भारतीय मानक

नदी घाटी परियोजना के लिए स्थल अन्वेषण के हीरक कोर ड्रिलिंग की रीति संहिता

(पहला पुनरीक्षण)

Indian Standard

DIAMOND CORE DRILLING — SITE INVESTIGATION FOR RIVER VALLEY PROJECTS — CODE OF PRACTICE

(First Revision)

ICS 93.020.173.100.30

BUREAU OF INDIAN STANDARDS
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October 1996

Price Group 5

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Geological Investigation and Sub-surface Exploration Sectional Committee had been approved by the River Valley Division Council.

River valley projects and other major civil engineering works being undertaken in the country may require, for site investigation, core drilling with diamond drills for sub-surface exploration. It is essential that such drilling is carried out in the best possible manner to obtain maximum possible data relating to the substrata and to obtain good cores for study. This standard has been prepared to provide necessary guidance for the same.

This standard was first published in 1973 and was based on the practices being followed by the various construction agencies at that time. This revised standard has been prepared based on the practices being followed internationally and which have also been adopted in this country. In this revision specific guidance has been provided on operating pump pressures and flow rates. Further, consequent upon the publication of IS 10208 : 1982 'Specification for diamond core drilling equipment' provision has been made in this revision that the equipment prescribed for usage is in conformity with those given in IS : 10208. Elaboration made in this respect provides guidance on the selection of bits for various strata which was not given in the earlier version.

Indian Standard
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1 SCOPE

This code covers the procedure for diamond core drilling designed for securing samples of rock and soils which are too hard to sample by soil sampling methods. This code is primarily meant for obtaining data for foundation design and treatment.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard :

IS No.	*Title*
2131 : 1981	Method of standard penetration test for soil (*first revision*)
2132 : 1986	Code of practice for thin walled tube sampling of soils (*second revision*)
4078 : 1980	Code of practice for indexing and storage of drill cores (*first revision*)
4464 : 1985	Code of practice for presentation of drilling information and core description in foundation investigation (*first revision*)
5313 : 1980	Guide for core drilling observations (*first revision*)
7422 (Part1): 1974	Symbols and abbreviations for use in geological maps, sections and subsurface exploratory logs : Part 1 Abbreviation
10208 : 1982	Diamond core drilling equipment

3 EQUIPMENT

3.1 *Diamond Core Drilling Machine*

The diamond core drilling machine should be capable of providing a sufficient rotary motion (rpm) and gear to control it for using suitable core drilling bits as specified in Table 1. The feeding, chucking and retraction process should be hydraulically/mechanically operated. The machine should also be capable of drilling angular holes, where required by the prevailing geological site conditions. Two types of Diamond Core Drilling machines used are:

i) Conventional, with wire line winch; and

ii) Hydrostatic machine.

Table 1 Selection of Core Drilling Bits in Bed Rock

(*Clause* 3.1)

Type of Rocks	Type of Bit							
	TC	Surface Set Diamond Bit						Impregnated Bit with W or Flat Profile
		Matrix		SPC				
		Extra Hard	Hard	15	20	30	50	90
1. Soft rock								
2. Soft and medium mixed								
3. Medium hard with abrasive rock								
4. Medium hard abrasive rock								
5. Hard slightly abrasive rock								
6. Hard non-abrasive rock								
7. Very hard rock								
8. Very abrasive rock								

NOTE — Impregnated Bits are available for various types of rocks. It is essential to mention the rock type for purchase of impregnated bits.

TC - Tungsten carbide
SPC - Stones per carat

3.2 Pump

3.2.1 *Requirement for Drilling*

The basic requirement of pump for core drilling is to supply water or mud at sufficient pressure and flow rate.

3.2.2 *Pump Pressures*

Normal pump operating pressures required on diamond core drilling rigs range from 5 to 50 kg/cm^2 depending on the depth of the hole.

3.2.3 *Pump Flow Rates*

Sufficient flow rates should be ensured for up-hole velocity of 1.5 m/s for water and 0.4 to 0.6m/s for mud. These velocities will keep the cuttings moving upward and will avoid blockages. Higher velocities will erode the walls of the hole. Table 2 shows the flow rates required for various hole sizes that may vary from 8.00 l/min to 50 l/min depending upon size of drilling bit used with W series of rods.

3.3 Core Barrels

Core barrels should conform to IS 10208 : 1982. The design of the core barrels should be selected, keeping in view the points given in **3.3.1** to **3.3.4.**

3.3.1 *WF Design*

The system minimizes the wash effect on the core and permits good core recovery in soft formations.

3.3.2 *WG Design*

WG design is characterized by a short, pin threaded bit into which core lifter is inserted. It is commonly used in fractured and broken formation. This design being of heavier construction is a fairly rugged tool for good overall performance.

3.3.3 *WM Design*

WM design double tube core barrel is the best available tool for recovering core in any type of formation even in the most friable and caving structure.

3.3.4 *WT Design*

These are thin wall core barrels used for hard, dense and friable, shattered rock formations. Thin kerf has the additional advantage of requiring fewer diamonds per bit and less torque for drilling in hard formations. This core barrel being thin and light weight in nature should be handled and used with utmost care.

3.4 Core Bit

Core bits should be selected from surface set with diamonds, impregnated with small diamond particles, polycrystallined diamond bits (PCD bits), tungsten carbide insert bits, all as appropriate to the formation being cored and with the concurrence of the geologist or engineer. Nominal size of the bits are given in IS 10208 : 1982. Guidance with regard to selection of suitable core drilling bit type is given in Table 1. For general relationship of casing to core bit sizes and metric barrel to casing nesting sizes reference should be made to Fig. 1 and 2 respectively.

3.5 Reaming Shells

Reaming shells should be surface set with diamond, impregnated with small diamond particles, inserted with tungsten carbide strips or hard faced with various types of hard surfacing materials, all as appropriate to the formation being cored (*see* IS 10208 : 1982).

3.6 Core Lifters

Core lifters of the split-ring type, either plain or hard faced, should be used and maintained, along with core-lifter cases or inner-tube extensions or inner-tube shoes, in good condition. Basket or finger-type lifters, together with any necessary adapters, should be made available on the job and available for use with each core barrel if so directed by the geologist or engineer.

Table 2 Recommended Pump Flow Rates for Various Hole Sizes

(*Clause* 3.2.3)

Size	Pressure	Size of hole(mm)	Type of bit	Flow rates l/ min	Remarks
A	Casing	57	Surface set general	12-18	With AW
	Coring	47-62		8-12	rod
B	Casing	73	do	30-38	With BW
	Coring	59-56		19-26	rod
N	Casing	88.9	do	35-50	With NW
	Coring	75.31		23-42	rod
H	Casing	114.3	do	45-60	With HW
	Coring	98.80		30-50	rod

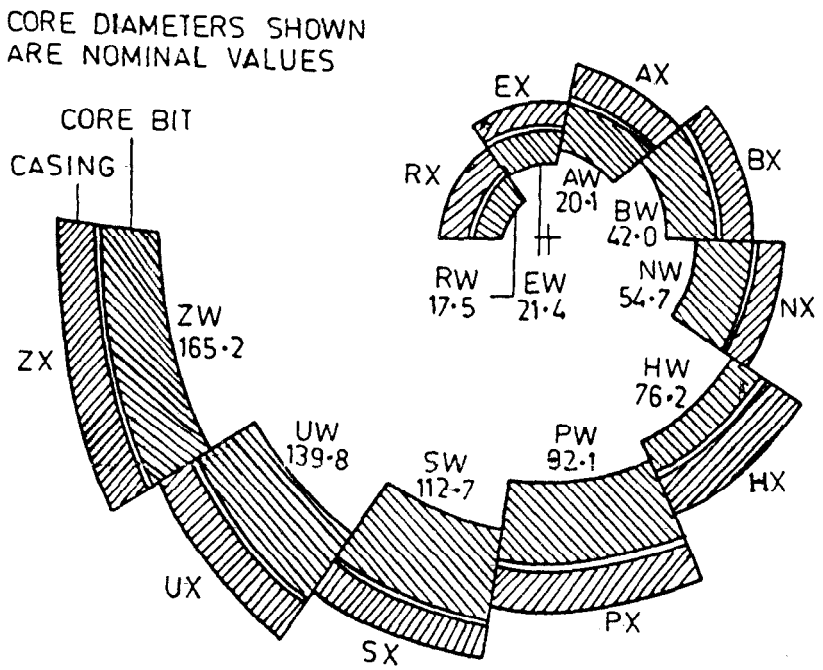

FIG. 1 GENERAL RELATIONSHIP OF IMPERIAL SIZED CASING TO CORE BIT SIZES (CONVERSIONS MADE TO mm FOR COMPARISON)

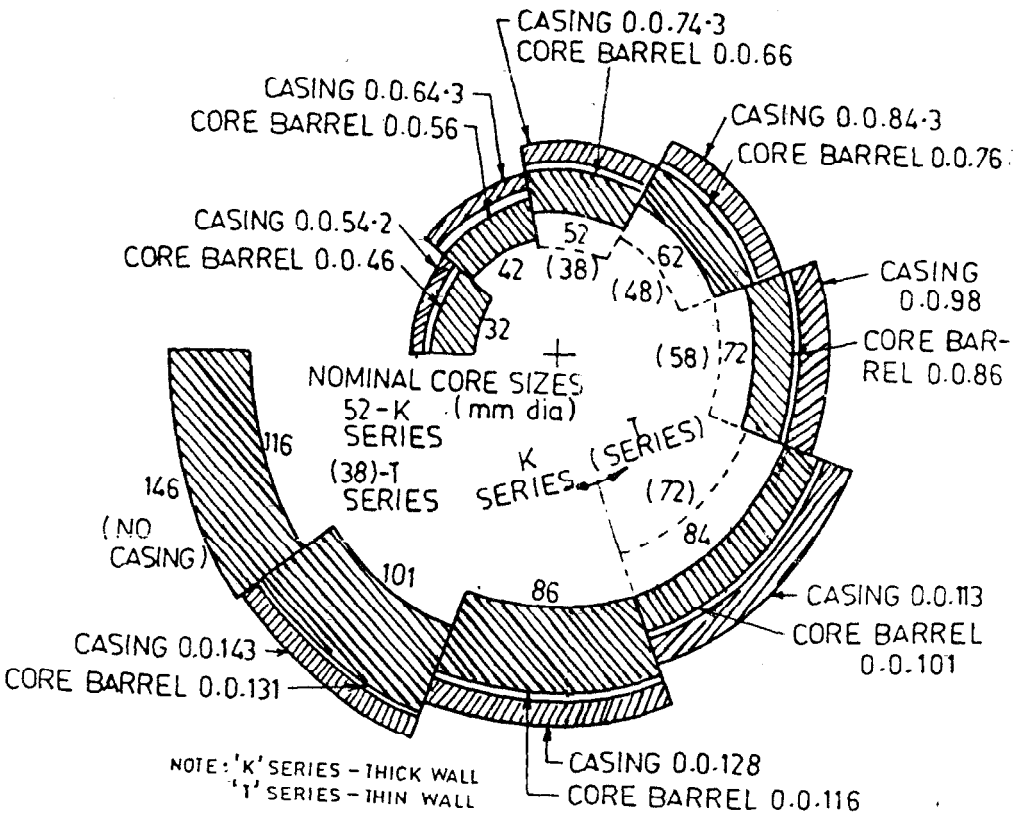

FIG. 2 METRIC CORE BARREL AND CASING NESTING SIZES

3.7 Casings

3.7.1 *Drive Pipe*

Drive pipe or casing should be of sufficient diameter to pass the largest core barrel to be used, and it should be driven to bed rock or to firm seating at an elevation below water-sensitive formation. A hardened drive shoe is to be used as a cutting edge and thread protection device on the bottom of the drive pipe or casing. The drive shoe inside diameter should be large enough to pass the tools intended for use, and the shoe and pipe or casing should be free from burrs or obstructions (*see* IS 10208 : 1982).

3.7.2 *Casing*

When necessary to case through formations already penetrated by the bore hole or when no drive casing has been set, auxiliary casing should be provided to fit inside the bore hole to allow use of the next smaller core barrel. Casing bits have an obstruction in their interior and will not pass the next smaller casing size. A casing shoe may be used, if additional telescoping casing is anticipated (*see* IS 10208 : 1982).

3.7.3 *Casing Liner*

Plastic pipe or sheet metal pipe may be used to line an existing large-diameter casing. Liners, so used, should not be driven, and care should be taken to maintain true alignment throughout the length of the liner.

3.8 Drill Rods

3.8.1 Drill rods of Tubular steel are normally used to transmit, feed, rotation and retraction forces from the drilling machine to the core barrel. Drill-rod sizes should conform to IS 10208 : 1982.

3.9 Auxiliary Equipment

Auxiliary equipment should be used as required for the work and should include; roller rock bits, drag bits, chopping bits, boulder busters, fishtail bits, pipe wrenches, core barrel wrenches, lubrication equipment, core boxes, and marking devices. Other recommended equipments include core splitter, rod wicking, pump-out tools or extruders and hand sieve or strainer.

3.10 Compatibility of Equipment

3.10.1 Whenever possible, core barrels and drill rods should be selected from the same letter-size designation to ensure maximum efficiency, for example NX core based with NW rod.

3.10.2 The combination of pump, drill rod and core barrel should be such that it yields uphole velocity of more than 40 m/min to get a clean hole and clear water. Similarly the combination of air compressor, drill rod and core barrel should yield uphole air velocity of more than 920 m/min.

4 TRANSPORTATION AND STORAGE OF CORE CONTAINERS

4.1 The details of core boxes and indexing and storage of core containers are given in IS 4078 : 1980.

4.2 Transportation of cores from the drill site to the laboratory or other processing point should be in durable core boxes so padded or suspended so as to be isolated from shock or impact transmitted to the transporter by rough terrain or careless operation.

5 PROCEDURE FOR CORE DRILLING

5.1 Core drilling is done where the formation encountered is too hard to be sampled by any soil sampling methods. The switching over from soil sampling method to core drilling should be normally done in accordance with the guidelines given in IS 2131 : 1981 and IS 2132 : 1986. However, the final decision should be taken by the geologist and engineer-in-charge of the site.

5.1.1 Casing should be seated on bedrock or in a firm formation to prevent travelling of the borehole and to prevent loss of drilling fluid. Surface of the rock or hard formation at the bottom of the casing, should be levelled, when necessary, using the appropriate bits.

5.1.2 The core drilling may be carried out by an N-size double-tube swivel-type core barrel or any other size or type and the design approved by the engineer-in-charge. Core drilling should be continued until core blockage occurs or until the net length of the core barrel has been drilled in. The core should be removed.

5.1.3 The recovered core should be placed in the core box with the upper (surface) end of the core at the upper-left corner of the core box. The cores with proper markings should be placed into core boxes at appropriate spacings, with blocks. Soft or friable cores, or those which change materially upon drying, should be wrapped in plastic film or seal in wax, or both as required by the engineer. Spacer blocks or slugs properly marked should be used to indicate any noticeable gap in recovered cores which might indicate a change or void in the formation. The fractured, bedded and/or jointed pieces of the core should be reassembled in the sequential order of their recovery before keeping the same in the core box.

5.1.4 Core drilling should be stopped when soft materials are encountered that produce less than 50 percent recovery. If necessary, samples of soft materials should be taken as per IS 2131 : 1981 and IS 2132 : 1986 in consultation with geologist or engineer-in-charge. Diamond core drilling should be resumed when hard formation is again encountered.

5.1.5 Sub-surface structures, including the dip of strata, the occurrence of seams, fissures, cavities and broken areas are among the most important items to be detected and described. Special care should be taken to obtain and record information about these features. If conditions prevent the continued advance of core drilling, the hole should be cemented and redrilled, reamed and cased, or cased and advanced with the next smaller-size core barrel.

5.1.6 Drilling mud or cementing/grouting techniques should be approved by geologist or engineer-in-charge before their use in bore hole.

5.2 In soft, seamy, or otherwise unsound rock, where core recovery is poor, the Type B (M design) or the triple tube core barrel with bottom discharge bits may be employed. In hard, sound rock, the single tube core barrel may be employed; if the core recovery is poor double tube core barrel should be preferred.

5.3 The core drilling observations should be done in accordance with IS 5313 : 1980, while the drilling information and core description should be done in accordance with IS 4464 : 1985.

6 SELECTION AND CARE OF CORE BITS

6.1 Rock Coring

There are no strict rules for the use of bits at rock drilling. Type, size, speed, bit pressure and water pressure should be adopted to the prevailing rocks to make the drilling operation economical. A choice of these factors which gives the best core recovery combined with good progress is the right one (*see* Annex A). However, fast progress and good core recovery as a rule cannot be combined. In foundations investigation, however, the emphasis should be placed on good core recovery.

6.2 Diamond-Set Bits

6.2.1 The harder and more fine grained the rock is, the smaller diamonds should be used. Bits with big diamonds (5 to 15 stones/carat) are suited for soft rocks and for fractured rocks of all types. Bits with 15 to 30 stones/ carat are intended for hard fractured rock and bits with 30 to 60 stones/carat are mostly used in hard solid rock. The diamonds that may be used for different rocks types are given in Annex A for guidance. The bits indicated with a cross (×) in this Annex should normally be used. In some cases other types of bits may be considered.

6.2.2 The diameter of the bits should be decided by the demands of the drilling programme; bigger diameters give a better core recovery and a less disturbed core.

6.2.3 *Precautions to be Taken With New Bits*

a) It is preferable to use an old bit to start a hole. Experiments have shown that in certain formations the bits used only for starting holes gave only 9 percent of the normal expected meterage. It has been stated that the first 5 cm of a run takes as much out of a bit as the next 6 m.

b) Speed and bit pressure should be low to avoid vibration and loss of diamonds (*see also* **8** and **9**).

c) As tools are lowered near to bottom of the hole, water circulation should be started to wash out settled cuttings which usually extend up some distance from the bottom.

d) A new bit should never be pushed to the bottom of a hole. Since an old bit is usually under gauge, a new bit should be stopped 5 to 10 cm from the bottom and drilled. When the bottom is reached, the new bit should be run at a moderate rate and slow feed for 3 to 5 cm to give the diamonds a chance to seat themselves. This prevents the sharp points from being broken off.

e) Wrench jaws should not be allowed to touch the diamonds in a bit. This applies also to reaming shells.

f) When bits and shells are not in use they should be well oiled over their entire surface and packed in a separate box used only for this purpose. Each diamond-set tool should be protected by waste, rags or other soft packing to prevent damage to the diamonds.

g) When drilling through very hard, fine-grained, siliceous rock, the diamonds may get polished after drilling only about a metre or more. When this happens the diamond bit cannot be expected to make any further progress in that particular kind of rock and should be removed from service and used later, either in another hole or in that same hole in some different kind of formation. Very often a slight change in the grain or hardness of the formation will remove the polish from the stones and render the bit useful for much additional drilling.

h) When drilling through highly abrasive rock, there is a tendency for the metal to wear away from the diamonds.

In these cases when the diamonds become exposed approximately one-third of their size, the bits should be removed and reset. After one-third of the bulk of each of the diamonds extends from the metal, there is danger of further wearing away of the metal to the point where the diamonds will drop out.

j) Burnt bits are sometimes caused by not tightening drill rods before lowering into the hole and depending on torque when starting to drill to do so. Because of wash water escaping through the joints the bit may run dry and hot in the mud and sludge at the bottom of the hole. The bit will also get burnt if it gets into the accumulated sludge at the bottom of the hole and drilling is started without cleaning the hole bottom.

6.2.4 *Resetting of Bits*

Items containing diamonds should be properly handled and maintained as any erroneous use may easily cause expensive damage to the equipment and/or hamper drilling operations.

Diamond-set bits have to be reset at intervals, that is, the diamonds are salvaged and replaced in a fresh matrix. Bits should be checked after each run. Resetting should be done on any of the following indications:

a) If the matrix is worn out to the extent more than 30 to 40 percent of most diamonds exposed. This may indicate that too soft matrix has been used; the bit may be reset in a harder matrix.

b) If the cutting edges of the diamonds are polished, the diamonds have a glare and are shiny. This is an indication that the bit has been run with insufficient water pressure. In such cases water pressure should be adjusted.

c) If more than 30 percent of the diamond points are broken, this often occurs in highly fractured rock where the diamonds are exposed to impacts which will break their points. In hard rock, vibrations in the rod string may have the same results. In such cases the spindle speed should be reduced or impregnated bits should be used.

d) If some diamonds are missing and the bit is continued to be used without resetting, more diamonds will fall out and be rolling at the cutting face and destroying this bit as well as other bits inserted in the hole. Furthermore the diamonds are lost and have to be replaced at great cost.

6.3 Impregnated Bits

These bits are self sharpening and are designed to be run to destruction. They are mostly used in very hard rock, for example, hard granite, gneiss, pegmatite, hard sandstone, quartzite, and flintstone (*see also* Annex A). In highly fractured rock the impregnated bits are often more resistant that diamond-set bits. The prerequisite for the use of impregnated bits is that the drilled rock is abrasive, that is, hard particles of the sludge will wear away the metal of the matrix thus exposing the embedded diamonds. Impregnated bits will become polished if used in wrong type of rock or at low bit pressure in connection with low spindle speed. In very hard and fine crystalline rocks they may get polished by using a too high spindle speed. Impregnated bits should never be run in rocks like limestone, marble, dolomite, or serpentine which create an adhesive sludge without any abrasive particles. If an impregnated bit does not cut, it can be sharpened by a gentle tapping of the cutting surface with edge of a big file.

6.4 Tungsten Carbide Tipped Bits (Saw-Tooth)

These are used for plaining of the rock surface before the more expensive diamond bits are used. They can also be used for drilling in very soft rock and in over-burden (*see* Annex A). They should be re-sharpened at intervals with a silicon carbide disc.

6.5 Reaming Shells and Casing Shoe Bits

These should be reset under the same conditions as other bits.

6.6 With each order for resetting there should be indicated the matrix (its hardness), carat content of diamonds in the bit (to define amount of additional diamonds) and diamond size (stones per carat).

7 CORE BARRELS

7.1 Single tube core barrels should be used only in solid unfractured rock and for the first 25 to 70 cm when a new hole is started. In fractured and/or soft rock, the use of single tube core barrel will cause the core to be ground, jammed or washed away. Double tube core barrels should always be used in fractured and/or in soft rocks. In very friable rocks Type B core barrels with bottom discharge bits should be used at slow speed and low bit and water pressures. Long core barrels may be used in solid rocks and short ones in fractured rock. The runs should never completely fill the core barrels; leave a few centimetres.

8 SPINDLE SPEED

8.1 Diamond-Set Bits

High spindle speed gives rapid progress but the core recovery will be hampered, especially in soft rocks. The spindle speed should therefore be regulated to the properties of the rock. At small diameters and holes down to 180 m the spindle speed may reach but should rarely exceed 1 500 rev/min while 100 to 200 rev/min is average at great diameters and for deep holes. As an example, spindle speed should be 100 to 750 rev/min for NX bits and 5 to 15 stones/carat; and for small diameter bits with 30 to 60 stones/carat, spindle speeds of 500 to 1 500 rev/min are suitable. The bit speeds suitable for various types of rocks are given in Annex A.

8.2 Impregnated Bits

The impregnated bits can work within a large range of spindle speeds and high speeds give more rapid progress. However, the spindle speed should never be so high as to cause vibration in the rods. The highest spindle speed should not exceed that giving a periphery speed of the bit equal to 2.3 m/s, which gives maximum speeds of 1 000 rev/min for AX bits, 700 rev/min for BX bits and 550 rev/min for NX bits.

9 BIT PRESSURE AND WATER PRESSURE

9.1 The bit pressure (feed pressure plus weight of the rods) should be low (160 to 315 kg) when a new bit is put into operation to prevent too rapid wear or break of the cutting points of the diamonds. As the polishing of the diamonds proceeds the cutting speed is reduced which can be made up for by increasing the feed pressure. The requirement for resetting the bit gives generally the limit for the pressure. However, the strength of the rods and the rig itself will mostly impose the maximum pressure, 900 to 1 130 kg with A-rods. If a worn out bit is operated at high pressure, there is a danger of deviation of the hole. Guidance on bit pressure and water pressure for various rock types is given in Annex A.

10 CORE RECOVERY

10.1 Regardless of the careful supervision an engineer may give to the drilling, the responsibility for good core recovery is largely in the hands of drill operators. Generally this may be assured by adopting correct drilling techniques and special coring equipment. In this connection the use of double tube or triple tube core barrel with bottom discharge bits would be found useful in ensuring the maximum possible core recovery in soft rock or fractured hard rock. Special drilling techniques in such cases may call for short runs of drilling and judicious control of water supply and speed of drilling. Core recovery may be ruined by drilling too fast, overdrilling a run, or dropping core and grinding it, or not pulling out the tools when the barrel is jammed and thereby grinding the core. This also damages the bit. Vibration in the drill string causes poor core recovery, diamond wear and diamond losses in bits and shells, wear and tear on drills and loss of footage. Guidance on the causes of vibration and the measures to be taken for controlling vibration are given in Annex B.

11 REPORT ON BORE HOLE LOGGING

11.1 The log of bore hole should be prepared as per IS 4464 : 1972, IS 4078 : 1980, IS 5313 : 1980 and it should include the following.

11.1.1 Project identification, bore hole number, location, date when boring began, date when boring completed, and driller's name.

11.1.2 *Elevation of the Ground Surface*

11.1.3 Elevation or depth of ground water and rise or fall of level including the dates and the times of measurement.

11.1.4 Elevations or depths of drilling of measurement at which return flow was lost.

11.1.5 Size, type, and design of core barrel used. Size, type, and set of core bit and reaming shell used. Size, type and length of all casings used. Description of any movements of the casing.

11.1.6 Length of each core run and the length or percentage, or both, of the core recovered.

11.1.7 Description of the formation recovered in each run.

11.1.8 Subsurface structure description, including dip of strata and jointing, cavities, fissures, and any other observations. For symbols and abbreviations (*see* IS 7422 (Part 1) : 1985).

11.1.9 Depth, thickness, and apparent nature of the filling of each cavity or soft seam encountered, including opinions gained from the feel or appearance of the inside of the inner tube when core is lost.

11.1.10 Any changes in the character of the drilling fluid or drilling fluid return.

11.1.11 Tidal and current information when the borehole is sufficiently close to a body of water so as to be affected.

11.1.12 Drilling time in minutes per metre and bit pressure in pascals when applicable.

11.1.13 Notations of character of drilling, that is, soft, slow, easy, smooth, etc.

ANNEX A

(*Clauses* 6.1, 6.2, 6.3, 6.4, 8.1 *and* 9.1)

AVERAGE DATA FOR DRILLING WITH N SIZE TOOLS TO ACHIEVE A CONCURRENCE OF RAPID PROGRESS AND GOOD CORE RECOVERY

Rock Type	*Bit Type*				*Diamond Impregnated Bits*	*Core Barrel Type B*	*Bit Speed Rev/Min*	*Bit Pressure*	*Water Pressure kg/cm2*
	TC	Diamond Set Bits							
		5, 15	15, 30	30, 60					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Laterite		x				x	100	Light	3.5 to 7
Weathered granite and soft geneiss		x				x	200	Light	3.5 to 7
Sandstone		x				x	200	Light medium	9 to 12.5
Clay shales	x					x	200	Light	9 to 12.5
Other bedded sediments	x	x				x	200	Light medium	9 to 12.5
Hard sand-stone		x					200	Medium	10.5 to 14
Black schist			x				400	Medium	10.5 to 14
Basalt (green-stone)			x				400	Medium	10.5 to 14
Porphyry			x	x			400	Medium	10.5 to 14
Diorite			x	x			400	Medium	12 to 15.5
Hard basalt (greenstone)				x			600	Medium heavy	14 to 17.5
Hard porphyry				x	x		600	Medium heavy	14 to 17.5
Hard diorite granite, gneiss				x	x		600	Heavy	14 to 17.5

Bit type : TC = Tungsten carbide saw tooth bits.
5,15; 15,30; 30,60 = Diamond-set bits with stones per carat within the limits indicated.

The bits indicated with a cross (x) should normally be used.
When using other sizes of coring equipment, multiply with factor given below:

Size	Factor		
	Feed Pressure	Water Pressure	Bit Speed
NX	1	1	1
BX	0.7	0.7	1.3
AX	0.5	0.5	1.6
EX	0.3	0.3	1.9

ANNEX B

(*Clause* 10.1)

CAUSES AND REMEDIES OF VIBRATION IN DRILLING

B-1 CAUSES OF VIBRATION

B-1.1 Causes of vibration for which the operator is responsible are the following:

a) Excessive rotational speed;

b) Excessive feed rate or pressure;

c) Excessive water pressure or volume;

d) Low water pressure or volume, resulting in slow removal of cuttings;

e) Drilling when the core barrel is filled;

f) Drilling over dropped core; and

g) Careless handling of drill rod. Bent rods cause vibration, deviation in holes and damage to bits. Rods can be bent through:

   i) rough handling of rods,

   ii) their improper use as crow bar or as lever arm, and

   iii) hoisting and lowering rods with pipe wrench instead of using safety clamps.

B-1.2 Causes of vibration controllable by the operator are the following:

a) Unsatisfactory setting up of drilling rig;

b) Incorrect size of rods and core barrel in relation to the size of hole;

c) Bent core barrel and rods;

d) Bit with missing stone or damaged bits;

e) Lack of rod grease;

f) Unsatisfactory condition of drilling equipment, such as worn out spindle and bearings of swivel head; and

g) Off-centre tightening of the chuck.

B-1.3 Causes of vibration not fully controllable by drillers are the following:

a) Worn out rod couplings;

b) Core bits with flat faces that 'Walk' in certain formations;

c) Crooked drill holes due to unfavourable geological features;

d) Cavities in the rock, allowing wide sway of the rod string; and

e) Variable hard and soft layers, such as limestone with chert or shale with hard quartizite layers.

NOTE — All causes of vibration listed have serious effects on core recovery and wear on bits and equipment.

B-2 REMEDIES FOR VIBRATION

B-2.1 Remedies for vibration are the following:

a) The use of rod grease on bottom rods;

b) Drill rods of maximum size for hole being drilled;

c) Use of drill collars;

d) The use of sharp bits;

e) The use of straight rod and core barrel, concentrically threaded;

f) Maintenance of rods, coupling, core barrel and drill itself in first class condition; and

g) Proper control of feed, rotational speed and drill bit pressure.

In coring operations as many of the adverse conditions which tend to induce rod vibrations as is physically and economically possible should be eliminated.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'.

This Indian Standard has been developed from Doc : No. RVD 5 (100).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Dee Kay Printers, New Delhi-110015, India.