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Technical Assistance
HYDROLOGY PROJECT

DHV CONSULTANTS & DELFT HYDRAULICS with HALCROW, TAHAL, CES, ORG & JPS

VOLUME 5
SEDIMENT TRANSPORT MEASUREMENTS

REFERENCE MANUAL

Table of Contents

1 INTRODUCTION TO BED LOAD MEASUREMENTS

Bed load gauging (also called bed load transport measurement) is often mixed up with bed material sampling. Bed load gauging is the measurement of the amount of sediment that is moving as “bed load”, i.e. rolling, sliding and bouncing (in “saltation”) on or over the stream bottom, while bed material sampling is the collection of the material composing the stream bottom.

Bed load transport measurements are rightly considered as very difficult and complicated. The reasons for this are:

- the poor understanding of the transport processes: (what are we measuring?)
- the very irregular character of the particle movement in the bed load
- the disturbance of the flow and of the bed load transport processes when a sampling device is lowered on the stream bottom

As bed load accounts only for a small fraction of the total load and because measurements are difficult to perform, bed load transport measurements are most often discarded and replaced by computations. However, the uncertainties on computations with bed load transport formulas are as bad as those on measurements. Moreover, the economic importance of bed load observations is usually underestimated, especially in sand bed streams.

Because of the complexity of bed load transport measurements, extensive training is required. Besides the obvious need for training in a proper operation and maintenance of bed load instruments, bed load gauging strategies are required to get the most representative samples and measurements. **Bed load measurements should be avoided if a good training and a thorough follow up of the measurement procedures can not be ensured.**

2 BED LOAD MEASUREMENT FREQUENCY

Bed load movement is by nature irregular and random. It is not often measured and a consensus does not seem to exist about how to determine the frequency of bed load gauging. As bed load has not yet been routinely observed in the Indian Peninsula, only crude rules may be suggested for determining in advance the minimum required bed load sampling frequency. In this respect, analyses of pre-existing suspended load observations and bed material sizes may be of some help.

Bed movement occurs above a flow threshold, e.g., a critical level of velocity or of shear stress. For all flow under this threshold, the bed material will not or barely move; above the threshold, bed material will be transported.

The geomorphic setting should be established before starting bed load observations. A survey with a questionnaire about the characteristics of river basin, river course and gauging station would reduce significantly the investment and cost for operation and maintenance of a bed load measurement network.

3 MEASURING TECHNIQUES

3.1 GENERAL

The total sediment transported by the stream can be classified under various load and transport modes:

1. according to origin:

- bed material load, which may be moving as:
    - bed load
    - suspended load
  - wash load moving as suspended load

2. according to transport mechanism:

  - bed load
  - suspended load, including bed material in suspension and wash load.

Sediment transported as bed load can be measured by:

- the **direct method**, in which the bed load transport rate at a point is measured directly over a given time lapse with the aid of a single device;
- the **indirect method** in which the movement of the bed material is **assessed** by an observation, e.g. the movement of dunes resulting from the bed load, over a given time period.

The selection of method and/or device should be made cautiously, taking into account the kind of environment and objectives, e.g. the type of river, the geomorphic setting, the variation of hydraulic conditions and sediment characteristics with changing stages, the data needs and their users. Sediment gauging strategies may be set up by adapting the methods, techniques and instruments depending to the conditions, for one station or for the network in a catchment.

3.2 BED LOAD AND NEAR-BED MEASURING TECHNIQUES

The instruments for bed load measurements are diverse and specific handling rules apply for each. However, some general rules can be given, some similar to the ones for near-bed sampling:

- hang the sampler so that it is inclined with the front higher than the rear; this will allow a smooth landing on the bed with little disturbance of the bed sediments;

- lower the instrument quickly over the vertical as to reduce the sampling in transit, but reducing speed when coming close to the streambed. This is needed as the drag by the flow will reduce when the instrument comes closer to the bottom, in slower moving flow layers. This makes the sampler touch the bed even when keeping the same unrolled length of suspension cable (the dry- and wet-line corrections become smaller). The frame will hit the streambed and scoop the bottom If the lowering speed is not reduced; the operator will feel with his hand at the cable when the tail of the frame touches the ground so that he can unroll the suspension cable slowly for 0.50 cm more, then unrolling some additional length so as to have the frame standing free on the streambed;

- start the stop-watch as soon as the sampler has reached the bed;

- the operator has to watch carefully the strength of the cable, otherwise the frame could be dragged over the stream bottom during sampling, due to the possible swinging of the survey vessel, disturbing the sampling, e.g. by getting the inlet/nozzle wrongly oriented;

- when sampling time is over, the operator will wind up the cable in time so as to have enough strength in the cable before lifting, otherwise sampling time could be exceeded. He then winds up the cable quickly but not unduly to avoid dragging the frame over the bed;
- pull the sampler quickly to the surface and empty it immediately.
- handle the sample with much care, especially not to loose solids.

Near-bed load measurements with transport-rate trap samplers may be considered as a special case of suspended load sampling, although the load may be either suspended- or bed load. The Delft Bottle sampler, as an example, is mounted on a frame (the sleigh, see Figure 3.1), in its near-bed version. It produces an additional drag, which complicates the handling. The same precautions as for the bed load measuring devices apply.

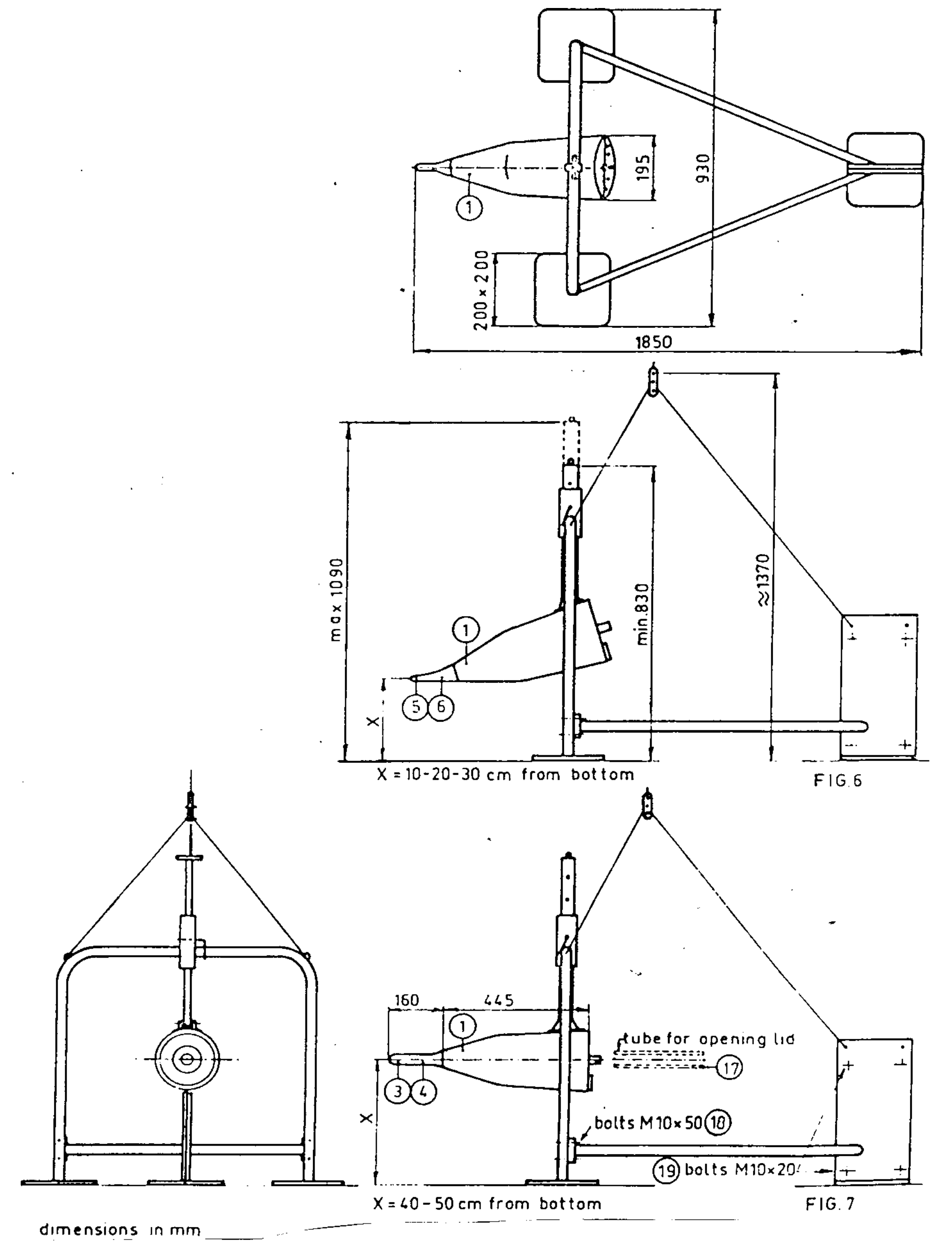


Figure 3.1: Delft bottle with bottom frame

3.3 BED LOAD DETERMINATION METHODS

The objective is to determine, by sampling or by calculation, that part of the sediment transported near the bed or in contact with it, most of it being bed material

3.3.1 BED LOAD SAMPLING

Bed load discharge can be extremely variable. Variations in bed load transport rates – both in space and with time – may be observed during steady-flow conditions, as well as during changing flow discharges. Moreover, morphological processes affect the bed load more than the suspended load. Even during conditions of constant flow, the streambed adapts with a certain lag to the changing flow.

In order to collect a sample, which represents the mean bed load discharge, all variations must be taken into account. Therefore, an in-depth preliminary site inspection and study should be conducted before starting bed load measurements.

In sandbed rivers, the spatial or cross-channel variation in bed load transport rate is usually significant. Bed load transport rates often vary from zero or a small value near banks to larger values toward midstream, but quite often this distribution does not follow the distribution of the flow velocity, flow discharge, shear stress or streampower.

The mean cross-channel distribution of transport rate may vary uniformly, may be uniformly consistent, may be erratic with tongues and stringers or may be an unpredictable combination of varying tendencies

The temporal and spatial variations in transport rates of bed load discharge that occur under steady flow conditions are amplified when the stage changes rapidly. In most field sampling programs, the number of samples collected must represent a compromise between accuracy and economic feasibility.

Another challenge encountered in bed load sampling is to collect a representative sample. Ideally, the sampler should trap, during the sampling period, all bed load particles that would normally have passed through the width occupied by the sampler and reject all particles that normally would not have passed through the width during the same period. The degree to which this is accomplished is termed the “sampling efficiency”. It is defined as the ratio of the mass of bed load collected to the mass of bed load that would have passed through the sampler width in the same time period had the sampler not been there.

The following general methods that minimise the number of samples required for obtaining a reasonable estimate of mean cross-sectional bed load discharge, can be used to collect the samples:

1. The single-equal width increment (SEWI, Figure 3.2) method of 20 evenly spaced verticals in the cross-section. The time the sampler is left on the bottom is equal for all the verticals.
2. The multi-equal width increment (MEWI, Figure 3.3) method: starting at one bank and proceeding to the other, one sample is collected at 4 to 5 evenly spaced verticals; then, return to the starting bank and the process is repeated 8 to 10 times until a total of 40 samples has been collected. Sampling time needs not to be equal at all verticals if the sample collected at each vertical is bagged separately.
3. The unequal-width increment (UWI, Figure 3.4) method: starting at on bank and proceeding to the proceeding to the other, one sample is collected from 4 to 10 unevenly spaced verticals, return to the staring bank, and the process is repeated until a total of 40 samples has been collected.

The most suitable method must be derived for each site at which bed load discharge data is to be collected.

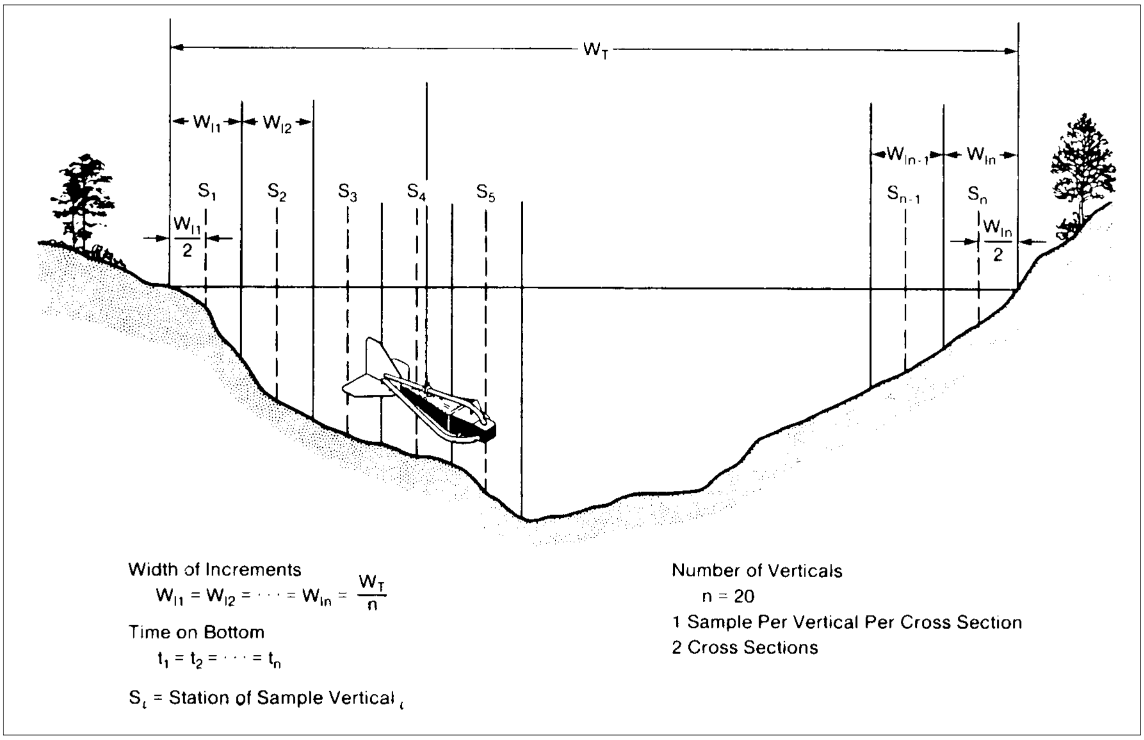


Figure 3.2: Single equal width increment (SEWI) bedload sampling method

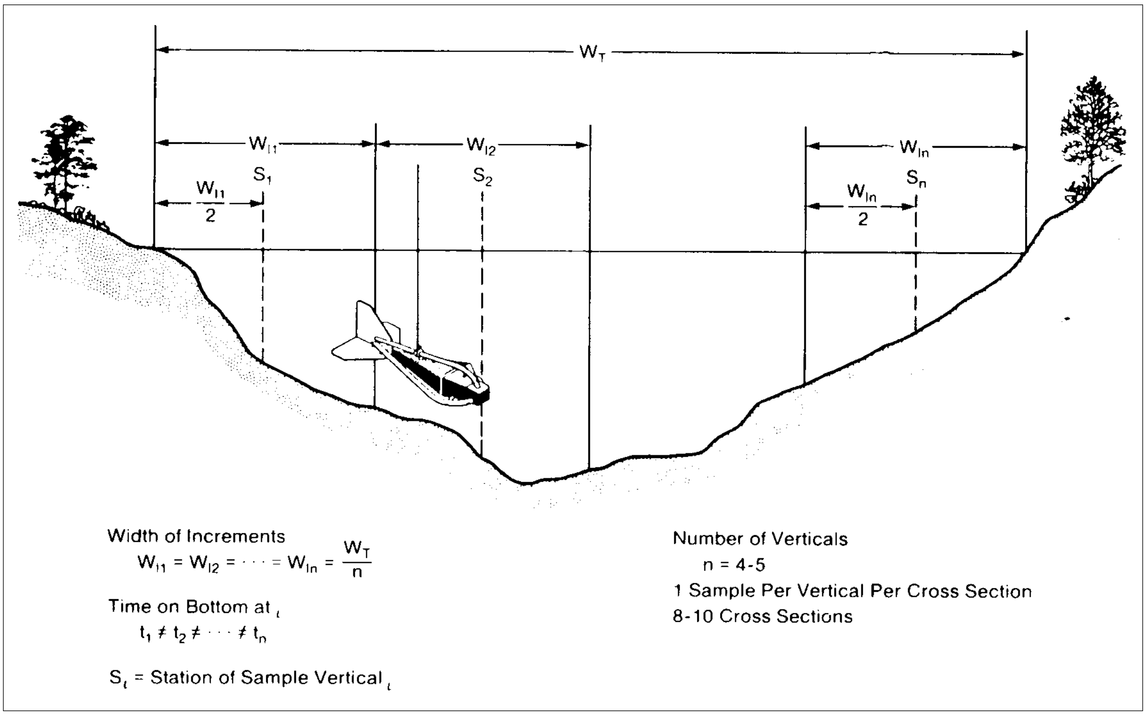


Figure 3.3: Multiple equal width increment (MEWI) bedload sampling method

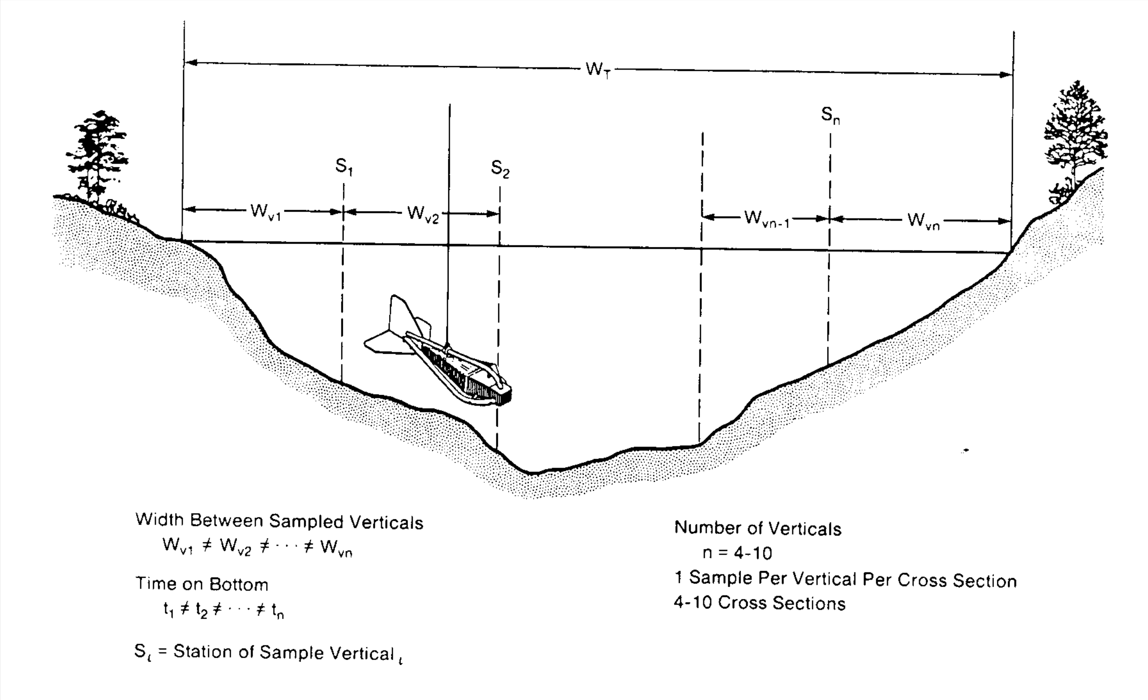


Figure 3.4: Unequal width increment (UWI) bedload sampling method

3.3.2 BED LOAD DISCHARGE COMPUTATIONS

The bed load transport rate at a sample vertical may be computed by the equation:

$$R_i = K \frac{M_i}{t_i} \quad (3.1)$$

Where:

Where:	R_i	=	bed load transport rate, as measured by bed load sampler at vertical i, in tons or in m³ per day and unit width (m)
	M_i	=	mass of the sample collected at vertical i , in grams
	t_i	=	time the sample was on the bottom at vertical i , in seconds
	K	=	a conversion factor used to convert grams per second per unit width (meter) into tons or m³ per day per unit width (m).

The simplest method of calculating bed load discharge from a sample collected with a Helley-Smith or BTMA type bed load sampler is the total cross-section method (Figure 3.5). This is applicable only if the sample times at each vertical are equal, the verticals were evenly spaced across the cross-section and the first sample was collected at one half the sample width from the starting bank.

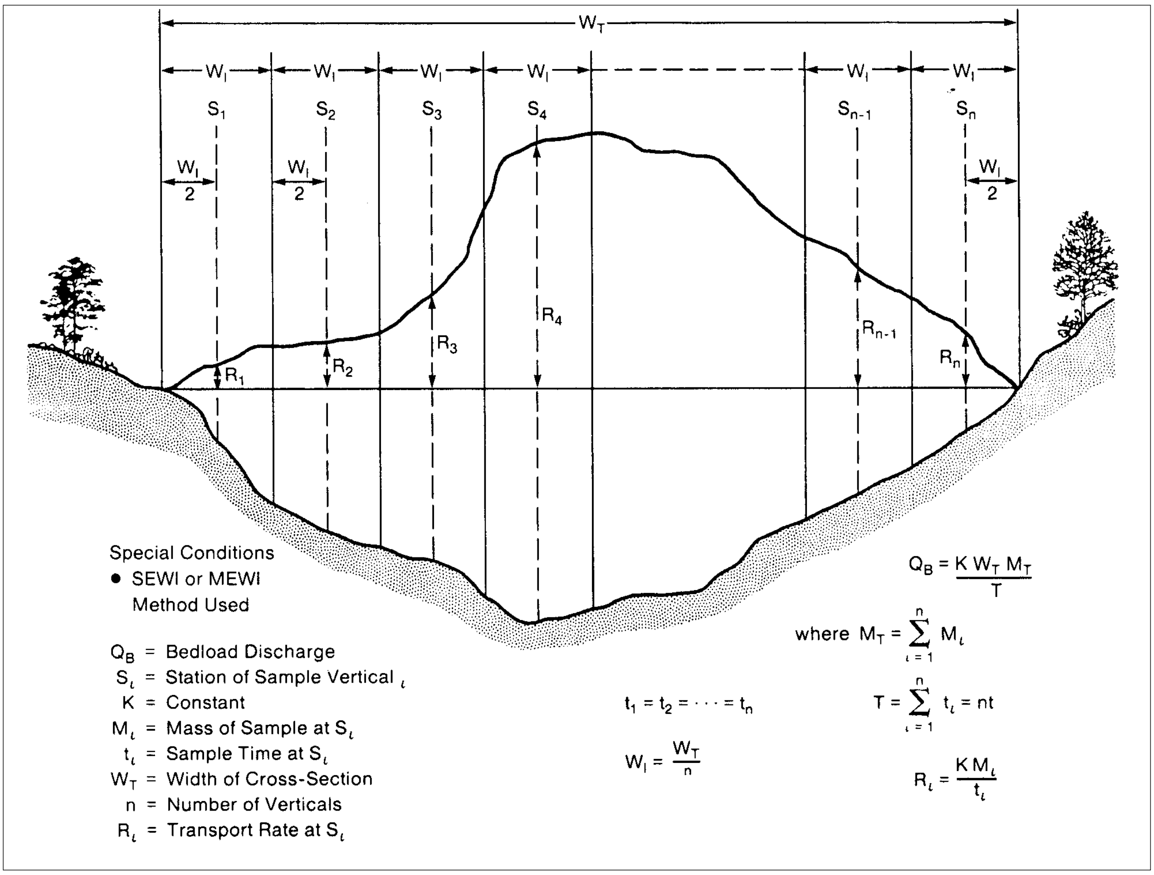


Figure 3.5: Total cross-section method for computing bed load discharge from samples collected with a Helley-Smith or BTMA bedload sampler

If these conditions are met then:

$$Q_B = K\ W_T \frac{M_T}{T} \qquad 3.2$$

Where:

Q_B	=	bed load discharge as measured by bed load sampler, in tons or m³ per day
W_T	=	total width of stream from which samples were collected, m
T	=	total time the sampler was on the bed, in seconds
M_T	=	total mass of the sample collected from all verticals sampled in the cross-section, in grams
K	=	conversion factor factor used to convert grams per second per unit width (meter) into tons or m³ per day per unit width (m).

If the total cross-section method can not be applied, then either the mid section or mean-section method should be used. The mid-section method (Figure 3.6) is computed using the following equation:

$$Q_B = \frac{R_1 W_{v_1}}{2} + \sum_{i=2}^{n-1} R_i \left[\frac{(S_i - S_{i-1})}{2} + \frac{(S_{i+1} - S_i)}{2} \right] + \frac{R_n W_{v_{n-1}}}{2} \tag{3.3}$$

where: W_{v1} = width between sampling vertical i and i+1

S_i = location of vertical i in the cross-section measured from some arbitrary starting point, in m.

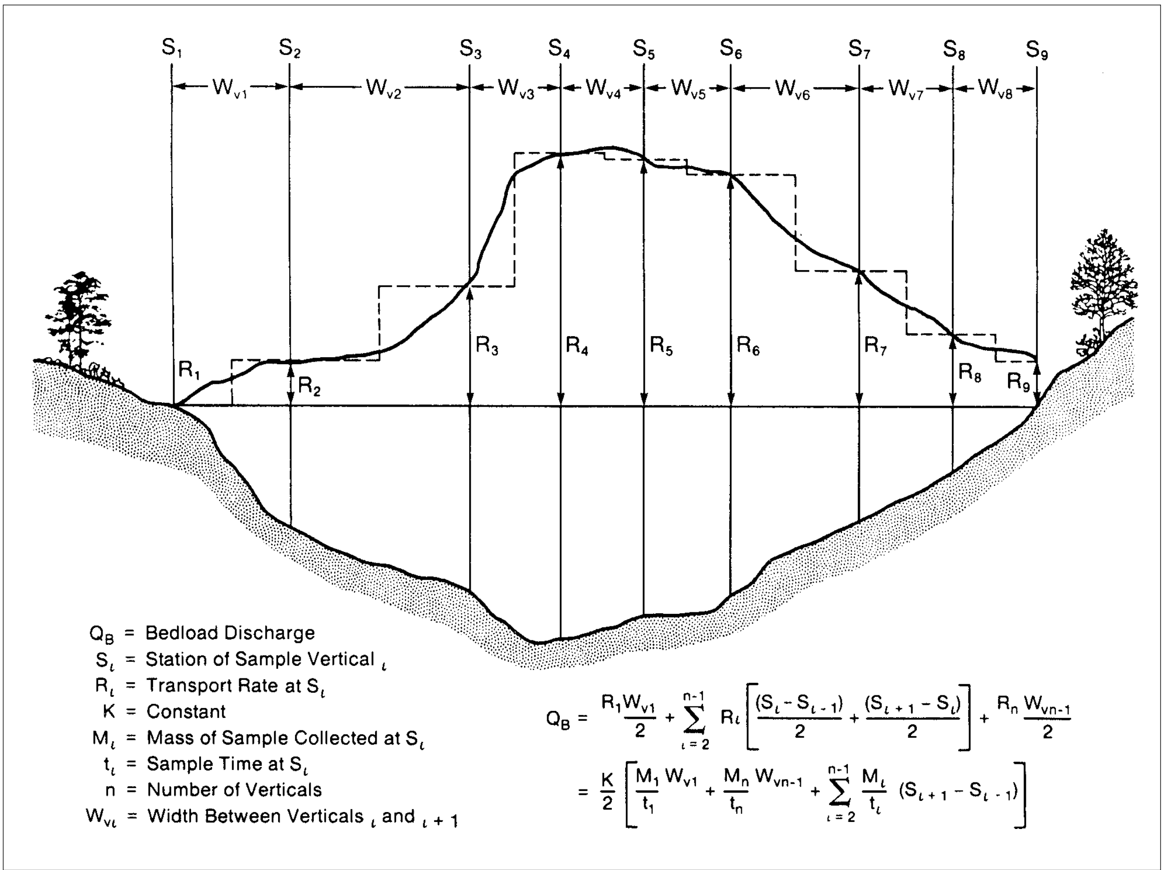


Figure 3.6: Midsection method for computing bedload discharge from samples collected with a Helley-Smith or BTMA bedload sampler

The third method, the mean-section method (figure 3.7), is computed using the following equation:

$$Q_B = \sum_{i=1}^{n=1} W_{v_i} \frac{(R_i + R_{i+1})}{2} \tag{3.4}$$

which is equivalent to:

$$Q_B = \frac{K}{2} \sum_{i=1}^{n-1} W_{v_i} \left(\frac{M_i}{t_i} + \frac{M_{i+1}}{t_{i+1}} \right) \tag{3.5}$$

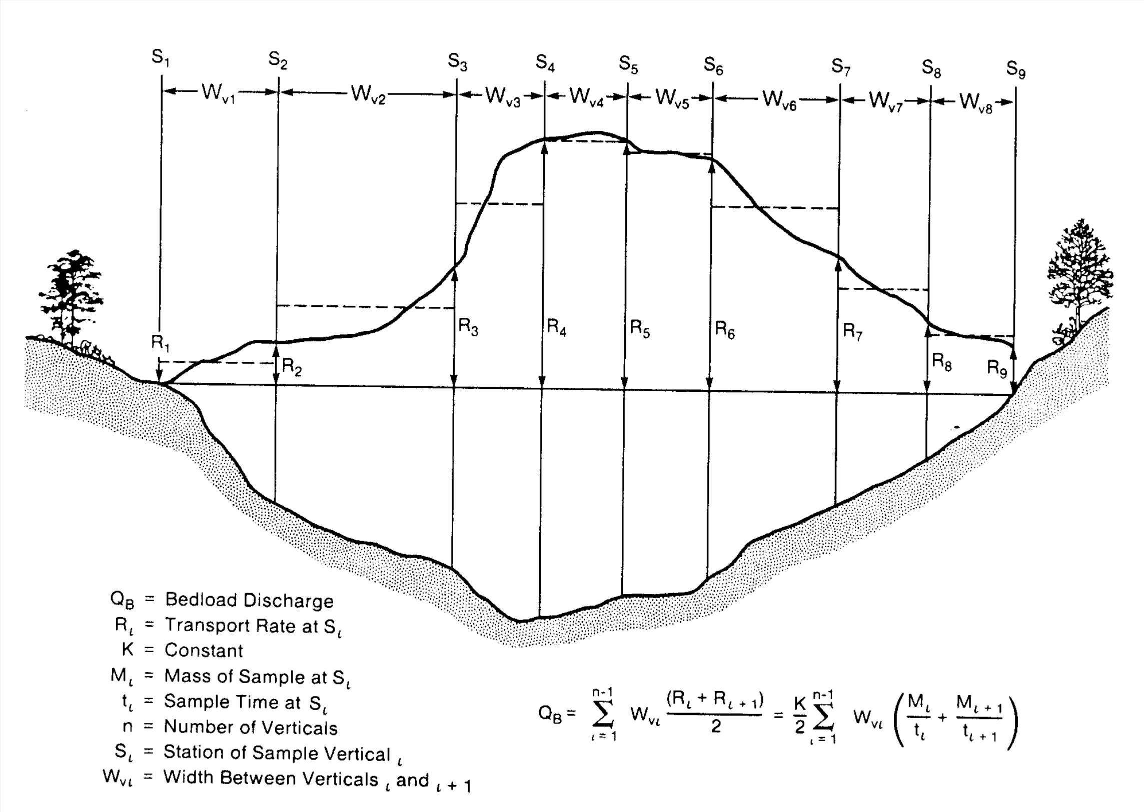


Figure 3.7: Mean-section method for computing bedload discharge from samples collected with a Helley-Smith or BTMA bedload sampler

4 BED LOAD SAMPLERS

4.1 PRESSURE DIFFERENCE - WINCH-OPERATED SAMPLER – FOR SHALLOW TO MEDIUM DEEP WATER (HELLEY-SMITH TYPE)

4.1.1 DESCRIPTION

Winch operated, medium-weight, streamlined sampler for collection of bed load composed of gravel and sand. The bed material sample is collected in a 0.250 mm-mesh, flexible polyester sample bag that can be replaced by a spare one. The mechanism to hang the sampler to the suspension cable must be well designed, making possible a soft landing on the stream bed without scooping of bed material, with the nozzle well in the direction of the flow.

The sampler efficiency must be provided with the description of the sampler.

4.1.2 SPECIFICATIONS

1 Operating conditions

- Flow velocity : up to 2.5 m/s
- Water depth : up to 15 m
- Sampled zone from the bed : at least 0.05 m

2 Features

- Steel frame, equipped with tail for keeping the sampler aligned in the flow
- Rectangular intake nozzle, with sharp front edges
- Iso-kinetic sampling
- 0.250 mm-mesh, flexible polyester sample bag
- Total weight (empty): 32 Kg

3 Drawings

4.2 PRESSURE DIFFERENCE - WINCH-OPERATED SAMPLER - FOR SHALLOW TO MEDIUM DEEP WATER (BTMA-TYPE)

4.2.1 DESCRIPTION

Winch operated, medium-weight, streamlined sampler for collection of bed load composed of gravel and sand. The bed material sample is collected in a 0.3 mm-mesh, rigid metal-wire sample basket. The basket is to be emptied through a brass tailpiece with emptying plug. The mechanism to hang the sampler to the suspension cable must be well designed, making possible a soft landing on the streambed without scooping of bed material, with the nozzle well in the direction of the flow. The nozzle has a rectangular opening, 0.085 m wide and 0.05 m high.

The sampler efficiency must be provided with the description of the sampler.

4.2.2 SPECIFICATIONS

1 Operating conditions

- Flow velocity up to 2.5 m/s
- Water depth up to 15 m
- Sampled zone from the bed at least 0.05 m

2 Features

<u>Sampler</u>:

- Steel frame, equipped with tail for keeping the sampler aligned in the flow
- Rectangular intake nozzle (8.5 cm wide by 5 cm high), with sharp front edges
- Almost iso-kinetic sampling
- 0.300 mm-mesh, rigid metal-wire basket
- Total weight (empty) : 32 Kg

3 Drawings

5 OBSERVATION PRACTICE

5.1 INTRODUCTION

This chapter on observation practices contains general instructions for operation and maintenance of samplers and instruments for bed load measurement.

As a matter of fact, many difficulties and questions may arise during implementation of sediment measurement methods, techniques and instruments; those may be so specific to the river or site that they have to be appraised separately for each site by qualified personnel. The routine procedures are making the operators/observers loosing alertness for basic details. The field checking procedures would therefore be given due importance.

Though the need to measure bed load was recognised in India, very little experience was gathered in this field. The CW&PRS can produce the Mulhofer box-basket type sampler, but this is not the most appropriate instrument available on the market. Both the BTMA and the Helley-Smith might be used in sand or gravel bed streams.

Quite a lot of devices, instruments and techniques have been developed for bed load measurements. Very little have passed the experimental stage. In streams where bed load is mainly composed of gravel and sand/silt, can best be sampled by trapping the transported material during a given time, with the transport-rate method. When the streambed is covered with bedforms such as dunes, the so-called “dune-tracking” method can be applied, though the reliability of the method is often disputed.

Considering the present needs in India, only the transport-rate trapping samplers based on the pressure-difference principle are described hereafter.

5.2 THE BED LOAD TRANSPORT METER ARNHEM (BTMA)

5.2.1 GENERAL DESCRIPTION

The BTMA (see Figure 5.1) was designed for sampling in the Dutch sand bed rivers. The sampling body is made of brass, with a streamlined shape having a rectangular open mouth directed towards the flow and a permeable tail through which the entering flow escapes. The shape is designed in such a way as to have a pressure difference between the front and rear so that it equalises the flow resistance in the sampler. This feature ensures an almost iso-kinetic sampling.

The mouthpiece is a rectangular tube, connected by an elastic rubber funnel to the “fishing-type” basket made of fine metal wire meshing (0.3 mm opening). Only the sediment particles having a size larger than the mesh openings are trapped. The efficiency of the sampler varies obviously with the rate of filling.

The rectangular mouthpiece may scoop the bed material if it hits the bottom too hard. In order to avoid this scooping, the sampler body is hanged in a frame equipped with two supporting plates in front and a tail especially designed to orient the sampler rightly in the flow when landing on the stream bed. The mouthpiece is attached to a system with lever arm and double leaf spring system, suspended from the supporting cable together with the tail. The sampler is hanged in such a way that it would land with the tail first. When the cable is further slackened, the front feet come to rest on the stream bottom, but with the mouthpiece still away from it. If correctly operated, this mouthpiece will touch smoothly the riverbed the latest.

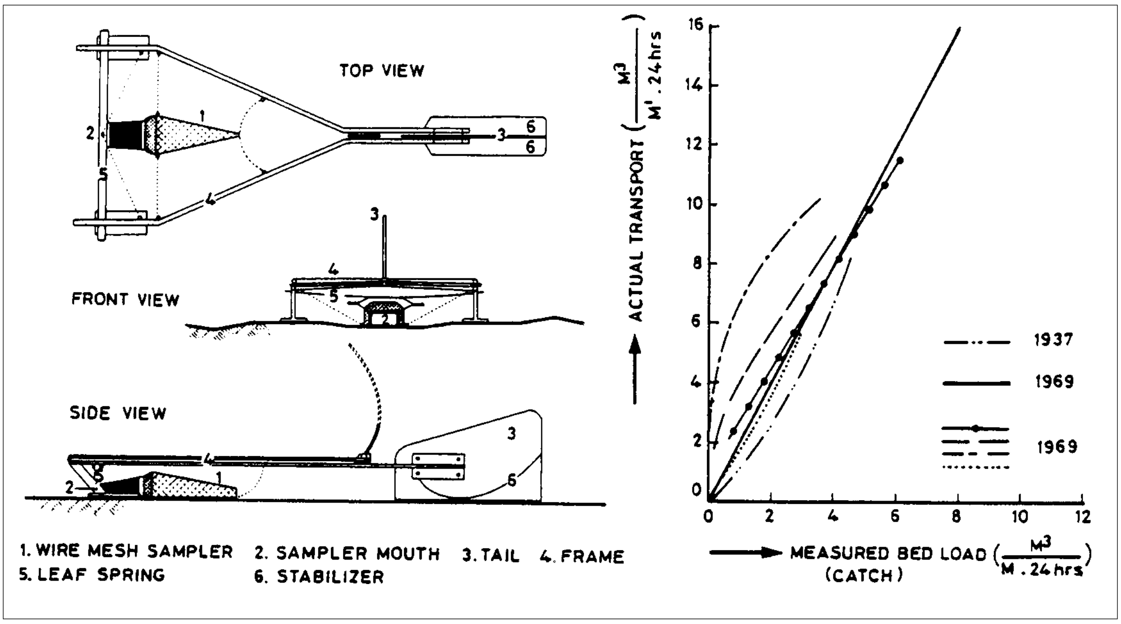


Figure 5.1: Bed load transport meter Arnhem (BTMA)

Though the device was designed for operating in flow depths and velocities limited respectively to 5 m and 1 to 1.5 m/s, it was utilised successfully in depths up to 20 metres (even more) and velocities larger than 2.5 m/s. When operated in high flow depths and strong currents, it is necessary to add some load on the front and rear supporting plates.

The efficiency of the sampler was studied and correction factors are given with the sampler's specifications.

5.2.2 OPERATION, PRINCIPAL ADVANTAGES AND LIMITATIONS; ALTERNATIVES OR CORRECTIONS

The instrument can be operated from a bridge or from a boat. The sampler must be suspended in such a way as to have the front plates higher than the tail plate. The water depth must be measured or assessed as accurately as possible before sampling. The sampler is lowered quickly to a position close to the stream bed, then much slower as to have a soft landing. The suspension cable must be sufficiently slackened, so that the sampler remains freely on the stream bottom. This is particularly true when operating from a boat as its position is never perfectly fixed and the cable can come under tension when the boat swings around its station. In that case, the sampler may be dragged over the stream bottom, with the risk to have the mouthpiece scooping in the bed material.

The risk for bed scooping is larger in strong currents, as described earlier. Because of the drag created by shape of the instrument, it will have the tendency to drift away during the lowering to the stream bottom. However, when approaching the bed, the drag reduces in the near-bed zone where the flow velocities are smaller, so that the sampler will move in upstream direction. With a length of the cable equal to the water depth measured vertically from the suspension point, the sampler could hit the bed if the unrolled cable length is higher than the water depth.

Overestimation of bed load transport is therefore quite common, as it is quite difficult to reject peak values for a transport process in which these peaks can be explained by the irregularity of the sediment movement on the bed.

Bed load movement is very irregular and unpredictable, especially for sand bed rivers for which the BTMA is well suited. Consecutive catch volumes may thus vary in a strong and erratic way, requiring repetitive sampling to get a representative average. It is obviously never possible to assess how much the variability in the catch size is due to the variation in time of the transport rate in comparison with the sampling errors due to the operation of the sampler (such as those due scooping effect, or due to dragging of the sampler over the river bed, besides others).

The bed load transport rates can display a strong spatial variation, mainly in relation with bedforms. This presence of bed forms may contribute to this variability. When sampling from a boat, this would always be positioning in the upper part of the upstream side of the bed form, never on the lee side or in the trough between two bed forms. In presence of bed forms, the sampling procedure becomes quite complicated, because the operators have first to survey by echo-sounder a longitudinal profile passing along the predetermined sampling position. Based on the presence of bed forms, the best possible sampling position is selected, usually not in the gauge line, mostly up- or downstream of it.

5.2.3 ESSENTIAL INSTRUCTIONS AND PRECAUTIONS FOR OPERATION FOR THE BTMA

Before sampling

- Verify the sampler for possible damage, among other mouthpiece, suspension of the basket, mesh wiring
- Verify the inclination of the sampler when hanging free from the davit : front support plates higher than the back one (by at least 20 cm)
- Check regularly the landing of the instrument on a flat surface, such as the boat deck
- Measure or assess the water depth at the sampling position

While sampling

- Lower the sampler as quickly as possible to about one meter above the stream bed, then slower in the last meter
- Control the tension in the cable to detect the landing of the sampler on the stream bottom, moment of the start of the sampling
- Some 20 seconds before the end of the sampling, start to wind up the cable, without bringing it under too high tension
- At the end of the sampling period, wind up quickly the suspension cable, but without any sudden movement
- Avoid dragging the sampler on the stream bottom; try to detect such dragging, if any
- Repeat the sampling to assess how much the catch varies with time

From a boat

- Keep the boat as much as possible in a stable position, eventually with the help of the engines if the boat is anchored
- Slacken more cable if this comes in tension when the boat swings around its anchor
- Wind up the cable sufficiently in advance – at least 30 seconds – to reduce the slack, without bringing it too much under tension
- Start hoisting the sampler at the predetermined time, taking the right end-time for sampling when the cable is fully under tension

From a bridge

- If the dry line is very long and the flow velocity strong, it might be difficult to assess when the sampler reaches the bed and a first “blank” measurement may be required to evaluate the length of cable needed for the sampler to reach the stream bottom dry- and wet-line corrections

- Cable must be given enough slack, but not too much
- Stop the measurement if the cable had enough slack at the start but comes into tension during sampling, as this would indicate that the device is drifting under too much drag
- If the sampler is dragged over the stream bottom by too strong currents, this may be corrected by:
- Adding some weight on the supporting plates (or “feet”)
- Fixing a heavy fish-weight on the cable just above the sampler, at the end of the suspension line
- Start hoisting the sampler at the predetermined time, taking the right end-time for sampling when the cable is fully under tension

After sampling

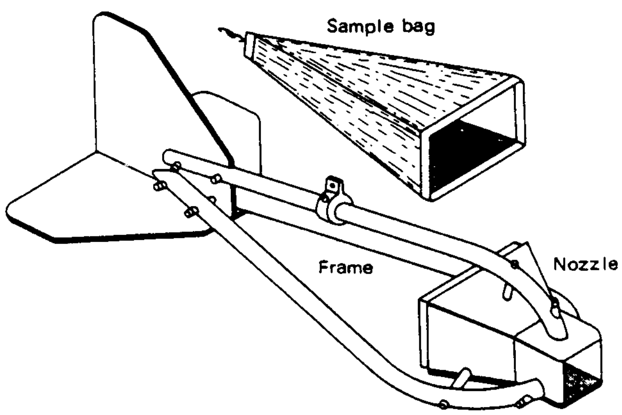
- Except for those samples for which the sampler was evidently not behaving correctly (e.g. scooping at landing, dragging over bed), no samples may be rejected before analysis
- Large variation in catch size and in particle size may be normal
- Empty the basket in the special tray and wash it out with clean water
- Drain the excess water
- Open the tray stop to fill the measuring glass while washing with clean water and let the suspension settle for 100 seconds
- Measure the sample volume and collect it in a polyethylene bag, to be stored in a cloth bag, properly sealed and labelled
- Record all circumstances of the sampling

5.3 THE HELLEY-SMITH BED LOAD SAMPLER (HSS)

5.3.1 GENERAL DESCRIPTION

The Helley-Smith sampler (Figure 5.2) was designed in the US, based on the experience with the BTMA. The concept is much more elementary. The quite large supporting frame of the BTMA has been replaced by a simple steel frame without front playing the role of sample support, and on which the nozzle (mouth-piece) is fixed rigidly. The brass mesh wire basket was replaced by a 0.250 mm-mesh, flexible polyester sample bag.

Several versions of the sampler have been used for various field conditions. Larger nozzles are needed for larger particle sizes and heavier samplers for deeper and faster rivers. The Helley-Smith is widely used and has been calibrated with a large number of experiments, in the field and in the laboratory.



Sketch of the Helley-Smith bedload sampler

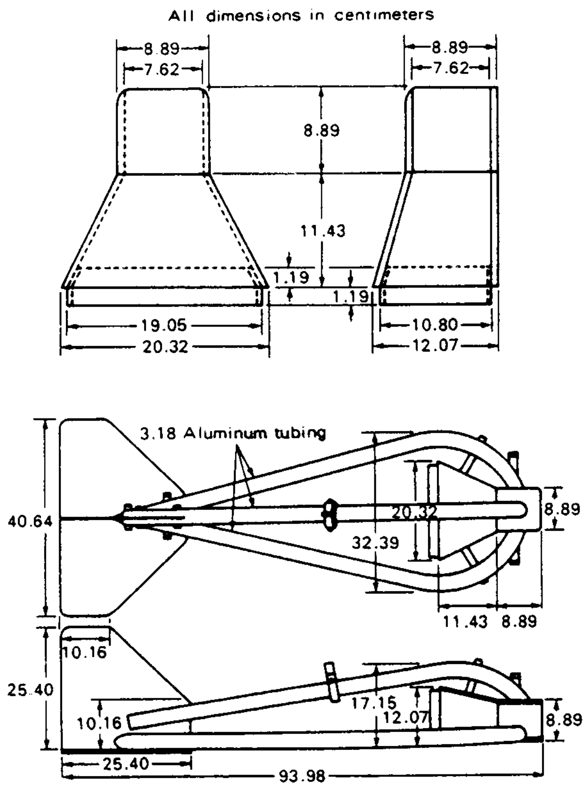


Figure 5.2:
Helley Smith bed-load sampler

5.3.2 OPERATION, PRINCIPAL ADVANTAGES AND LIMITATIONS; ALTERNATIVES OR CORRECTIONS

The advantage of the sampler is its simplicity. It is well suited for gravel bed rivers, with particle sizes above the silt fraction (mainly the “coarse” fraction). The design is elementary, without moving parts and there is little risk of malfunctioning of the device itself. The flexible polyester basket is easy to handle and to replace if damaged.

The sampler is quite popular, but it is not always utilised in an optimum way. The rather limited frame is appropriate for coarse bed material, but in very mobile sand bed rivers, the frame may become buried in the sand. As the nozzle is rigidly fixed to the frame, it will also be buried and take more material than carried by the actual bed load transport. The landing of the instrument on the stream bottom in fast flowing rivers can also be problematic when lowered too quickly, scooping the bed (see Figure 5.3).

The efficiency of the Helley-Smith was assessed in field and laboratory conditions. The efficiency is said to be related to the difference between intake velocity and the local flow velocity. However, during some laboratory tests, the sampler was taking more sample than the actual bed load transport rate. Video observations showed gravel particles travelling aside of the nozzle suddenly “sucked” into it; the corresponding sampling efficiency for that experiment appeared to be of the order of 140%.

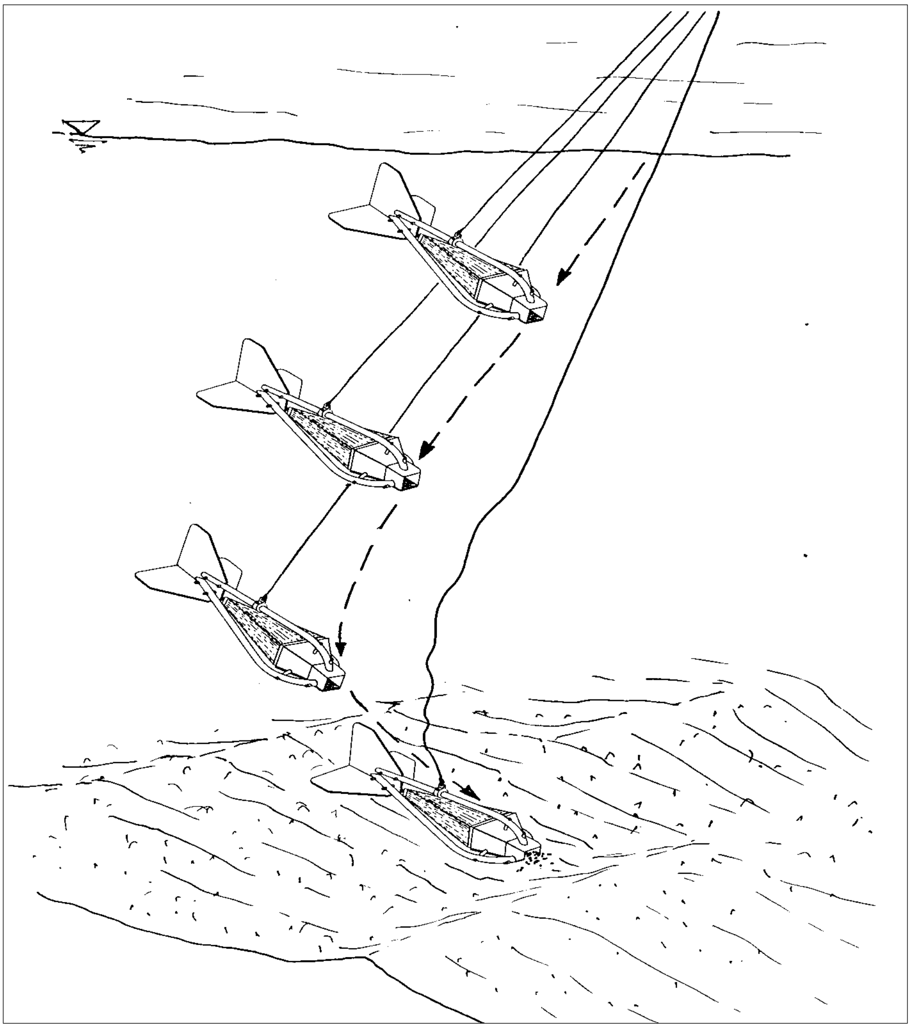


Figure 5.3: Scooping when lowering too fast

Most important is to select the appropriate version of the Helley-Smith sampler for the conditions prevailing in the river to be gauged. In case the discharges, flow velocities and water depths vary widely, different versions of the sampler may be needed.

The instrument can be operated from a bridge or from a boat. The sampler must be suspended in such a way as to have the nozzle basis higher than the tail plate. The water depth must be measured or assessed as accurately as possible before sampling. It is lowered quickly to a position close to the stream bed, then much slower as to have a soft landing. The suspension cable must be sufficiently slackened, so that the sampler remains freely on the stream bottom. This is particularly true when operating from a boat as its position is never perfectly fixed and the cable can become under tension when the boat moves around its station. In that case, the sampler may be dragged over the stream bottom, with the risk to have the nozzle scooping in the bed material.

The risk for bed scooping is larger in strong currents. In fine-sand bed rivers, for which the Helley-Smith is not so well suited, the bed load movement is very irregular and unpredictable. For gravel bed rivers (bed load particles coarser than fine sand), the instrument is well suited, but the bed load transport can still be quite irregular.

The bed load transport rates can display a strong spatial variation. This presence of bed forms may contribute to this variability. When sampling from a boat, this would always be positioning in the upper part of the upstream side of the bed form, never on the lee side or in the trough between two bed forms. In presence of bed forms, the sampling procedure becomes quite complicated, because the operators have first to survey by echo-sounder a longitudinal profile passing along the predetermined sampling position. Based on the presence of bed forms, the best possible sampling position is selected, usually not in the gauge line, mostly up- or downstream of it.

5.3.3 ESSENTIAL INSTRUCTIONS AND PRECAUTIONS FOR OPERATION FOR THE H-S

Before sampling

- Verify the sampler for possible damage: frame, nozzle and basket
- Verify the inclination of the sampler when hanging from the davit : nozzle higher at least 20 cm higher than tail bottom plate
- Check regularly the landing of the instrument on a flat surface, such as the boat deck
- Measure or assess the water depth at the sampling position

While sampling

- Lower the sampler as quickly as possible to about one meter above the stream bed, then slower in the last meter
- Control the tension in the cable to detect the landing of the sampler on the stream bottom, moment of the start of the sampling
- Some 20 seconds before the end of the sampling, start to wind up the cable, without bringing it under tension
- At the end of the sampling period, wind up quickly the suspension cable, but without any sudden movement
- Avoid dragging the sampler on the stream bottom; try to detect such dragging
- Repeat the sampling to assess how much the catch varies with time

From a boat

- Keep the boat as much as possible in a stable position, eventually with the help of the engines if the boat is anchored
- Slacken more cable if this comes in tension when the boat swings around its anchor
- Wind up the cable sufficiently in advance – at least 30 seconds – to reduce the slack, without bringing it under tension
- Start hoisting the sampler at the predetermined time, taking the right end-time for sampling when the cable is fully under tension

From a bridge

- If the dry line is very long and the flow velocity strong, it might be difficult to assess when the sampler reaches the bed and a first “blank” measurement may be needed to evaluate the length of cable needed for the sampler to reach the stream bottom dry- and wet-line corrections
- Cable must be given enough slack, but not too much

- Stop the measurement if the cable had enough slack at the start but comes into tension during sampling, as this would indicate that the device is drifting under too much drag
- If the sampler is dragged over the stream bottom by too strong currents, this may be corrected by fixing a heavy fish-weight on the cable just above the sampler, at the end of the suspension line
- Start hoisting the sampler at the predetermined time, taking the right end-time for sampling when the cable is fully under tension

After Sampling

- Except for those samples for which the sampler was evidently not behaving correctly (e.g. scooping at landing, dragging over bed), no samples may be rejected before analysis
- Large variation in catch size and in particle size may be normal
- Empty the bag in a tray and wash it out with clean water
- Drain the excess water
- Open the tray stop to fill the measuring glass while washing with clean water and let the suspension settle for 100 seconds
- Measure the sample volume and collect it in a polyethylene bag, to be stored in a cloth bag, properly sealed and labelled
- Record all circumstances of the sampling