INTERNATIONAL STANDARD

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Measurement of liquid flow in open channels — Bed material sampling

Mesure de débit des liquides dans les canaux découverts — Échantillonnage des matériaux du lit

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical commitees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 4364 was prepared by Technical Committee ISO/TC 113, *Hydrometric determinations*, Subcommittee SC 6, *Sediment transport*.

This second edition cancels and replaces the first edition (ISO 4364:1977), which has been technically revised.

Annex A of this International Standard is for information only.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

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Introduction

Bed material samplers are used to obtain samples of sediment from the bed of a watercourse. They are not to be confused with bed-load discharge samplers which are used to determine the discharge of sediment as bed load.

Particle size data derived from bed samples, together with hydraulic data, are necessary for the computation of bed-material load and for flow estimation.

This International Standard covers methods for sampling both non-cohesive and cohesive bed material. Sediment composed of material with a particle size finer than 30 µm is cohesive. However, coarser material can also be cohesive if it contains a small proportion of this finer fraction.

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Measurement of liquid flow in open channels — Bed material sampling

1 Scope

This International Standard gives guidance on methods for sampling of both non-cohesive sand bed material and cohesive bed material (both of which may contain some fine gravel), principally for the purpose of determining the grain size frequency distribution of the bed material in open channels.

NOTE — Other publications of relevance to samplers and sampling techniques are listed in the bibliography in annex A.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 772:1996, *Hydrometric determinations — Vocabulary and symbols.*

ISO 4363:1993, *Measurement of liquid flow in open channels — Methods for measurement of suspended sediment.*

ISO 4365:1985, *Liquid flow in open channels — Sediment in streams and canals — Determination of concentration, particle size distribution and relative density.*

ISO 9195:1992, *Liquid flow measurement in open channels — Sampling and analysis of gravel bed material.*

3 Definitions

For the purposes of this International standard, the definitions given in ISO 772 apply, together with the following.

3.1 sand

Sediment having a particle diameter between 0,0625 mm and 2 mm.

4 Sampling procedure

Ideally, the size composition of the bed material should be determined for various stages of flow, as composition can change due to scour and fill activities.

In cases where information is required on the composition of layers at greater than approximately 0,05 m below the surface of the bed, the use of core-type samplers is recommended.

Precautions should be taken to prevent fine particles escaping from the sample

5 Selection of site

The site for sampling bed material for the purpose of computing bed material load or for flow estimation should be located as near as possible to the site where hydraulic measurements are made or need to be estimated. Equations for estimating bed load transport and flow resistance usually need measurements from a straight uniform section of channel. Site conditions should be selected that are suitable for the estimating equations which are to be used.

When estimates of total load are to be made, it is also essential that the site conforms to the conditions specified for the measurements of suspended sediment loads in ISO 4363.

For investigations of bed material transport rates it is recommended that as a minimum a sample should be taken at each vertical in the cross-section where sediment transport is to be measured.

6 Selection of sampler

In order to sample successfully, the sampler and the sampling method need to be chosen for their suitability for the particular circumstances. Results obtained using different methods may not necessarily be comparable.

When bed material is sampled, the sample inevitably suffers some form of disturbance. This can result in loss of fines, in which case the sample is referred to as `disturbed', or in loss of fabric, which is referred to as `structural disturbance'. Structural disturbance of the sample does not affect the assessment of the erodability of non-cohesive sediments, whereas it does affect the results of tests on the erodability of cohesive sediments.

The construction and use of different types of samplers are described in clauses 7, 8 and 9.

7 Hand-held samplers

7.1 General

Hand-held samplers are lightweight devices which can be operated by an individual while wading or, in deeper water, by a Scuba diver. Hand-held samplers include bed surface samplers and core samplers.

7.2 Bed surface samplers

7.2.1 *Sampling cylinders*

7.2.1.1 *Construction*

A sampling cylinder comprises a metal cylinder which encloses the area of bed to be sampled, and which is heavy enough to resist the flow. If practicable, the cylinder should break the water surface.

7.2.1.2 *Deployment*

Digging tools are used to remove samples from within the enclosed volume. The cylinder helps to minimize the washout of fines.

7.2.1.3 *Sample type*

This method yields disturbed samples. The top 0,1 m approximately of the bed is sampled.

7.2.2 *Pipe scoops*

7.2.2.1 *Construction*

A pipe scoop comprises a pipe, one end of which is closed and the other end of which is bevelled to form a cutting edge, attached to a wading rod. A hinged cover plate, held closed by a spring, is mounted over the open end. The plate is opened by a rope (see figure 1).

7.2.2.2 *Deployment*

The pipe is pushed along the bed into the current. The plate is opened to sample then immediately closed, thus minimizing washout.

7.2.2.3 *Sample type*

This method yields disturbed samples. Samples of mass up to 3 kg can be obtained. The top 0,05 m approximately of the bed is sampled.

7.2.3 *Bag scoops*

7.2.3.1 *Construction*

A bag scoop comprises a metal ring with an attached flexible bag, mounted on a wading rod (see figure 2).

7.2.3.2 *Deployment*

The ring is forced into the bed and dragged upstream until the bag is full (see figure 2a). As the sampler is raised the bag seals automatically (see figure 2b).

7.2.3.3 *Sample type*

This method yields disturbed samples. Samples of mass up to 3 kg can be obtained. The top 0,05 m approximately of the bed is sampled.

7.3 Core samplers

7.3.1 *Push or hammer corers and boxes*

7.3.1.1 *Construction*

These include metal or plastics corers up to 150 mm in diameter and boxes of up to 0,25 m side.

7.3.1.2 *Deployment*

The cylinder or box of the corer is pushed or hammered into the bed and dug or pulled out. Sample retention can be ensured by use of one or more of the following methods.

A plate is slid beneath the corer and the cylinder or box is dug out.

A partial vacuum can be created above the sample.

After the insertion of the cylinder or box, the water-filled space above the sample can be sealed off by means of a screw cap, thus forming a partial vacuum when the sampler is withdrawn (see figure 3).

Alternatively, in the case of cylinder samplers the cylinder can be fitted with a piston which rises on the surface of the sample and is locked when the sampler has been pushed or hammered to the desired depth. A partial vacuum develops below the piston and helps to hold the sample in the cylinder as it is withdrawn from the bed (see figure 4).

In the case of cylinder samplers a core catcher (sphincter) of flexible stainless steel petals can be located at the bottom opening of the cylinder (see figure 5).

7.3.1.3 *Sample type*

This method disturbs the texture and structure of the sample, although the gross particle population may be preserved. Maximum penetration is approximately 0,5 m.

A freeze-core sampler comprises a thin walled copper or mild steel tube with a hardened steel tip. A probe, through which liquid carbon dioxide, liquid nitrogen or solid carbon dioxide mixed with acetone can be injected, is inserted into the tube. In the case of liquid carbon dioxide, delivery is from a pressurized cylinder via fine nozzles in the probe (see figure 6).

7.3.2.2 *Deployment*

The outer tube is hammered into the bed and the probe, connected to the coolant, inserted into it. After a suitable period, which depends on the sediment properties and the ambient temperature, the tube is pulled out of the bed with the adjacent sediment frozen to it.

7.3.2.3 *Sample type*

This method yields a spindle-shaped frozen `core' up to 0,5 m in length and with a maximum diameter of approximately 0,3 m. Sedimentary structures are disturbed but recognizable.

7.3.2.4 *Limitations*

The method is not suitable for Scuba use or for water depths in excess of 3,5 m.

8 Lightweight remotely-operated samplers

8.1 General

These samplers can be hand-operated and can be deployed from small boats. They include bed surface samplers and core samplers.

8.2 Bed surface samplers

8.2.1 *Pipe scoops and bag scoops*

8.2.1.1 *Construction*

Pipe scoops and bag scoops are constructed as described in **7.2.2.1** and **7.2.3.1**, respectively. The scoop is attached to pole up to 4 m in length.

8.2.1.2 *Deployment*

The scoops are deployed as described in **7.2.2.2** and **7.2.3.2**, respectively. Normally it is necessary for the boat to be anchored.

8.2.1.3 *Sample type*

This method yields disturbed samples. Samples of mass up to 3 kg can be obtained. The top 0,05 m approximately of the bed is sampled.

8.2.1.4 *Limitations*

Use of this method is limited to water depths of less than 4 m and velocities of less than 1,0 $m \cdot s^{-1}$.

8.2.2 ***Drag buckets***

NOTE. These are also known as dredges.

8.2.2.1 *Construction*

The sampler comprises a weighted bucket or cylinder with a flared cutting edge at one end and a sample collecting receptacle at the other. A drag rope is attached to a pivoting bridle towards the cutting end of the cylinder (see figure 7).

8.2.2.2 *Deployment*

The device is lowered to the bed and dragged along it from a boat moving slowly into the current. To ensure contact of the cutting edge with the bed a streamlined weight can be attached to the rope.

8.2.2.3 *Sample type*

This method yields disturbed samples. Samples of mass up to 1 kg can be obtained. The top 0,05 m approximately of the bed is sampled.

8.2.2.4 *Limitations*

Samples are liable to be affected by washing-out of material.

8.2.3 ***Grab samplers with 90° closure***

8.2.3.1 *Construction*

Two quarter-cylinder shaped buckets are hinged to each other, forming a half-cylinder when closed. Arms are attached to each bucket to which a rope and pulley system is fastened. A latching system holds the buckets open until the grab reaches the bed. The slackening of the

rope releases the latch, and the tightening of the rope as the grab is retrieved closes the buckets (see figure 8).

8.2.3.2 *Deployment*

The grab is latched open and lowered slowly to the bed from a slowly drifting or anchored boat. The rope is allowed to slacken momentarily then a steady pull is applied and the grab retrieved.

8.2.3.3 *Sample type*

The samples obtained are often relatively undisturbed. Samples of mass up to 3 kg can be obtained. The top 0,05 m approximately of the bed is sampled.

8.2.3.4 *Limitations*

This method is not suitable for use in sand when amounts of coarse gravel are present as stones wedge open the jaws allowing the sample to wash out.

The grab may be too light to use when water velocities exceed 1,0 $m \cdot s^{-1}$.

8.2.4 ***Grab samplers with 180° closure***

8.2.4.1 *Construction*

A half-cylinder shaped bucket is pivoted and spring-mounted within a streamlined housing with a flat base. The spring is tensioned when the bucket is rotated into the housing. A latching system keeps the bucket in this position until the bed is reached and the tension goes out of the support rope, at which point the bucket snaps shut enclosing the sample. The sampler has a mass of approximately 15 kg (see figure 9).

8.2.4.2 *Deployment*

The bucket is rotated into the housing and, keeping a steady tension on the rope, the grab is lowered slowly to the bed. The rope is slackened to close the bucket, then the grab is retrieved.

WARNING. This device can maim if accidentally triggered whilst it is being handled.

8.2.4.3 *Sample type*

This method yields disturbed samples. Samples of mass up to 1 kg can be obtained. The top 0,05 m approximately of the bed is sampled.

8.2.4.4 *Advantages and limitations*

This equipment can be used to sample sediment containing stones up to approximately 30 mm in diameter without serious wash-out of material. However, stones caught between the bucket and the body of the sampler, keeping the bucket wedged open, can allow some material to fall out. The sampler has been observed to bounce off the bed on hard-packed sands.

8.3 Corer samplers

8.3.1 *General*

The samplers are as described in **7.3**, but are restricted to push or hammer corers (see **7.3.1**) 100 mm or less in diameter.

8.3.2 *Push or hammer corers*

8.3.2.1 *Construction*

The sampler comprises a corer up to 100 mm in diameter attached to pole up to 4 m in length, with a vacuum or core-catcher sample retention mechanism as described in **7.3.1.2**.

8.3.2.2 *Deployment*

The sampler is deployed from a boat which needs to be anchored fore and aft.

8.3.2.3 *Sample type*

Samples of non-cohesive material are undisturbed. Samples of cohesive material suffer structural disturbance. The corer has a maximum penetration of approximately 0,5 m, and yields samples of up to 1,5 kg mass per 0,1 m penetration.

8.3.2.4 *Limitations*

This type of sampler is difficult to use if water velocities exceed 1,5 $m \cdot s^{-1}$.

9 Remotely-operated samplers requiring handling machinery

9.1 General

To obtain larger samples, either in terms of surface area or depth of penetration of the bed, or for sampling under conditions with high flow velocities (> 1,5 $m \cdot s^{-1}$) heavier equipment has to be deployed. Derricks and winches need to be mounted on a reasonably sized vessel (> 5 m length), the draft of which generally makes it impracticable to work in water depths of less than 1,2 m.

9.2 Bed surface samplers

9.2.1 *Anchor dredges*

9.2.1.1 *Construction*

An anchor dredge comprises a cylindrical or rectangular-section open-ended box of up to 0,5 m diameter or length of side. A large heavy-duty flexible bag is laced to one end, and the other end is flared to provide a cutting edge. A bridle spans the open end, pivoted from the centre of the box, to which a tow line is fastened (see figure 10).

9.2.1.2 *Deployment*

The dredge is deployed as described in **8.2.2.2**.

9.2.1.3 *Sample type*

This method yields disturbed samples. Samples of mass up to 0,5 t can be obtained. The top 0,1 m approximately of the bed is sampled.

9.2.1.4 *Limitations*

Considerable power is needed to pull the equipment.

9.2.2 *Grab samplers with 90° closure*

9.2.2.1 *Construction*

A variety of designs are in use, ranging from larger versions of the simple grab described in **8.2.3.1** to devices where the buckets are mounted in a frame and triggering is effected via contact plates protruding below the grab base. One type uses a spring system to force the open buckets partially into the bed prior to the jaws being wound shut. The mass of the grabs is of the order of 0,5 t, but can be doubled by the addition of lead. An example is shown in figure 11.

9.2.2.2 *Deployment*

The grabs are deployed as described in **8.2.3.2**.

Grabs with trigger plates protruding from the base need special tables to land upon.

9.2.2.3 *Sample type*

The samples obtained are often relatively undisturbed. This equipment can take samples of up to 0,1 m^2 to a depth of approximately 0,15 m.