Notes:

FM APPROVED

Certificate of Compliance

This certificate is issued for the following:

Tiger Dam Perimeter Flood Barrier

2-1 Stackable Configuration – 19" Diameter
Single Tube Configuration – 19", 24", & 36" Diameter

Prepared for:

US Flood Control Corp
Suite 201, 505 8th Ave SW
Calgary, AB T2P 1G1
Canada

Manufactured at:

US Flood Control Corp
Suite 201, 505 8th Ave SW
Calgary, AB T2P 1G1
Canada

FM Approvals Class: 2511

Approval Identification: 3054525 Approval Granted: September 25, 2015

To verify the availability of the Approved product, please refer to www.approvalguide.com

Said Approval is subject to satisfactory field performance, continuing Surveillance Audits, and strict conformity to the constructions as shown in the Approval Guide, an online resource of FM Approvals.

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FM Approvals
Member of the FM Global Group

Dyke Protection Brochure

General Information and Methodology

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Photos and images courtesy of the German Federal Agency for Technical Relief (THW), Regional Office Emden. (www.deichverteidigung.de)

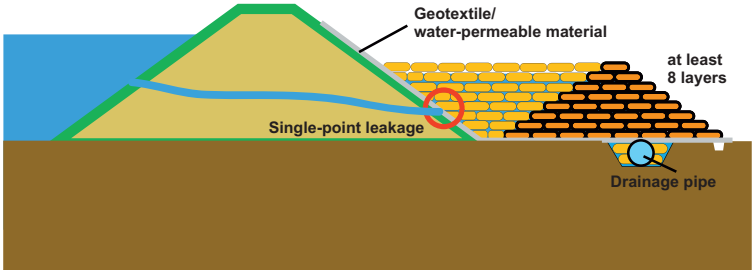
Tiger Dam Tube System
Assembly Instructions

Assembly in 7 steps

Please note:
To join the Tiger Dam tubes, use the supplied sleeves. Simply overlap the Tiger Dam tubes up to the mark printed on the tubes. Then fold the tubes over and pull the sleeve over this join (the sleeve must first have been pulled over one of the tubes before folding/joining). The ends of the tubes must also be secured using the supplied sleeves so as to decrease the pressure on the seams.

Methods and Usage
Ring Dams / Seep Water Dykes

Construction



First, the leakage/source should be marked using a sandbag, to take pressure out of the leakage. Additionally, a geotextile can also be used.

Next, place about 4 sandbags approx. 1 m from the leakage, placing them parallel to the defect. Another 4-5 sandbags are placed end-to-end on this foundation.

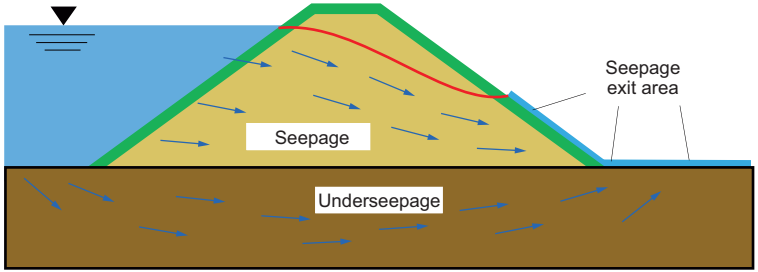
Subsequently, sandbags are placed along the dyke to the left and right. The result should be a curve.

Once the foundation has been laid, the ring dam sandbags are stacked the same way as for a sandbag dam, to achieve an increase in height. Particular care must be taken to pack the sandbags very tightly. Further sandbags can be added at any time, to increase the height of the ring dam from behind.

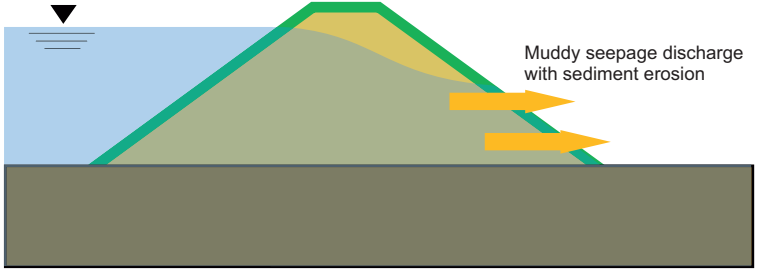
The required height has been achieved once the water level in the ring dam ceases to rise higher.

Photo credits: THW Emden

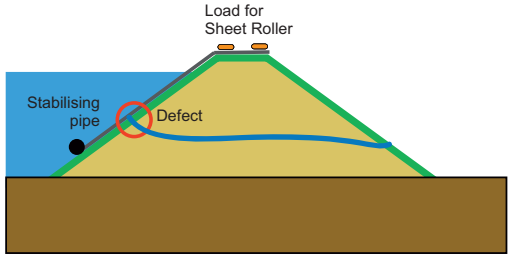
Seepage



When water levels rise in the vicinity of a dyke, natural seepage discharge will occur over time and will exits from the lower third of the levee. The red seepage line marked in the above diagram represents the boundary between the dry and water-logged parts of the dyke.
Particular attention must be paid to the type of seepage discharge on the landside of the dyke. Silty or muddy seepage water indicates that sediment has been washed out of the dyke. This means that the core of the dyke is being eroded internally. In this situation, urgent action is required and an expert must always be consulted to examine the dyke.



Sheet Roller / Installing Plastic Sheeting



A sheet roller is a dyke protection tool used mainly in Hamburg, Germany.
It can help repair damage to the waterside of the dyke.
Plastic sheeting is rolled around a pipe, which can be easily put in place in the flowing water, using trusses.

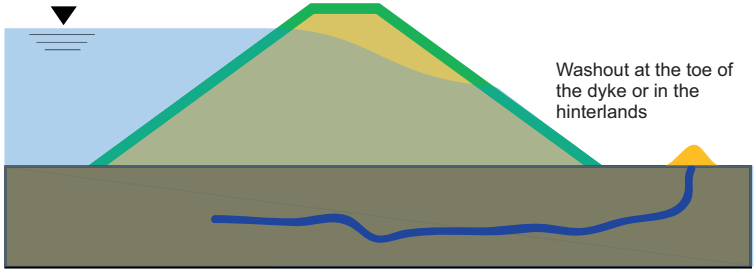
Plastic sheeting installed by divers has also proven effective. Here, divers place sheeting over the presumed defect and weigh the sheeting down with sandbags. Caution must be taken, as the divers must work in extreme conditions and suitable safety measures must be taken.

Success can be ensured, if the plastic sheeting is drawn to the defect via a suction process, forming an airtight seal around the defective area.

Photo credit: THW Emden (Dannenberg 2006)

Please note that plastic sheeting must only be used on the waterside of a dyke.
Of course, there are exceptions to this rule but these can only be assessed by an expert.
Plastic sheeting should not be used to protect large areas of the waterside of a dyke as sheeting cannot be fully sealed when it is installed on the surface of the dyke.
Such large-scale protective measures require excessive manpower and cannot guarantee successful results. Hence, sheeting should only be used for single-point leakages.

Dyke Hinterlands



If floodwater levels remain high over a long period of time, water discharge may occur in the immediate vicinity of a dyke, or in its hinterlands. Seepage beneath the dyke itself may lead to crater-shaped water discharge points on the landside of the dyke, which are often associated with sediment erosion. Primarily, sediment from the foundation of the dyke is eroded, which leads to a significant decrease in the structural soundness of the dyke. Such erosion can lead to seepage failure, causing the dyke to break over a considerable distance.

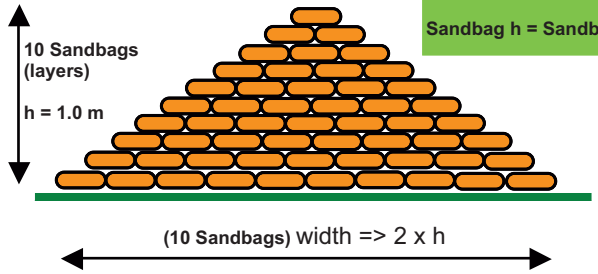
These photos show examples of water discharge points on the landside of a dyke
Photo credits: THW Emden

! Risk of seepage failure.
Urgent action – in consultation with an expert – must be taken.

Sandbag dam, normal stability

The number of sandbags for the base width is generally the same as the number of sandbags for the height.

Sandbag h = Sandbag w

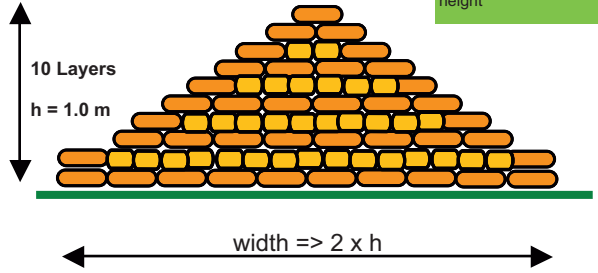


Sandbag dam, increased stability

Total number of sandbags in the cross-section:

$sum = n * (\frac{n}{2} + 0.5)$

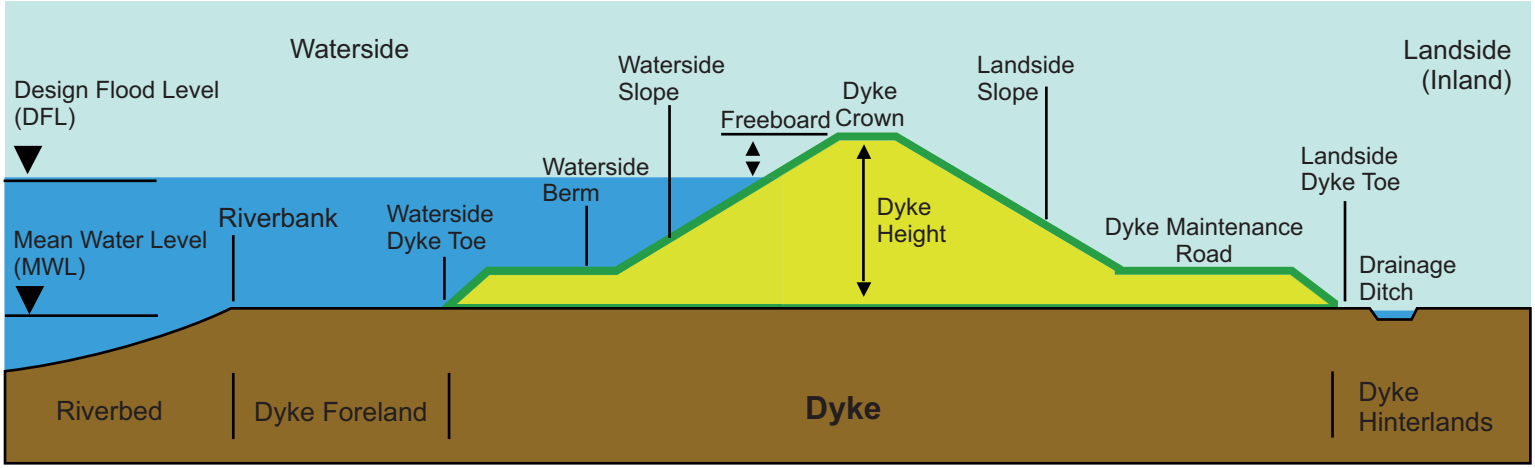
n = number of sandbags per height



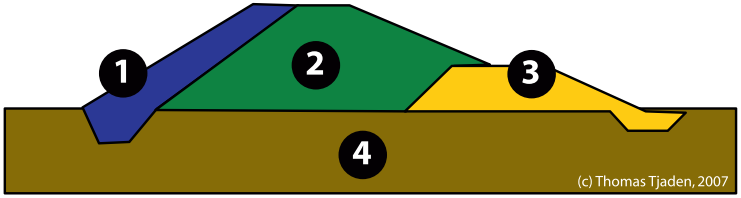
! Sandbag dams should always be tightly packed, so that the dam becomes almost impermeable.
Using additional plastic sheeting on the waterside has also proven effective.

General Information

Dykes - Terms and Characteristics



Ideal Dyke Construction



! Dykes are built according to the specific requirements and conditions on site. Always consult an expert.

1. Sealing layer of the dyke, impermeable
2. Supporting body of the dyke, permeable
3. Drainage/ filtration body of the dyke, very permeable
4. Contact with a sealing foundation

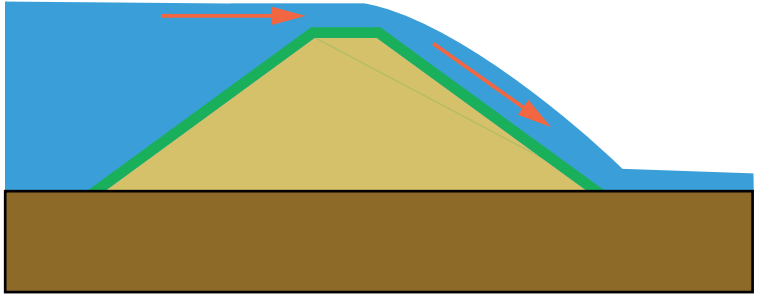
! River dykes are built to withstand hydro-static pressure (from the water). Coastal dykes are built to withstand dynamic pressure (from wave action). Therefore these two types of dyke differ in their structure.

Please note:

The underlying principles of how an ideal dyke functions should be observed when applying dyke protection measures in practice. A sealing layer should face the waterside, next to which a supporting body should be installed (although a supporting body is not always required). Facing the landside, a drainage body must to be installed, which allows water to exit the dyke/ levee and which filters out sediment.

General Information

Over-topping



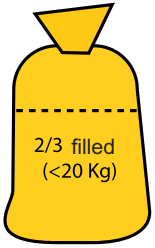
Floodwaters may cause over-topping to occur in some sections of a dyke. If there is a risk of over-topping, it is vital to begin raising the height of the dyke crown immediately. In addition to raising the height of the dyke using a sandbag dam, it may also possible to use sandbag-replacement systems like the EFC dam tubes. However, this system must only be used under the supervision of an on-site expert.

Photo credits: THW Emden

When work is commenced on raising the height of a dyke crown, it is important to also consider reinforcing and supporting the dyke toe at the same time, because the additional weight of the sandbags on the crown will decrease the overall stability of the dyke even further.

Methods and Usage

Sandbags



Sandbags are the absolutely essential, key piece of dyke protection equipment for disaster relief work.

While there are no set standards for sandbags, they can generally be classified as follows:

- hessian (jute) sandbags
- PP (synthetic) sandbags

Sandbags can be bought in lots of 1,000 or 2,000.

Sandbags are filled to a maximum weight of 20 kg and should not be filled to more than 2/3 of their total volume (improved handling).

Sandbags can be filled using numerous different methods. Sandbag filling funnels and truncated (cut) traffic cones have proven particularly useful and effective.

In addition to sandbags, “bulk bags” or “big bags” can also be used, however, these can only be transported using heavy machinery.

Photo credit: Heiner Bach, THW

Photo credit: THW Emden

Filling and shifting sandbags is hard manual labour. Therefore it is vital to provide refreshments and beverages to helpers and to ensure adequate safety measures are in place for them. Also, a sufficient reserve contingent of helpers should be arranged.

Methods and Usage
Dyke Toe Protection

Construction

Photo credits: THW Emden

Dyke toe protection serves to additionally stabilise the levee toe. It also serves as a drainage layer when widespread seepage discharge occurs on the landside of the dyke.

The first construction step is to spread out a water-permeable material* or reinforcement steel mesh, or both.

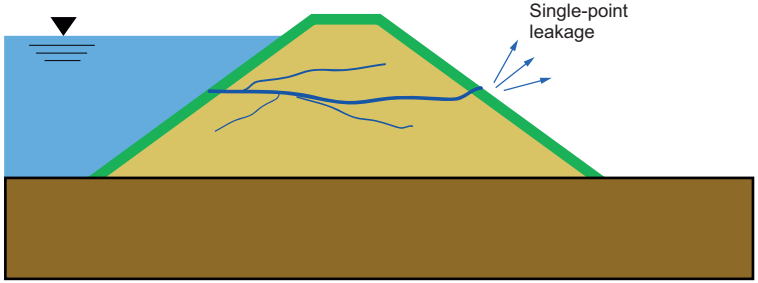
Next, a foundation is constructed by placing 2 sandbags next to each other, while creating a “gap” of approx. 5 cm (or a foot's width) between these and the next 2 sandbags. This gap will channel the water directly out of the dyke and enable the water volume to be controlled.

Once the foundation has been laid, further layers are added to provide additional weight until the required stabilisation is achieved. (This must be determined by an on-site expert.)

*) Water-permeable materials such as geotextiles or fleece are used to filter out the sediment which has been washed out. Additionally, these materials help to achieve an even surface pressure from the weight of the sandbags.

Water-**im**permeable materials must never be used for this purpose!

General Information
Single-point leakage



In addition to large seepage discharge areas, damage to a dyke can also occur as a single-point leakage. While large seepage discharge areas generally arise due to “natural” seepage, single-point leakages are usually the result of a defect in the dyke, for example due to:

- trees or shrubs
- animal burrows
- mechanical influences

Such defects in a dyke – in combination with adjacent floodwater – will often result in sediment being washed out of the dyke (so-called washout). This means that urgent action is required – otherwise the structural soundness of the dyke can no longer be guaranteed.

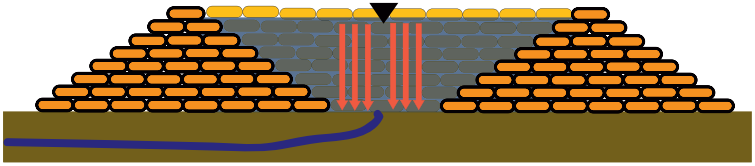
To help limit the damage caused by such defects, a ring dam can be constructed – see pages 16 + 17 – which will prevent further washout.

! Silty water is a sign of dyke erosion and washout. Urgent action – in consultation with local experts – must be taken!

Methods and Usage

Ring Dams / Seep Water Dykes

Function



For single-point leakages on dykes – or for such leakages in the dyke hinterland – seep water dykes or ring dams are used to repair the damage.

Ring dams work according to the principle of “communicating vessels”. Due to the pondage of discharged water, which takes place inside the ring dam, counter pressure ensues which stops the leak's flow after some time. Additionally, a ring dam reduces the amount of sediment erosion, helping to ensure the structural soundness of the dyke.

If plastic sheeting is simultaneously applied to the defect on the waterside of the dyke, the ring dam may run dry again. This is usually a sign that the sheeting applied to the waterside of the dyke was installed successfully.

Photo credits: THW Emden (Dannenberg 2006)

Tiger Dam Tube System

Assembly Instructions

Assembly of the Tiger Dam Tube System in 7 steps

1. Only two people are needed to assemble the flexible EFC dam tubes. Fully unroll the tubes and join them together using tie straps, before filling the tubes with water.
2. Diagram 2 on the previous page shows three tubes being placed on the ground parallel to each other. The valves have been opened, so that the tubes can be filled with water.
3. The bottom layer of a tube pyramid is then filled with water to its maximum capacity.
4. Next, the second layer of tubes is put in place. Ensure that each tube is secured using tie straps and runs parallel to the bottom layer of tubes.
5. The second layer of tubes is also filled with water to maximum capacity.
6. Once the second layer of tubes has been filled with water, the third and final layer of tubes is put in place on top of the second layer. Ensure the tubes are positioned evenly and parallel to the other tubes.
7. Six tubes, which have been layered to make a pyramid, present a highly effective floodwater barrier. The overall assembly time is approx. 1 hour, but depends on which method is used to fill the tubes with water.

Joining two EFC dam tubes together

Simply overlap the dam tubes up to the mark printed on the tubes. Then fold the tubes over and pull the supplied sleeve over this join. The ends of the tubes must also be secured in this manner – fold at the printed mark and pull a sleeve over this fold.

Methods and Usage
Key Calculations

Sandbags

Weight:	approx. 20 kg	Sandbags/m²:	approx. 8
Euro-pallet:	approx. 70 sandbags	Sandbags/m³:	approx. 80
Weight/pallet:	approx. 1.5 t		
1 t is equivalent to:	50 sandbags	**80 sandbags / helper / hour**	

Sandbag Dam

Length (m)	Height (m)	Sand Quantity (m³)	Sandbags
1	0.5	0.50	30
1	1.0	2.00	120
1	1.5	4.20	260
1	2.0	7.40	450
5	0.5	2.60	160
5	1.0	9.60	600
5	1.5	21.00	1300
5	2.0	36.75	2250
100	0.5	52.50	3200
100	1.0	192.50	11800
100	1.5	420.00	25800
100	2.0	735.00	45000

Ring Dam

For a standard ring dam with a height of 80 cm, approx. 800 sandbags are required.

Dyke Toe Protection

Layers	Height (m)	Sandbags (m²)
1	0.1	8 - 10
2	0.2	16 - 20
3	0.3	24 - 30
4	0.4	32 - 40
5	0.5	40 - 50

Tiger Dam Tube System
Technical Data & Applications

Technical Data

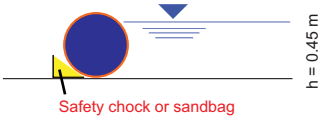
Length:	**15 m**
Height (filled):	**0.50 m**
Water content:	approx. **2750 l**
Weight (empty):	**30 kg**
Material:	**PVC**

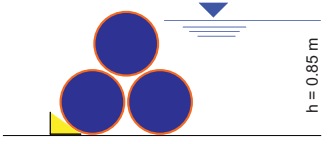
All Tiger Dams are FM-approved

Comparison: Tiger Dam vs. Sandbags (150m long protective dam)

Height of protective dam:	**0.45 m**	**0.85 m**	**1.20 m**
No. of Tiger Dams required:	**10**	**30**	**60**
max. assembly time (for 1 person):	**4 h**	**8 h**	**12 h**
Equivalent no. of sandbags:	**5500**	**14500**	**32500**
Assembly time (for 1 person):	**125 h**	**350 h**	**800 h**

Using Tiger Dam Tube System for different dam heights





The tubes must be securely joined together using tie straps.
For each length of tubing (15 m), 4 tie straps (h = 0.85 m) or 8 tie straps (h = 1.25 m) are needed.
The tubes must also be secured to the ground using anchors!