WEDC

MOBILE NOTE 28

Apron slabs for water points

Introduction

Despite the large number of concrete slabs installed around water points throughout the world, relatively few detailed drawings of apron slabs exist. Those few drawings have many similar features and a number are copied from a common source. With the aid of technical and hand-drawn illustrations, this guide provides information about apron slabs in a new form. It explains what apron slabs are and why they are needed. It considers physical, social and organizational factors and presents technical options and recommendations for their design and construction.

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Contents

Although the main focus of this mobile note is on the use of apron slabs with handpump-equipped boreholes, many of its recommendations will be relevant to other types of water point such as tapstands and wells.

What is an apron slab?

An apron slab is a smooth impermeable surface constructed around a water point to prevent spilt water soaking into the ground. Its purpose is to prevent pollution of the groundwater supply and prevent the development of puddles or muddy conditions that are unpleasant, can attract mosquitoes, flies and animals and lead to the transmission of disease.

Apron slabs are not only used with handpumps installed over boreholes. They are also necessary for hand-dug wells (whether fitted with handpumps or not), spring water delivery points and public and private tapstands.

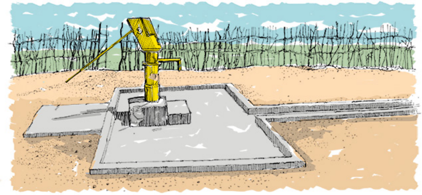

Figure 1. A typical apron slab with a plinth to raise containers close to the spout

Location of the water point

Avoiding pollution

Identifying potential pollution of groundwater sources is critical before deciding on the location of a well or a borehole (see Figure 2). Guidance on the risks of groundwater contamination is given in *Guidelines for assessing the risk to groundwater from on-site sanitation* (BGS, 2001).

The safe distance from the location of the water point to a potential source of pollution can be based on the time of travel of pathogens (disease-causing germs) from the point of pollution to the borehole.

If this exceeds 25 days, the risks of disease transmission are low and beyond 50 days the risks are very low.

Surface water may also transport pathogens, so drainage routes need to be taken into account too.

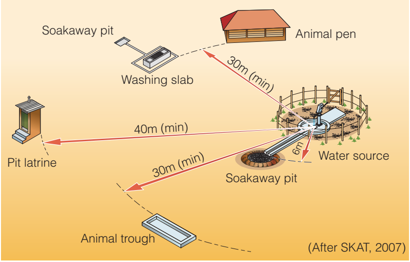

Figure 2. Location of a water point at a safe distance from potential sources of pollution

Drainage

It is also important to consider whether drainage from the site is feasible. For example, it is usually not possible to drain wastewater from an apron slab sited in a depression in the ground as such conditions make it difficult to provide a steep enough fall for run-off water.

Flood protection

In areas where seasonal floods may submerge a handpump, the entire operating platform and apron slab may have to be raised above ground by the required height for the predicted depth of the flood (perhaps a metre or more) to keep the pump and the upper section of the borehole casing above flood water level (Appendix 3).

During a flood, the pump must be reached by wading through the water or by boat. In the dry season, the platform is reached by steps.

A depression may also be prone to flooding. It may also be difficult to construct a drainage channel that slopes away from the apron slab in very flat areas.

If there is no alternative to siting a water point in a flat area then it may be necessary to raise the apron slab and part of the drainage channel above the ground so that the wastewater can drain away.

In sloping areas, water points should not be sited within reach of sources of surface water.

If this cannot be avoided, surface water should be diverted away from the slab by a mound of compacted earth or a ditch.

This will prevent contamination of the slab from the surface water source and avoid erosion of the soil around the slab.

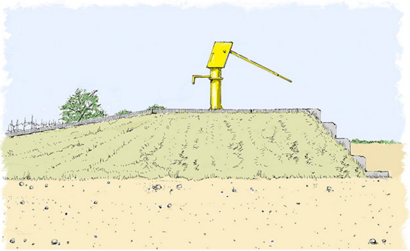

Figure 3. A raised apron slab and channel for flat areas or depressions

Social factors

The number of users at peak times

Problems can occur at a busy water point because of the congestion that occurs around it. In some cases, people will place their jerrycans in a line and wait patiently for their turn, but in some communities people will jostle for position, causing water to be spilt and fences to be damaged. A typical flow rate should be calculated to determine the time needed to supply the required amount of water per person. This will indicate the likely pattern of use. Refer to Appendix 4 for further information about calculating flow rates from handpumps.

To encourage the collection of enough water for maintaining a safe level of hygiene, the handpump needs to be situated at a convenient distance from people's homes, ideally less than 250 metres away. The potential for long queues to develop should be avoided, if necessary by installing a second water point within the same community.

Activities at the handpump

Personal habits
Food eaten at the handpump, such as sugarcane, is likely to cause litter – in this instance the casing of the sugarcane and the pith could block the drainage system. Likewise, if people wash dirty feet, animals, agricultural tools or vegetables at the water point, the soil and dirt will also create unhygienic

conditions and block the drainage and soakage systems.

Washing

Some people find it easier to carry their laundry to the water point to wash, rinse and partly dry it rather than carry the water home.

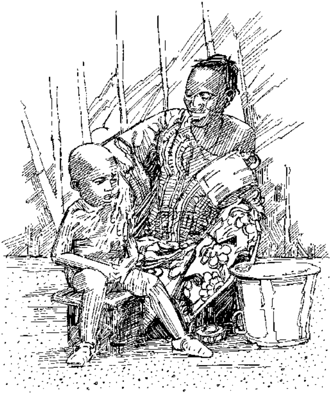

Figure 4. Providing washing facilities will encourage people to wash and bathe away from the water point

Others may bring their pots and pans or even children to be washed near the water source. This may overload a disposal system that relies on soakage, particularly during the rainy season.

Providing alternative facilities such as washing slabs nearby will encourage people to wash and bathe elsewhere.

Meetings
If payment is made at the water collection point, there needs to be provision for the collector. Often, water collection points are social meeting places and the community may want to maintain the opportunity for meeting together.

Animal watering
Where the water point is to provide water for cattle, special provision will be needed to facilitate water delivery to an animal trough located outside the fenced area (see Figure 2).

Management and maintenance

Behaviour of users
The way in which users are likely to behave at a water point should inform its design. It is best if users agree what is, and what is not, acceptable behaviour, and what penalties will be applied to those who default.

Rules may need to be set banning, for example, washing on the apron slab or using it for animal watering.

A caretaker may be appointed to oversee the use of the handpump, but unless this person is assertive, he or she may not be able to control users properly.

Peer pressure from a wider group may be required, so that the whole community becomes aware that care should be taken during use.

If, for whatever reason, it is difficult to encourage good practice, then some means of intercepting silt and debris may need to form part of the apron slab design, so that the drainage system continues to operate.

Such a system, however, will require maintenance.

Careful use of handpumps

If the pump handle is continually struck against the pumphead, not only will it damage the pump, but it will stress components which may loosen and cause further fractures.

People sitting on the handle when it is in its lowered position applies a greater force on the pump's foundation than during normal use.

Whilst this behaviour should be discouraged, the installation should be designed to cope with the maximum forces likely to be applied.

Preventive maintenance
The effect of seemingly minor problems, such as soil erosion around the apron slab, the development of cracks in the drainage channel, the loosening of a bolt and so on, can worsen over time. It can even lead to the failure of the slab, the drain or the pump or lead to pollution and the spread of disease. It is essential, therefore, for someone to take responsibility for the pump – someone who has been trained to recognize problems and who knows how to put them right (or whom to approach to do so).

Aspects of use

It very important that the design of the apron slab and its surroundings arises from consultations with the community.

If the community is involved it will be more likely that people will respect and maintain the water point.

Access and access barriers

If the local surface soil contains clay, a gravel path to the pump can reduce the amount of mud that people deposit on the slab.

Where there is a risk of animals congregating around the water point, it is advisable to provide a barrier (such as a fence, a wall or a hedge) fitted with a self-closing gate (see Figure 1). This prevents animals from eroding the slab and adjacent ground or contaminating the slab with faeces. The barrier will also prevent animals applying force to the water point by, for example, rubbing themselves against the pump to relieve itches!

Where there is a risk of vandalism or theft of parts of the handpump, it may be necessary to erect a high fence with a lockable gate around the water point. If people are required to pay for water when they collect it, then a fence will be also be necessary to stop people collecting water when there is no attendant. As an alternative, some communities choose to chain down the handle of the handpump, or temporarily disable it in another way, so it cannot be used outside the desired operating hours.

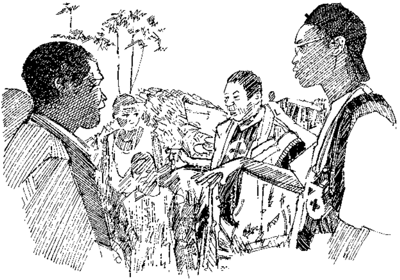

Figure 5. Consultation with the community

Preventing erosion

If a large number of people use a water point (or worse, if animals can gain access) the ground around it can be eroded. This may undermine the slab or drainage channel causing cracks (Figure 6). This erosion is aggravated if the soil becomes wet with spilt water. Surrounding the apron slab with flat rocks or a layer of crushed stones is a useful way to prevent erosion (Figure 7).

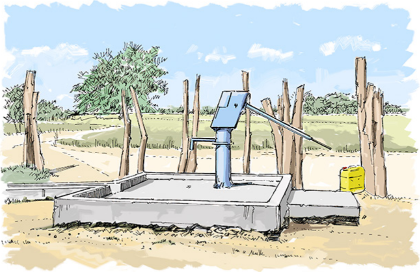

Figure 6. Problems of erosion and poor maintenance of the perimeter fence

Collecting water

The apron design needs to cater for the types of container that are commonly used by the community.

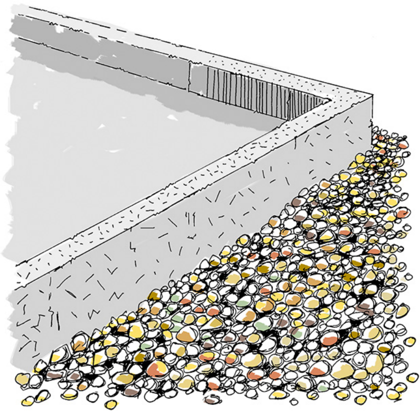

Figure 7. A layer of stones around the slab is a simple way of preventing erosion

A lot of water can be wasted if the container, such as a jerrycan, has a small opening and cannot be set at the right distance from the spout to concentrate the flow of water into a manageable stream (Figure 8).

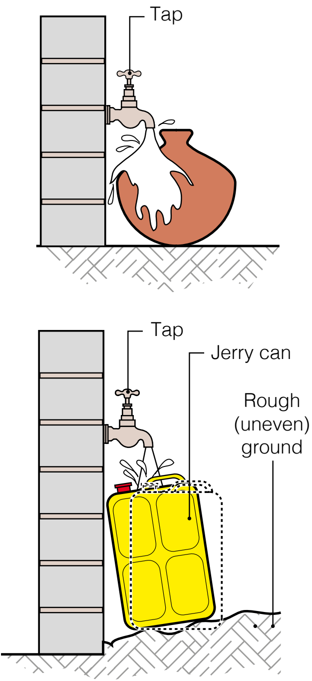

Figure 8. Spillage problems

Water collection will be quicker if less is wasted. The amount of water that the disposal system needs to cope with will also be reduced. A raised concrete (or brick) plinth under a pump's spout may bring the opening of the container to the right height, helping to prevent waste Use of a permanently installed funnel (such as a plastic bottle with the base removed) may also be necessary (Figure 9).

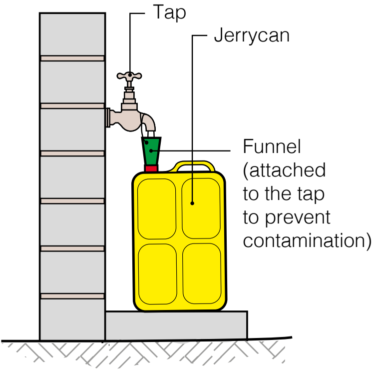

Figure 9. A funnel helping to prevent waste

Some designers set a large, entirely flat, durable stone into the concrete slab under the spout of the handpump as the slab is being cast.

This is designed to prevent erosion of the slab from the abrasion caused by containers (Figure 10).

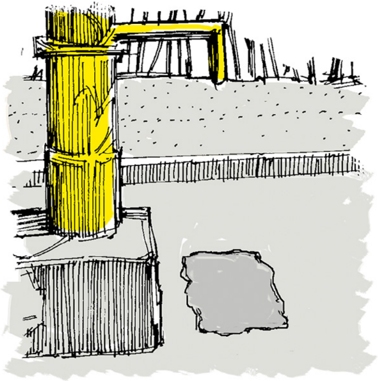

Figure 10. A durable stone at the collection point

Containers that have a hemispherical base may need a 'dished' area on the apron slab, or a small rubber tyre to support them as they are being filled.

Figure 11. A small rubber tyre supporting a hemispherical container

If water containers are carried on the head or back then a pillar of some sort, constructed to a height of about 1.3m, can provide a useful intermediate resting point onto which the filled container can be lifted before it is raised onto the head or strapped to the back – or the container can be filled at that height (Figure 12).

Figure 12. A raised collection platform

If water from the water point is regularly collected in containers carried in panniers on an animal then it may be appropriate to raise the water point higher than normal. Additional pipework can be temporarily inserted to collect and divert the flow from the spout to the container. This may need to reach beyond the fenced area.

The shape and size of the apron

The apron slab needs to:

- contain all splashed, wind-blown and spilt water during the operation of the water point and the rinsing of containers; and
- provide enough space for people to collect the water, including space for a number of containers.

Space for people waiting should be considered but this does not need to feature as a physical component of the apron slab.

Room to operate the pump

The user of a handpump needs a firm slab on which to stand when he or she operates the pump. This platform does not need to be part of the main apron slab. For example, with the standard design for the India Mk II and Afridev handpumps, the operator's platform is a separate slab set against the apron slab.

With lever-operated handpumps, the user usually stands a short distance from the pedestal opposite the spout (although in some designs they can stand at the side). Deeper settings of handpump may have longer lever handles with T-bars that can be used by two or more operators – so more space for the operator may be needed. With direct action handpumps, the user stands very close to the pump pedestal and he or she pulls directly on a T-bar connected to the vertical operating rod, so a separate platform for the operator will not be required.

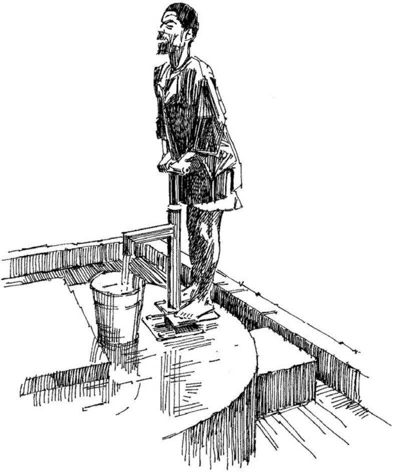

Figure 13. Using a direct-action pump

Some handpumps, particularly those drawing water from deep boreholes, are purposely set quite high (e.g. 0.3m above the normal level) so that a user mainly pulls down on the handle to lift the water, rather than leaning over the handle and pushing down. The level of the top of the borehole casing and the design of the apron slab will need to be higher than normal to cater for this method of operation.

Alternatively, the pump handle can be adapted by welding an angled extension to it to raise the operating end to a suitable height for easy use. For such pumps the operator's platform will also need to be longer.

Provision for use by people with disabilities

The community needs to decide about the extent to which the facilities should be adapted to suit those in their community who are disabled and who want to collect water themselves. Good advice on this is available from Jones and Reed (2005).

Containing splashes

The shape of the apron slab should be sufficient to include a circle with a radius of at least 0.9m centred on the spout of the pump.

If the ground around the handpump is well drained and protected from erosion with stones then such a size may even be suitable when large numbers of people use the pump, although a larger diameter would be preferable.

Designers often mistakenly centre the apron slab on the borehole. Instead, it is better to centre the apron slab on the position of the pump spout since that is the centre of the origin of the water.

Some designers extend the pump spout so that the collection point is several metres away from the borehole or well, so that any spilt water remains at a distance from the source.

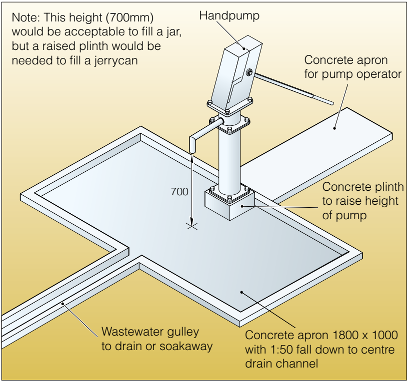

Figure 14. A slab, centred on the spout

The figure above shows a rectangular slab, but a round slab is often used as it requires the minimum volume of concrete to protect an area centred on the spout of the handpump. A circular shape is easy to achieve with factory-produced steel shuttering, but difficulties can be experienced when constructing circular shuttering from other materials.

Square, hexagonal or octagonal slabs are easier to produce using wooden shuttering and are equally suitable – but they require more concrete (Figure 14).

Surface finish

A smooth finish to the slab surface will help water to drain effectively.

A layer of 1 : 3 cement : sand mortar can be used on top of the concrete slab for this, but there is a danger that the layer may separate from the underlying concrete at a later stage, so it is best to smooth the concrete surface at the time it is cast.

Skill and good timing are needed by the mason to produce a smooth, durable finish, using first a wooden and then a steel trowel.

But the surface should not be so smooth that there is a danger of it becoming slippery when wet.

Draining spilt water

The apron slab is designed to collect spilt water and rainwater. This water needs to be carried away from the slab and not run off onto surrounding soil. The apron slab should have a raised edge, therefore, and a slope that ensures water is directed to the lowest point at the edge of the slab. Here it is collected by a drainage channel (or pipe) that can carry the water away to a safe disposal point.

Raised edge to the apron slab

The raised edge, or 'upstand', to the apron slab should be about 75 to 100mm high. This will stop water flowing easily off the edge of the slab, particularly when someone washes out a bucket, or the slab is being cleaned.

Building a round-edged upstand may be preferable to a square-edged design which, if sharp could cause injury. A round-edged design has been used for tapstands in Malawi and works well as long as care is taken when emptying buckets and cleaning the slab to ensure water does not overflow.

Slopes

The surface usually needs to be 'dished' or 'folded' so that the collected water flows towards the drainage channel (Figure 15). The slope needs to be steep enough to quickly shed any water that falls onto it. A slope of at least 1 in 50 (2%) is recommended.

Drainage channel

The drainage channel (or pipe) that carries the water from the apron slab to the disposal point should not be carrying much water so does not need to be too wide. It does need to be wide enough, however, to be cleaned easily to prevent blockages. The typical size of a rectangular channel is 100mm wide by 75mm deep and so it is usually the same height as the upstand.

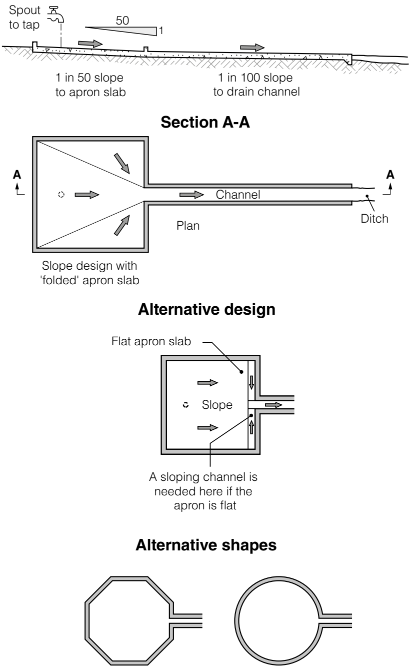

Figure 15. Slopes and shapes of apron slabs

A semi-circular channel is less likely to suffer from sedimentation than a channel with a flat base, but a semi-circular channel is difficult to construct in concrete. Installing half-sections of cut plastic pipe is not advised since the material is likely to deteriorate under the effect of sunlight, but a short piece of pipe can be used like a trowel to form the semi-circular shape in the concrete or mortar. A shallow, trough-shaped channel without vertical edges can also be used and it can be easier to construct than other types.

Some external providers use sections of pre-cast concrete channels laid end to end, but cracks and displacement can result at joints.

A buried pipe can be used instead of a drainage channel, as long as it is protected from damage from traffic and animals and provision is made to prevent it becoming blocked with silt or debris.

Usually, the drainage channel should be at least 3m long, but this depends on site conditions as this distance may not be enough to prevent the water from the disposal point adversely affecting the borehole and its surroundings. If the channel is constructed from concrete that has not been reinforced, there is a risk that it will crack because of differential settlement along its length. A good foundation to the channel should minimize this risk. A minimum foundation depth of 125mm is recommended. To be safe, it is best to reinforce the concrete by setting two 8mm or 10mm diameter bars longitudinally into the concrete, about 30mm below the surface.

Channel gradient

The channel (or pipe) should be laid to a gradient of at least 1 in 100 (1%).
A steeper gradient will be more effective since the velocity of flow will be higher which will reduce the risk of silt becoming deposited in the channel.

Controlling silt

A means of capturing silt and debris before it enters the channel, pipe or soakage system is useful, but a caretaker will need to regularly remove debris at the point where it gathers. A grille can be used, but placing some 25mm stones in the channel at its start point can be equally effective at intercepting larger pieces of debris that may otherwise be washed down the channel and enter the soakage system.

Some designers install a 'sump' (a water-filled box structure) below the entry to the channel so that heavier particles of sand or silt will settle here as the water passes across the box. Periodically the deposits are scooped out using an empty tin or similar container, to be disposed of away from the apron slab. Mosquitoes may breed in sump water, however, so sumps are not advised in areas where mosquito-borne disease is prevalent.

Disposing of the spilt water

A drainage channel can lead to a ditch or to existing surface water drainage systems; irrigation channels; cattle troughs; and sometimes evapo-transpiration beds (i.e. where the water is absorbed by plants). If there are no drainage channels nearby, the water can soak into the ground in a way that will not place the groundwater source at risk. Typically, 'soakaways' (stone-filled pits) are used, as well as 'French drains' (shallow stone-filled trenches).

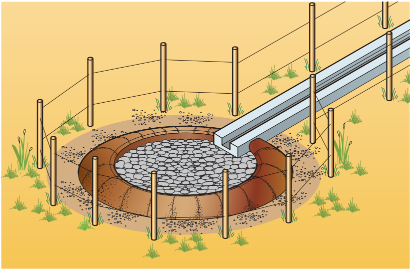

Figure 16. A soakaway pit

The safe distance between the disposal point and the borehole will mainly depend on the nature of the soil, the distance between the base of the soakage system and the groundwater table, and the length of borehole casing. The performance of all systems needs to be suitable for rainy as well as dry season conditions.

Sanitary seals

Sealing the borehole is the main way of protecting the water in a borehole from contamination. Such protection is designed to prevent water from the surface reaching the groundwater. The apron slab itself is an additional precaution. The sanitary seal often consists of at least 3m of grout or clay surrounding the borehole casing (or well lining) to prevent water seeping between the outside of the casing (or precast/ brick well lining) and the adjacent ground. It should be installed when the borehole is constructed.

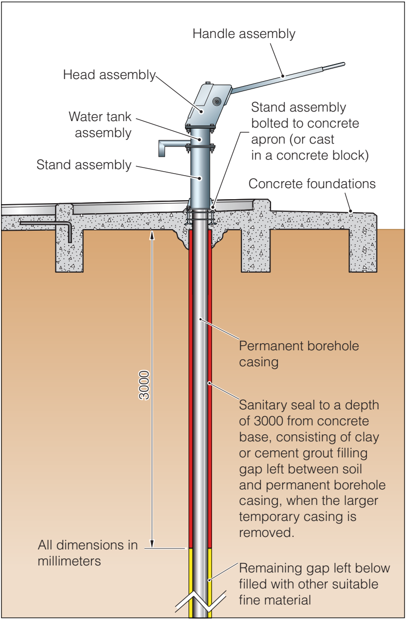

Figure 17. A sanitary seal, protecting the water in the borehole from contamination

Foundations

Pump foundations

A foundation may be needed below the apron slab to provide firm resistance to the overturning forces applied to a water drawing device when it is in use. For a handpump, this foundation usually consists of a block of concrete cast around the top of the borehole. Sometimes the handpump has a flange that can be secured to the apron slab using bolts to fix it firmly in place. In such a case it may be necessary to make the slab thicker at the fixing point.

One problem with excavating around the borehole for a foundation block is that it will require the removal of at least 0.5m of the sanitary seal. However, if the quality of the concrete for the foundation and apron slab is good, and the foundation is keyed into the sanitary seal, water should not penetrate the upper section of the borehole.

The pump pedestal needs to be firmly fixed to the foundation block. In the case of the India Mk II, India Mk III and Afridev pumps the pedestal having three legs fixed to it is normally placed over the borehole casing and then surrounded with concrete to form a block typically about 0.75m x 0.75m square and 0.4m deep (Figure 18). The alternative is to fit the pump pedestal with a large flange that is bolted on to the finished apron slab (Figure 19).

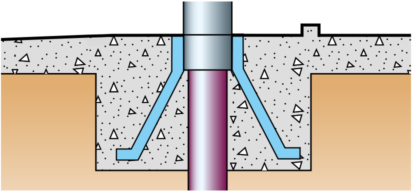

Figure 18. Pump pedestal firmly fixed to the foundation block

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If the handpump is to be bolted to the slab, it is important that corrosionresistant bolts are properly secured in the concrete at exactly the right distances apart. Welding or bolting spacers between the bolts to hold them vertical and in exactly the right position is the best solution. This spacing device is cast into the concrete where it also helps the bolts resist the loads applied to them.

Where a flanged pedestal is used, spilt water can easily pass between the lower flange and the surface of the apron slab. Raising the slab slightly under the flange will reduce this risk, but the best method of preventing the entrance of water to the borehole is to ensure that the top of the borehole casing rises in the pedestal to a point above the slab level (Figure 19).

This will mean that if a flood reaches the level of the raised edge of the slab, it cannot enter the borehole casing to pollute the groundwater, even though water may pass under the flange.

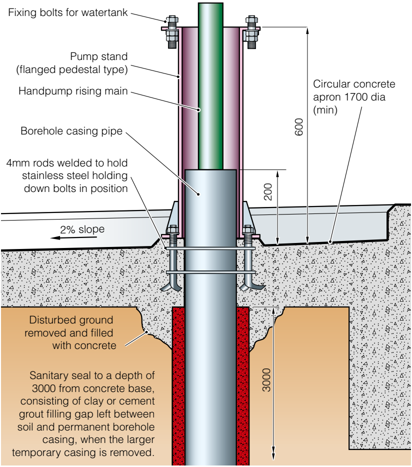

Figure 19. Bolting the flange of a handpump to the slab

Slab foundations

Apron slabs cannot be expected to perform well if they are not constructed on firm ground. Sometimes they are constructed on the pile of loose cuttings that are deposited around the borehole during the drilling of the hole, in which case it is not surprising cracks arise from later settlement. The borehole cuttings should be removed from the site of the borehole before construction starts.

Organic topsoil also needs to be removed from the ground on which the slab is to be constructed. Otherwise settlement will take place when the organic matter decomposes.

If the ground on which the slab is to be cast is not firm, then it should be compacted by applying force using a heavy log or a similar object. If one is available, use a heavy, petrol-powered, vibrating plate compactor.

Many designs show a layer of 'hardcore' (large stones) that are compacted together and into the ground using a large sledgehammer. The hardcore forms a firm layer on which to lay the concrete. These stones can also be useful to replace the removed soil since this will reduce the amount of concrete needed to raise the surface of the apron slab to just above ground level. In flat areas, the apron slab level may need to be raised further above ground to create a suitable gradient for the drainage channel to discharge at a suitable distance away.

Once the large stones are in place, the spaces between them can be filled with smaller stones followed with coarse sand. All materials should be well compacted. The finer materials will improve the quality of the concrete at the base of the slab, and they too will reduce the volume of concrete required.

To prevent the edge of the apron slab from being undermined, it is recommended that there is a 0.25m wide trench excavated 0.4m below the ground level around the perimeter, and that this trench is filled with concrete at the same time that the apron slab is cast. This forms a perimeter beam which supports and stiffens the slab. A similar beam is required under the operator's platform if this is separate from the apron slab. Laying brickwork or masonry using cement mortar is an alternative to using concrete for the perimeter beam. If the designer is sure that no erosion around the handpump will take place, then there will be no need for a perimeter beam.

Regular inspection of the apron slab by the caretaker is nonetheless advised to ensure that any eroded materials can be replaced immediately to protect the apron slab from damage.

Drain foundations

The drainage channel also needs a firm foundation or it will crack and fail. It may be necessary to make arrangements similar to those made for the apron slab.

At the end of the channel, where water discharges into the disposal system, the end of the slab should be about 0.4m thick to prevent the slab from being undermined by erosion at that point (see Appendix 2).

Constructing the slab

Construction material

The apron slab can be made from stone masonry or durable well-burnt clay bricks and plastered with 1 : 3 ratio cement : sand mortar. However, unless the masons are very skilful, such construction is prone to cracking and deterioration. By far the most durable material is concrete, which is the focus of most of the following recommendations.

If the concrete is to be impermeable and durable, the components (cement, sand, aggregate and water) used in concrete need to be of good quality and mixed using the correct ratio. The cement needs to be fresh and to have been unaffected by damp conditions during storage or transportation.

The sand needs to be coarse, clean and free from clay. The aggregate needs to be clean, durable, rough and made up of a mixture of sizes of stones, typically ranging from between 5 and 25mm in size.

Often designers will recommend a 1 : 2 : 4 or a 1 : 2 : 3 mix ratio by volume (i.e. cement : sand : aggregate) for the components of the concrete.

This needs to be well mixed, without adding excessive water which will weaken the concrete.

Concrete that has not been reinforced can perform well but due to the large number of variables on site, it is much safer to include steel reinforcement in the concrete slab to protect against cracking.

Reinforcement should also be used to firmly link the drainage channel slab to the apron slab (see Figure 17).

Casting concrete

The surface of the slab, or at least its raised edge, will normally be above ground level, so strong shuttering needs to be erected to support the wet concrete at these places. Purpose-made steel shuttering to support the inside edge of the upstand, is available in some countries.

Some cement–water mixture in the base layer of the concrete will be lost, seeping into the sand and hardcore layer below the slab. Sand can be dampened before the concrete is placed to minimize this loss. It is best if it is also covered with paper or empty cement bags.

The dampening of the sand is not necessary if a layer of polythene is used instead of paper.

As the concrete is placed it should be roughly levelled with shovels or hoes. Then the wet concrete should be compacted to remove any trapped air and to ensure that the components form a dense mix. This compaction can be achieved by using a straight, heavy beam of wood with raised handles that is repeatedly raised 20–50mm, and then dropped onto the concrete.

Alternatively, a square plate (say 0.2m x 0.2m) on a pole can be repeatedly pounded over the surface of the concrete.

For the pump foundation, and for the perimeter beam, the concrete should be laid in layers not exceeding 0.2m in depth. Each layer should be compacted using a 25mm diameter metal rod, rapidly pushed into and pulled out of the concrete until no more air rises to the surface.

The minimum depth of the finished slab should be at least 125mm, although 150mm is recommended.

Figure 20. By far the most durable material for an apron slab is good quality concrete

Programming construction

Concrete needs to gain strength before it can resist loads applied to it, so it is best if the final installation of the head of the handpump does not take place until at least a week after the concrete foundation is cast. Otherwise impatient people are likely to try to use it with the danger that the foundation is permanently damaged, the pump becomes loose and water penetrates underneath the apron slab.

If the fence is constructed before (or just after) the apron slab, this will prevent animals from damaging the slab before it has gained strength. Alternatively, the slab can be covered with branches to deter animals.

Reinforcement

For best effect, reinforcement bars should be placed about 30mm below the finished surface of the slab. If the concrete is firm enough, this position can be achieved by first laying concrete up to that level and compacting it, then adding the steel bars pre-wired together. Follow this by a further layer of the remaining concrete and then compact this layer too. There can be a danger with this approach, however. During the second round of compaction, the steel may settle into the concrete below. To avoid this, tie pre-cast concrete blocks onto the reinforcement, or insert bent reinforcement bars to form 'chairs' that can be wired to the steel to hold it permanently in the correct position.

Typical sizes and spacing of reinforcement is welded mesh of 3mm bars at 50mm x 50mm or 8mm bars tied together at 150mm centres to form a grid. Barbed wire at 100mm centres can be used if bars are not available.

Casting the upstand

Difficulties are often experienced with casting the upstand at the same time as the apron slab because it is difficult to secure the shutter needed to support the inner face of the upstand. To overcome this, the slab may be cast initially to the correct shape without forming the raised edge. Then the inner shuttering is added and secured and the upstand is cast.

Ideally, the upstand should be formed before the concrete has fully hardened, since this improves the bond between it and the slab. Before placing the concrete for the upstand, the surface of the concrete at the joint should be roughened, swept clean and painted with a thick cement/water slurry to improve the bond between the two surfaces.
If the raised edge to the slab is to be cast some time after the slab itself, it will be advisable to cast bars or wires into the edge of the slab at appropriate places so that these can later be cast into the upstand when it is constructed. This will ensure that the raised edge does not separate from the slab. Well-fired burnt bricks, laid in and plastered with 1 : 3

cement mortar, can be used to form the raised edge, although this is likely to be less durable than concrete.

Curing concrete

For concrete to achieve its maximum strength it needs to be 'cured', that is kept wet for some time. Shortly after the concrete has set hard the apron slab can be flooded with water, held in place by dams of sand across the direction of slope.

Figure 21. Building a clay dam to hold the curing water on the slab

Alternatively, the whole slab can be covered with sand, or sacking, that is then kept saturated. The curing should last for at least one week, during which time more water will need to be added to replace evaporated water. Covering the damp sand with polythene sheeting will reduce the evaporative losses.

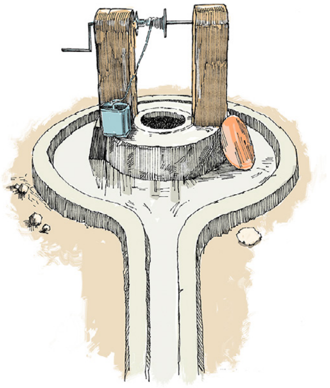

Figure 22. These recommendations are also relevant to well aprons

Summary

Choosing an appropriate design for an apron slab is not straightforward. This is because there are many factors other than the physical design of the slab that have to be considered.

Care should be taken to avoid selecting one particular least-cost design in every case, because there are unique factors about communities and sites that will mean that the least-cost design may not be appropriate.

Reasons for failures and successes of past designs used in the locality, or elsewhere in the country, should be used to assist with determining the basic minimum design criteria.

Appendices

Appendix 1: A typical arrangement for an apron slab and drainage

Appendix 2: Further design details for an apron slab and drainage

[**Appendix 3:** A raised arrangement for areas prone to flooding]

Appendix 4

Calculating flow rates at peak times
It is hard to know for sure whether or not congestion will occur at a water collection point.

If you know the discharge from the pump (which will vary with the depth from which the water is being collected and the model of the pump) and the amount of water people will collect, then you can do a rough check as shown below.

1. **Supply – find the rate of discharge from the pump**

   It is best to measure the actual discharge from the pump (or a typical tap for a piped supply) using a bucket and a stopwatch. If that is not possible then test a similar pump elsewhere. (Bear in mind that if the ground water level falls seasonally then the rate of discharge is likely to decrease. Also, if the pump is worn, then the rate of discharge can considerably decrease). In the absence of other information the graph opposite provides typical ranges of discharge for different depths of suction, deepwell and direct action pumps.

Let's assume that the discharge (supply rate) for the pump, $Q_{Sh} = 1$ m^3/hr

2. **Demand – find the amount of water to be collected per day**
   Whilst ideally at least 40 l/person/day is required for a good level of hygiene, people will rarely collect that amount from a handpump unless it is very close to their house.

   Let's assume that on average, each day, a community member will demand:

$$Q_{D24hr} = 20 \text{ l/p/d} = 0.02 \text{ m}^3\text{/p/d}$$

If we can estimate the future design population (N) for the handpump, we can now calculate the total volume, V_{D24hr} demanded from the pump each day. It is:

$$V_{D24hr} = N \times Q_{D24hr}$$

If we assume there are 200 people in the community at the end of the design life, then:

$$V_{D24hr} = 200 \times 0.02 = 4\text{m}^3\text{/d}$$

3. **Check the number of hours the pump will be in use**

The number of hours, T_p, the pump will need to operate continually is

$$T_p = (V_{D24hr} / Q_{Sh}) = (4 / 1) = 4 \text{ hr}$$

We need to allow time, T_{ex}, for exchange of water containers between users and maybe rinsing out of these containers before filling them. If this is Te per user then the total extra time needed for this over the day is:

$$T_{ex} = N \times T_e$$

Let's assume that on average it will take an extra 30 seconds per person (i.e. T_e = 0.00078 hrs per person).

Then in this example this will add another:

$$T_{ex} = (200 \times 0.0078) = 1.56 \text{ hr}$$

So the total time that the pump will be in use per day is:

$$T_{Total} = T_p + T_{ex} = 4 + 1.56 = 5.56 \text{ hr}$$

Bearing in mind that people like to collect water only at certain times of the day (e.g. relating to times of bathing needs, laundry and food preparation and washing utensils) it could be that with the pump needing to be in continual use for nearly 6 hours of the day that long queues may develop at times of the day when there is peak demand. This could cause frustration to users and result in them reducing the amount collected from the pump and possibly use of alternative, poorer quality water from alternative sources.

Warning

Note, some published sources suggest that a typical deepwell handpump is suitable to supply water to 300 people per day. If we used this number in the above example then the pump would be in continual use for over 8.5 hours every day. Whilst this is feasible it would not be very convenient for users who will not stagger their arrival evenly over this period, so are likely to sometimes need to wait a long time for their turn to use the pump.

Problems with standardization

Organizations responsible for implementing water projects usually look for ways to reduce the unit cost of installations such as borehole-equipped handpumps.

The danger with a standard design that can reduce costs is that it may not be the most appropriate design for some situations. There may be factors (such as a large number of users, the type of soil, the topography, the local materials and skills available, or the presence of users with disabilities) that mean the standard design will not be appropriate.

Cutting costs unreasonably, or failing to ensure that an appropriate design is chosen and the slab is well-constructed, can result in the failure of the handpump, unpleasant conditions for users around the handpump or pollution of the water source.

continued …

There are numerous examples all over the world of handpumps installed on apron slabs that are poorly designed or constructed. The adverse environmental conditions that result can seriously affect the health of the community.

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Numerous resources relating to handpumps and cost-effective boreholes are available at http://www.rwsn.ch/

A checklist of some important design features

Design

- Consult with members of the community and other key stakeholders
- Consider the needs of disabled people and other vulnerable groups
- Find out if the area is prone to flooding and if it is, design the waterpoint with this in mind
- Ensure the water point is designed taking into consideration the types of water containers used by the community
- Check that the design includes an apron slab with a minimum radius of 0.9m centred on the spout and a minimum concrete slab thickness of 125mm

- Design the apron so that it can drain easily: allow a minimum slope of 1 : 50 for the slab
- Consider the type of pump (or tap) to be used

Construction

- Mix and cure concrete to recommended specifications
- Ensure the borehole is sealed
- Construct pump, slab and drain foundations
- Construct a slab perimeter beam
- Construct a separate slab for the operator to stand on
- Construct raised edges to the slab
- Construct a fence around the site
- Provide an alternative drinking point for animals away from the pump

- Consider providing washing and bathing facilities nearby

Operation and maintenance

- Make sure users know how to use the handpumps or taps properly
- Plan for long-term maintenance
- Protect the water point from erosion by placing gravel on the ground around the slab
- Consider measures for mitigating against theft and vandalism

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