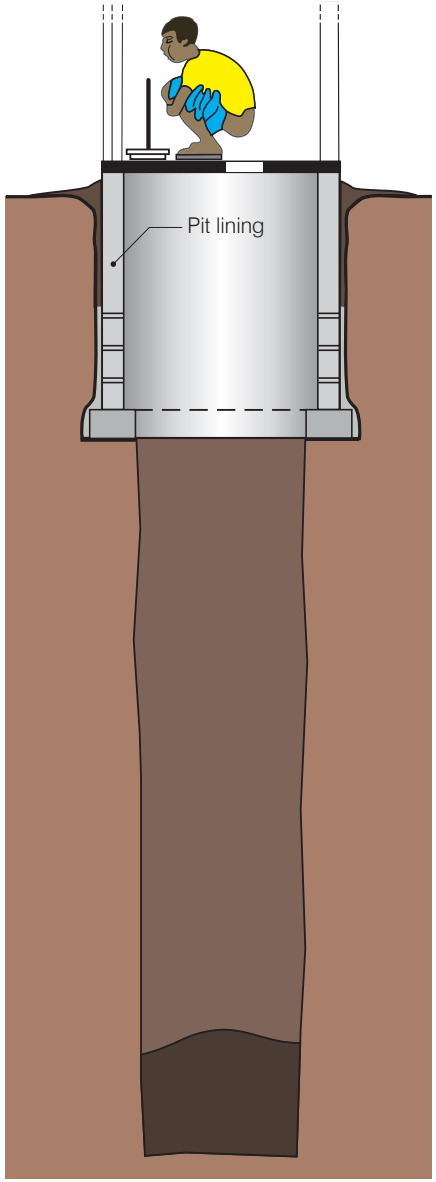


Figure 3. A deep pit with lining

- Check the unlined soil surface for weak points which may collapse in the future. If you find any, cut them back and insert a lining.

Pits in firm soil

It is often the case that soils are stable and self-supporting when they are first excavated but become unstable later. In such cases the hole can be dug to the full depth and then lined from the bottom.

Pits in loose soil

It is unusual for deep pits to be dug in loose soil. The costs involved and the technical skills required to undertake the task are inappropriate for pit latrines. It is usually better to look for an alternative solution such as a raised pit or a twin pit latrine.

When to line a pit

The top 0.5 to 1.0 metre of a pit should always be lined but the decision as to whether to line the rest of the pit will depend on the type of soil in which the pit is dug and whether the pit is likely to be emptied.

Pits dug in soils that are likely to collapse will need to be lined, but how do you decide whether the soil is stable or not? This is not an easy decision to make.

The simplest method is to examine other excavations in the area, such as those for hand-dug wells.

It is reasonable to assume that if existing excavations have not collapsed and are

Notes

Foundations

Nearly all linings need a foundation to prevent the lining sinking into the ground below. In firm soils a simple pad foundation about three times the width of the linings is sufficient (see Figure 7a). The foundation is usually made of the same material as the lining.

In soft ground a thicker foundation may be needed. Cover the base with a 10 to 15cm layer of compacted mixed stone and construct the foundation on that (see Figure 7b).

When only partially lining the pit, leave a step in the pit wall on which to build the foundation (see Figure 7c).

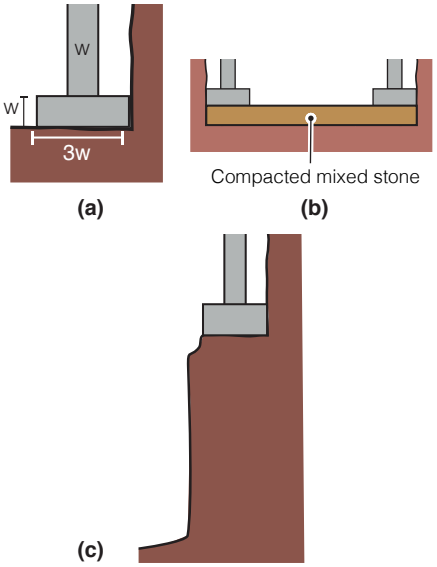
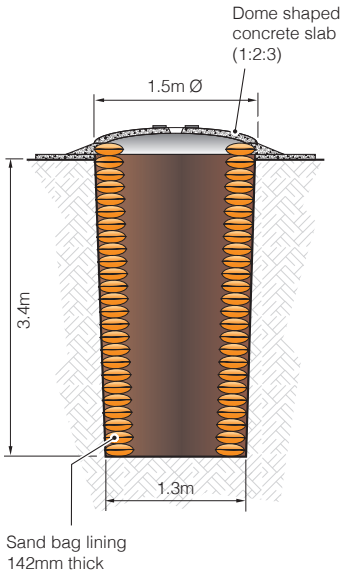


Figure 7. Foundations

Sandbag pit lining in emergencies

In Kenya and Sudan, sandbags have been used to line pits in unstable soils in refugee and internally-displaced people camps. These were found to be cheaper, more durable and more stable than oil-drum liners that had been used previously. Sandbags are placed within the circular pit. In areas of shallow groundwater, cement was added to the sand mix to improve stability. A dry mix was used when the bags were first filled and a few buckets of water were poured over them once the bags were installed in the pit.



not lined then pit latrine excavations will not require lining either.

In fact the process of excavating a pit is similar to the process of digging a well.

In the absence of any other information the suggestions given in Table 1 may help.

Lining material

The pit can be lined using any material that is strong enough to prevent the walls of the pit from collapse, can support the weight of the structure above, and is durable enough to ensure that it will last for as long as the pit will be in use.

Common lining materials include:

- Local stone, burnt bricks, concrete blocks, soil/cement blocks
- Termite resistent timber

Bamboo and cane should only be used if a pit is intended to have a very short life (less than 2 years).

Jointing

No matter what type of lining is used, the top 0.5m of the pit should be fully sealed – all the joints in the lining must be mortared to make a continuous ring

Table 1. Soil types and pit lining

Soil types that require lining	Soil types that do not require lining
Soft sands and gravels	Soils with a significant clay content*
Unconsolidated soils (loose)	Most consolidated sedimentary rocks (strongly bonded)
Filled land	Soils with a high proportion of iron oxides (laterites)
Compressed mudstones and shales	

** Soils with a high clay content can change their stability with soil moisture content. The characteristics of the soil when it is excavated may change as the soil dries out.*

There is even more uncertainty if the soil is subject to periodic wetting and drying, for example, when the water table rises and falls at different times of the year.

If in doubt, line the whole pit.

Important

Pits that are likely to be emptied and re-used should always be fully lined.

The pit lining should extend at least 10cm above ground level. This will help prevent surface water getting in the pit.

of support. The sealed ring serves a number of purposes:

- it supports the weak soils that are found close to the surface;
- it provides a foundation for the cover slab and superstructure above; and
- it prevents surface water and burrowing animals (rats, mice, rabbits etc.) from entering the pit.

Below the sealed ring, the lining must be porous so that any liquid wastes can percolate into the surrounding soils. A porous lining can be made by leaving some of the vertical joints in brick and blockwork unmortared or leaving holes in continuous linings of concrete or clay.

A large number of small holes is better than a small number of big ones. Big holes may allow the soil behind the lining to fall into the pit, producing voids that could cause the pit to collapse. This information holds true for all pit latrines except raised pits without soil mounds. In this case the lining must be fully sealed above ground and for the first 0.5m below ground.

Figure 4. A porous section of lining

Brick, blockwork and stone linings

Linings made of brick, blockwork or stone are built up from the foundations. With deep pits it is important to allow time for the cement mortar to gain strength before the space behind the lining is filled to prevent deformation of the lining. Again, with the exception of the first 0.5m – 1.0m, some joints are left unmortared to allow some infiltration of the liquid into the soil.

Corbelling

If the size of the pit is reduced as it approaches the surface then the size of the cover slab can also be reduced. This can be achieved by 'corbelling' the lining.

The pit lining is constructed in the shape of a dome either using brick or blockwork, concrete or ferrocement (see Figure 5). The method reduces the quantity of lining material required as well as the size of the coverslab. However it is a skilled process so experienced masons should be employed.

Behind the lining

Space between the back of the lining and the excavated soil face must also be filled. Where the lining is porous, the space should be filled with a granular material such as sand or gravel. Close to the surface where the lining is sealed, gaps should be filled with compacted earth.

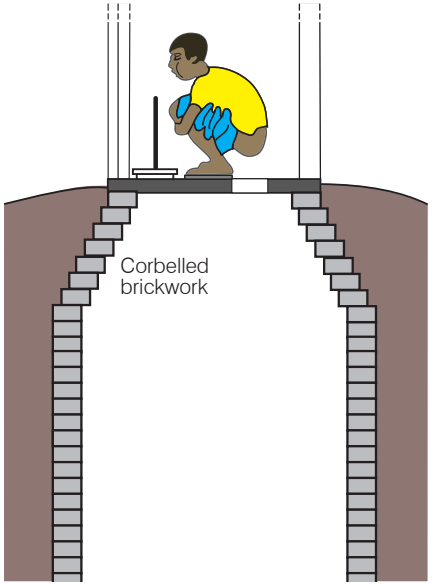
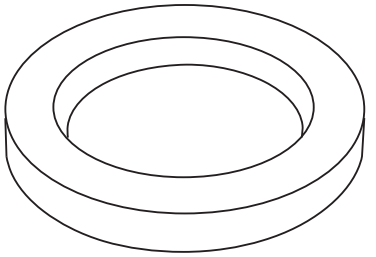


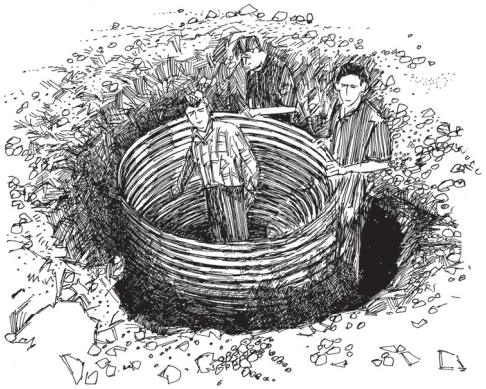
Figure 5. Pit with corbelled lining

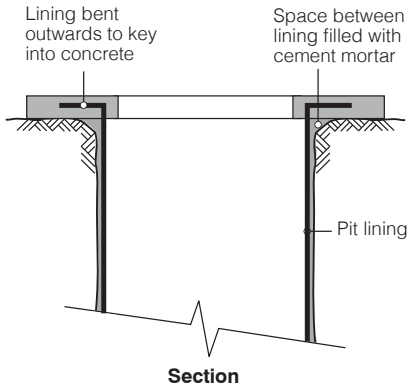
Thin linings

Thin linings such as old oil drums are not strong enough to carry the weight of a floor slab or superstructure without bending or breaking. They should be strengthened at the top by a ring beam such as the one shown in Figure 6.



Perspective view





Section

Figure 6. Thin linings require a ring beam