International Standard 4375

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Measurement of liquid flow in open channels — Cableway system for stream gauging

Mesure de débit des liquides dans les canaux découverts — Systèmes de suspension par câbles aériens pour le jaugeage en rivière

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4375 was developed by Technical Committee ISO/TC 113, *Measurement of liquid flow in open channels*, and was circulated to the member bodies in July 1977.

It has been approved by the member bodies of the following countries :

Australia	Ireland	South Africa, Rep. of
Canada	Italy	Spain
Czechoslovakia	Korea, Dem. P. Rep. of	Switzerland
Egypt, Arab Rep. of	Mexico	United Kingdom
Finland	Netherlands	USA
France	Norway	USSR
Germany, F. R.	Portugal	Yugoslavia
India	Romania	

No member body expressed disapproval of the document.

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Measurement of liquid flow in open channels — Cableway system for stream gauging

0 INTRODUCTION

0.1 To obtain the measurements required in the velocity-area method of discharge measurement and in sediment sampling, it is necessary to suspend the measuring or sampling equipment at numerous points along the cross section of the channel. The most practicable way of suspending the equipment is by a cableway spanning the channel. Cableways may be erected at sites where the frequency of gaugings warrants the expense of erection. Suspension from cableways avoids the difficulties which may be experienced in gauging from bridges with piers, or from boats.

0.2 There are two basic types of cableways, namely :

a) those with an instrument carriage controlled from the river bank (see figures 1 and 2); and

b) those with a carriage (trolley) in which the operator travels and makes observations (see figure 3).

1 SCOPE AND FIELD OF APPLICATION

This International Standard gives a general description, functional requirements, specification and guidelines for the design, and for the operation and maintenance of a cableway system used for stream gauging.

2 TERMINOLOGY

For the purpose of this International Standard, the terms and definitions used are in accordance with ISO 772 *Liquid flow measurement in open channels — Vocabulary and symbols.*

3 UNITS OF MEASUREMENT

For the purpose of this International Standard, the units of measurement used are SI units in accordance with ISO 31 and ISO 1000.

4 GENERAL DESCRIPTION OF A CABLEWAY WITH INSTRUMENT CARRIAGE

The cableway system with instrument carriage consists of (see figures 1 and 2) :

a) towers;

b) track or main cable;

c) anchorages;

d) tow cable;

e) suspension cable;

f) instrument carriage;

g) double drum winch, or two independent winches; and

h) staylines.

4.1 Towers

The towers are erected one on each bank of the channel. The towers support the main cable at a height which will ensure unimpeded progress of the suspended equipment as it travels along the main cable between the towers. The tower on the operating bank has sheaves for guiding the suspension cable and tow cable and also means for securing the winch(es). The track or main cable must pass freely over the saddle on the top of the tower at the operating bank with negligible bending moment on the tower. The tower on the bank opposite to the operating bank has a saddle at its top for the main or track cable and a sheave for the tow cable. The height of the tower on the opposite bank shall be suitably fixed in accordance with the topography at the site.

4.2 Track or main cable

The track or main cable runs over the saddles on the top of the towers and the two ends are fixed to the anchorages. The instrument carriage travels along the main cable.

4.3 Anchorages

The anchorages are fixtures to which the track cable and staylines are attached.

4.4 Tow cable

The tow cable is attached to one of the drums in the double drum winch (or to a separate winch) and passes over the sheaves fixed to the towers. The two ends of the tow cable are fixed to the carrier making it an endless circuit to move the carriage across the stream. (See figure 1.) Alternatively the endless circuit may be made by the tow cable (whose one end is fixed to the carrier and the other end is wound on a drum) and the suspension cable. (See figure 2.)

4.5 Suspension cable

The suspension cable is wound on the second drum in the double drum winch (or on a separate winch) and passes over the sheave on the tower at the operating bank and then passes over the pulley in the carrier. The measuring instruments are attached to the end of the suspension cable. The suspension cable incorporates an insulated inner core which serves as electrical conductor for the instruments.

4.6 Instrument carriage

The instrument carriage is generally triangular in shape with its apex downwards. Two track pulleys are fixed at the top and one suspension pulley at the bottom. The carriage runs along the track cable when pulled from either side. The suspension guide pulley guides the suspension cable. When spans are larger than 125 m, an additional guide pulley may be fixed.

4.7 Double drum winch or two independent winches

The double drum winch incorporates two drums. The suspension cable is wound on one of the drums and the endless tow cable passes round the other then over the sheave on the tower on the opposite bank. Alternatively the tow cable is wound on the other drum. Horizontal and vertical movements of the measuring instrument attached to the suspension cable are controlled by a lever which either couples only the suspension cable drum or both drums simultaneously. Each drum has a counter to indicate the released length of the cable, one for measuring the horizontal distance travelled by the carriage and the other indicating the depth, or sounding, of the suspended instrument. Winches are generally fitted with automatic brakes by which the suspended instrument is retained at the desired place.

Instead of a double drum winch, two separate winches may be used for horizontal and vertical movements.

4.8 Staylines

The staylines are cables attached to the top of each tower and to the anchorages to counteract the load of the main cable between the towers and to ensure the stability of the towers.

5 GENERAL DESCRIPTION OF CABLEWAY WITH MANNED CARRIAGE

The manned carriage cableway consists of (see figure 3) :

a) towers;

b) track or main cable;

c) anchorages;

d) staylines;

e) carriage.

5.1 The towers, track or main cable, anchorages, and staylines are similar to those described in clause 2.

5.2 Manned carriage

The carriage from which the observer makes the gauging observations travels along the main cable by means of two track pulleys. The carriage may be driven manually or by a power unit. The carriage could be designed to make operations from the standing position or sitting position or both. (See figure 4.)

6 FUNCTIONAL REQUIREMENTS OF CABLEWAY COMPONENTS

6.1 Safety factor

All the components of the cableway system shall be designed to provide a minimum safety factor at maximum load for

a) safety factor 2 for cableway with instrument carriage;

b) safety factor 5 for cableway with manned carriage.

The maximum load is the weight of instruments plus the incidental loads on the cables and instruments (wind, frost, floating matter, etc.). The suspension cable shall break before the track cable, towers and anchorages. The maximum load to be considered shall be the breaking load of the suspension cable.

6.2 Towers

6.2.1 A safe and convenient approach should be available throughout the year on both the banks so that an observer may have easy access to the installation for inspection and operation.

6.2.2 The towers shall be designed to take all loads which are to be supported, in addition to their own weight. The design shall also take account of likely wind loads. The pressure on the tower due to wind load depends on a number of factors, but for towers not exceeding 30 m in height, this pressure may vary from 1 000 to 2 000 N/m^2.

6.2.3 The foundation of the tower should extend from below the frost line to at least 1 m above the highest flood level.

6.2.4 The height of the towers shall be such that the bottom of the equipment, suspended from the centre of the main cable span, will not be less than 1 m above the highest flood level and ensure that no hazard is presented to navigation along the channel by the main cable or any equipment associated with the cableway.

6.2.5 The provision of aircraft warning lights may be necessary to conform to regulations governing high structures in the locality in which the towers are erected. Similarly, warning signs are necessary to mark the location of the main cable.

6.3 Track or main cable

6.3.1 The sag shall not be more than 2 % of the span.

6.3.2 The tension (T) in the cable suspended between supports of equal height and neglecting additional tension due to wind load on the cable is given by the formula

$$T = \frac{wS^2}{8D} + \frac{PS}{4D}$$

where

T is the horizontal tension in cable, in newtons;

w is the weight per metre run of wire rope or cable, in newtons;

S is the horizontal span, in metres;

D is the ultimate sag (dip), in metres;

P is the concentrated moving load, in newtons.

The actual tension (F) in the cable is given by the formula

$$F = T\sqrt{1 + \frac{16D^2}{S^2}}$$

6.3.3 The main cable in cableways shall be corrosion resistant and, for a comparatively short span, wire rope may be used, but in structures of large spans, particularly where a manned carriage is to be supported, it may be necessary to use special cables such as "tramway track".

It is an advantage to place a stop near the far end of the main cable and at a known distance, to allow for verification of the horizontal measurement given by the distance indicator.

6.4 Anchorages

6.4.1 The anchorage shall be adequate to sustain the maximum load for which the cableway is designed.

6.4.2 The anchorage shall be set in direct line with the track cable.

6.4.3 The anchorage should be so placed that it can be easily inspected.

6.5 Stayline

Staylines shall be provided at manned carriage installations. The stayline shall be of corrsion resistant steel and of sufficient strength to maintain the tower in a vertical position under all loading conditions. Means for adjusting the tension in the stayline shall be provided.

6.6 Tow cable

6.6.1 The tow cable should be as light and flexible as possible, and should be corrosion resistant.

6.6.2 The tow cable shall have means of adjusting the tension in the cable if it makes an endless circuit. (See figure 1.)

In the case of figure 2, the tension in the tow cable is given by the weight of the suspended instruments.

The tow cable shall have sufficient strength to move the carriage.

6.7 Suspension cable

6.7.1 The cable shall be of corrosion resistant material, preferably be preformed and reverse laid to inhibit spinning.

6.7.2 The cable shall have a strength sufficient for suspending the current meter and the sounding weight. (It has been found that a breaking load not less than five times the maximum sounding weight to be used provides a suitable safety margin to allow for the loading effect of drag and live load due to vertical movement of the point of suspension).

Its elongation under load should not exceed 0,5 %.

6.7.3 The cable shall have the minimum diameter consistent with the strength requirement so as to offer minimum resistance to the force of the current.

6.7.4 The cable shall be equipped with suitable attachment for suspending the measuring equipment.

6.7.5 If the suspension cable should serve for the transmission of the signals of the current meter, an insulated conducting core shall be incorporated in it.

When used with sediment samplers, it should cater for the specific requirements of the different types of samplers.

6.7.6 The cable shall be smooth and flexible, so that it can take turns without any permanent bends or twists, which would affect its usability and length.

6.7.7 When used as hand-line from cradles, the cable should have suitable covering to prevent hurting the hand.

6.8 Carriages

6.8.1 *Instrument carriage*

6.8.1.1 The carriage shall have sufficient strength to support the measuring equipment.

6.8.1.2 It shall be simple in design and protected against corrosion.

6.8.1.3 It shall permit the operation of the equipment without any hindrance.

6.8.2 *Manned carriage*

6.8.2.1 The carriage shall be of adequate strength to carry the observer and measuring equipment to any desired point. It shall ensure the observers' safety and provide reasonable comfort for the operator making the measurements. It should afford adequate means of support for the gauging reel.

6.8.2.2 The carriage shall be provided with a brake to secure it in all desired positions.

6.8.2.3 It shall be equipped with a protractor which may be used in the computation of the air-line and wet-line corrections.

6.9 Double drum winch or two independent winches

6.9.1 The winch shall be able to carry the required load from the meter suspension cable and tow cable.

6.9.2 The winch shall be provided with a locking device, such as a pawl and ratchet, by means of which the suspended instrument can be held at any desired depth, in steps not greater than 10 mm. Additionally, a friction brake should be fitted.

6.9.3 The winch shall be equipped with pulleys to lay the cable evenly on the drums as it is wound into or from the drums. The diameters of the drums of double drum winches should be matched to ensure that the towing cable and suspension cable are payed out at the same rate.

6.9.4 The diameter of the drum shall be not less than the minimum winding diameter recommended for the cable.

6.9.5 There shall be an arrangement which enables the suspension drum to be disengaged from the traversing drum and to be operated independently or both drums simultaneously.

6.9.6 When driven electrically, there should be provision to select the most suitable speeds and arrangements to operate it manually in case of power failure.

6.9.7 When an electrical cored suspension cable is used, the suspension drum shall have a suitable slip-ring housing and connections for picking up signals transmitted by the current meters.

7 MAINTENANCE

7.1 The cable shall be regularly inspected and lubricated.

7.2 All the mechanical accessories shall be properly lubricated.

7.3 Anchorages shall be regularly inspected and remedial measures should be taken.

7.4 The sag shall be checked at regular intervals, particularly when large changes in temperature occur, and adjustment made accordingly.

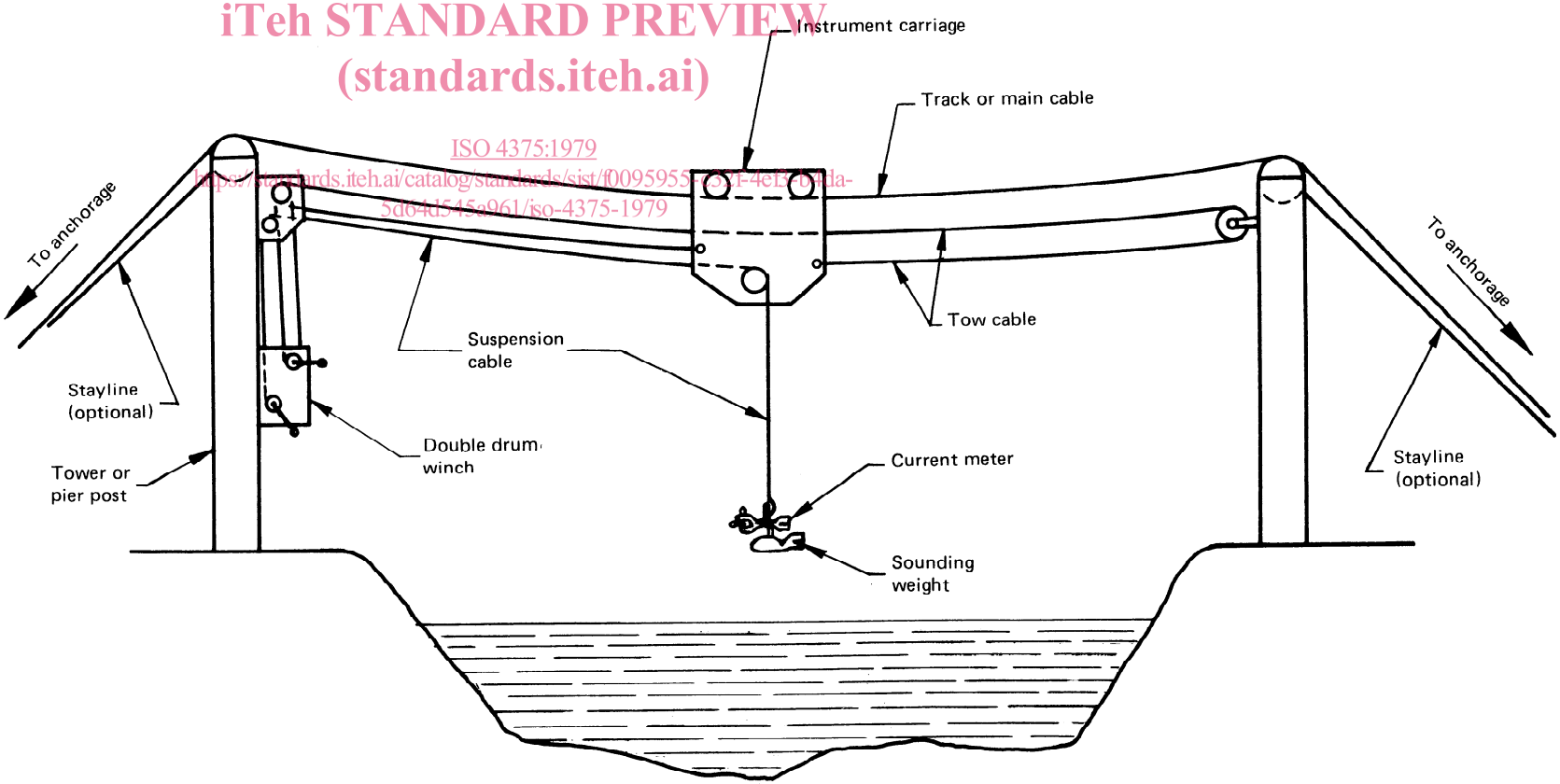

FIGURE 1 — **Cableway system — Unmanned instrument carriage, with tow cable in endless circuit and separate suspension cable**

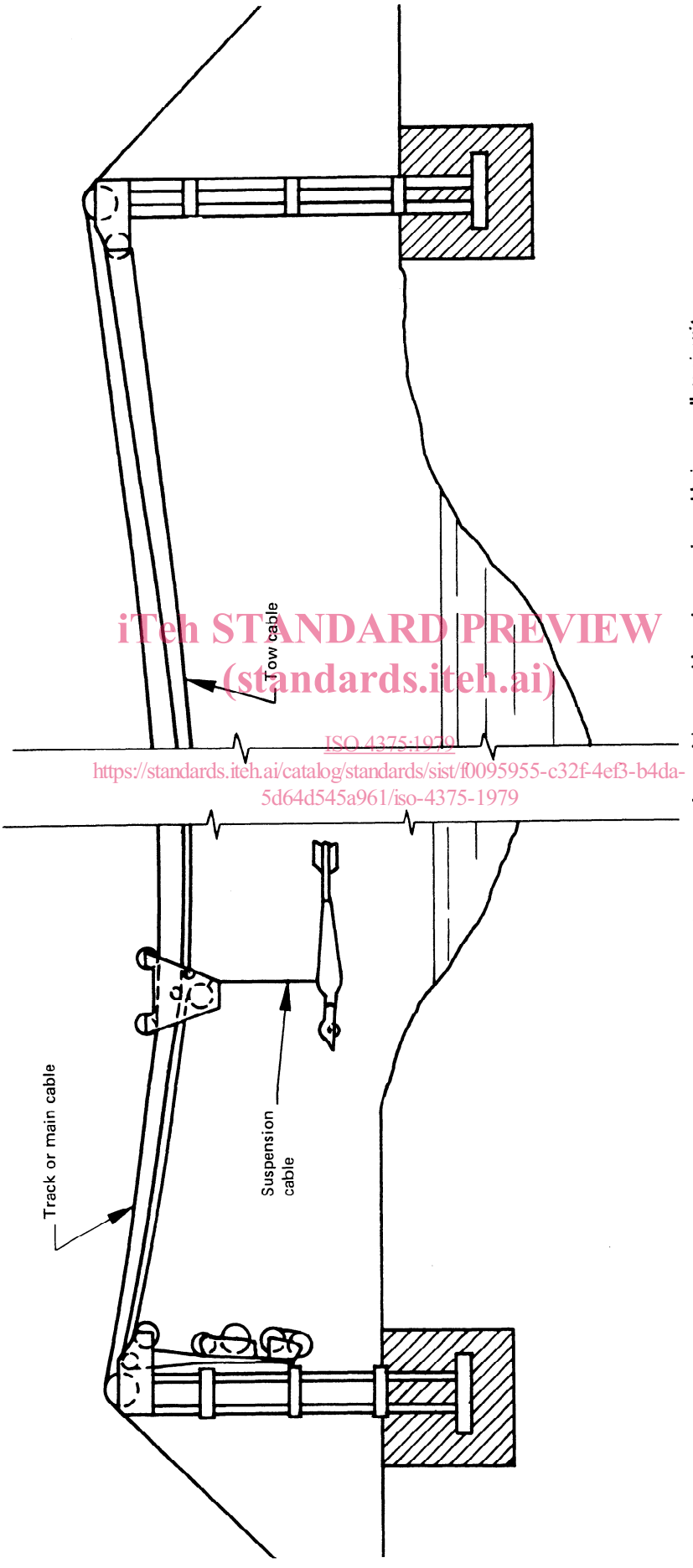

FIGURE 2 — Cableway system — Unmanned instrument carriage, with tow cable and suspension cable in an endless circuit

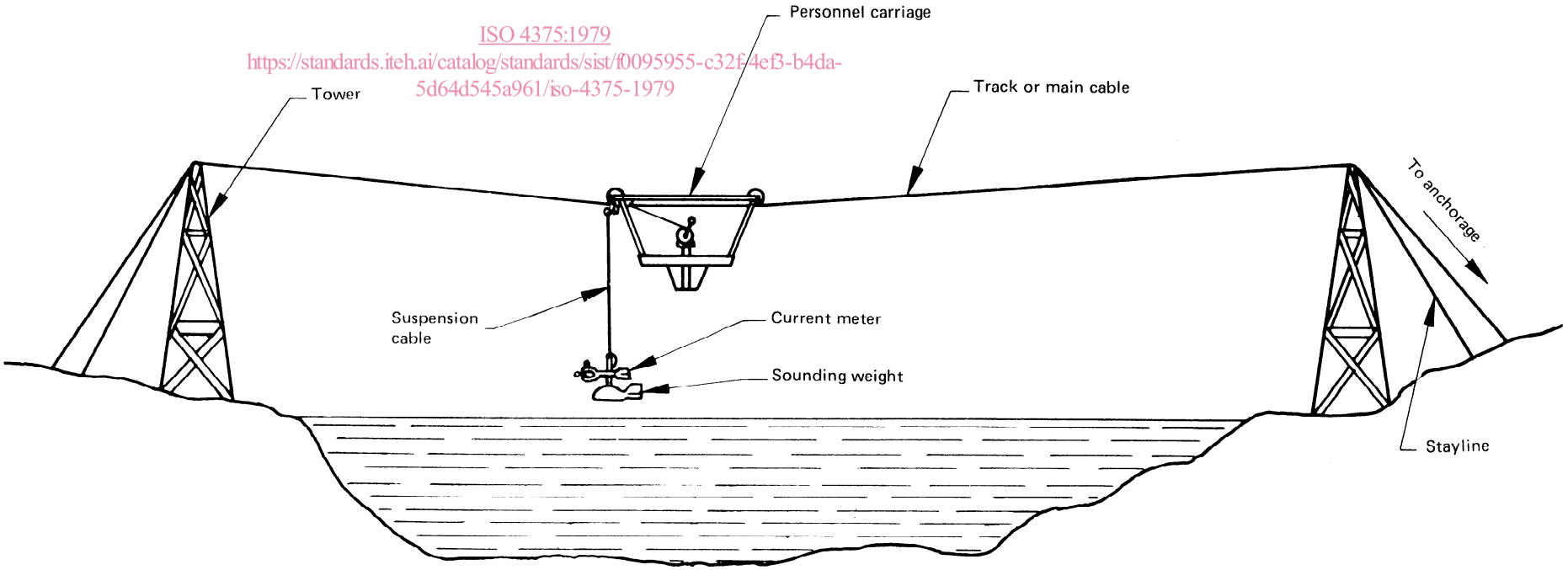

FIGURE 3 – **Cableway system – Manned carriage**