

CHAPTER NO. 7

SPECIFICATION NO. 7.1—Rock Cutting

1. The specifications for excavation in earthwork shall apply to excavation in rock as far as possible.

Excavation.

2. The centre line or a line parallel to it shall first be set out by a theodolite and marked with pegs. All curves shall be properly laid out and the apex and tangent points shall be fixed, the apex peg being fixed in concrete. The position of tangent and apex points shall be clearly indicated by marks painted white on the nearest rock on which shall also be painted the distance of these points from the mark. Bench marks shall be fixed at convenient intervals on the firm rock or in concrete for marking and checking levels of rock cutting.

Setting out.

3. Before work is started, cross-sections shall be taken every 25 ft. (10 metres) at right angles to the central line of the proposed alignment. The position of these cross-sections will be marked at site by a permanent reference peg or marks painted on rock, which will be fixed clear of the cutting. The reference pegs or marks are very important and their location will also be clearly shown on the survey plan. The cross-sections will be got verified by the contractor and got signed by him as correct. Work done before cross-sections have been verified and signed will not be paid for. The earthwork and rock cutting shall then be carried out according to approved longitudinal section. After the work has been completed, the new profile will be plotted on the cross-sections, which will again be got signed by the contractor in token of his acceptance of the measurements.

Profiles.

4. (i) Rates for rock cutting will normally be admissible for soils of dry bulk density of more than 2.2.

Difference between earthwork and rock cutting.

(ii) The Superintending Engineer should decide whether hardness should be paid or whether rates for rock cutting should be paid for soils with dry bulk density of more than 1.9 and upto and including 2.2.

(iii) In the plains, there should normally be no necessity to pay rock cutting items and the Superintending Engineer, must satisfy himself of the existence of rock conditions before allowing payments for rock items.

(iv) Sheet kankar may, however, be treated as rock at the discretion of the Superintending Engineer after personal inspection.

5. (i) **Pickworks**:—This includes cutting in hard soil and in all kinds of disintegrated rock, or shale or indurated clay interspersed with small boulders which can be loosened and removed with pick-axes and does not require the use of jumpers or blasting.

Classification of rock cutting.

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(i) **Pick and jumper work:**—This shall include cutting in all kinds of disintegrated rock, shale or slate which can be loosened and removed with pick-axes and jumpers and does not need blasting.

(ii) **Jumper work:**—This shall include cutting of soft, fractured or other rocky materials soft or loose enough in its natural condition to be loosened and removed with jumpers and shovels without the need of any blasting.

(iv) **Pick jumper work with occasional blasting:**—This shall including cutting of soft, fractured, disintegrated or loose rock which can be removed with pick-axes, jumpers and shovels but where blasting may have to be resorted to occasionally to remove large pieces of rock or big boulders.

(v) **Blasting ordinary rock:**—This shall include cutting of rock in solid beds or masses which cannot be removed without blasting. Ordinary rock may comprise of lime stone, sand stone, laterite etc.

(vi) **Blasting hard rock.**—This shall include cutting of hard rock in solid beds or masses with drilling and blasting. Hard rock shall comprise of quartzite, granite and other igneous rocks.

(vii) **Blasting conglomerate mass:**—Conglomerate mass is a rock consisting of rounded pebbles and boulders cemented together in nature by any cementitious materials. This mass cannot be removed without blasting.

Chiselling in
hard rock,

6. Where blasting is prohibited or is not practicable, rock cutting shall be carried out by chiselling. Special rate, is as contracted, shall be paid for such work.

Excavated
materials

7. The stone etc. obtained from excavation will remain Government property. The useful portions shall be separated from the useless ones and deposited in regular stacks as directed by the engineer-in-charge.

Payment on
composite rate
basis.

8. The work of rock cutting shall be paid for on composite rate basis. While issuing notice of tenders or quotations, the Executive Engineer or Sub-Divisional Officer must clearly state that the rate includes all classes of rock cutting and that nothing extra will be payable to the contractor as allowances or extras of any kind. The rates to be quoted in tenders or quotations shall be specific item rates and not percentage above or below the schedule rates of rock cutting.

While framing estimates, the Sub-Divisional Officer should do the classification of rock cutting and the Executive Engineer should check a reasonable percentage of the same.

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9. The rates for rock cutting include handling of materials within 50 feet (15 metres), dressing, cost of explosives, compressed air, and the working and hire of pneumatic equipment and other tools and plant, which if supplied by Government, the costs thereof will be recoverable from the contractor.

Rate.

Rate for rock cutting in case of hill roads shall include the making of side drains also.

SPECIFICATION NO. 7.2—Blasting Operations

Introduction.

1. All contractors who execute blasting operations shall observe the rules and precautions set forth below and any further additional instructions which may be given by the engineer-in-charge and shall be responsible for any accident which may occur to workmen or the public due to such blasting operations. The engineer-in-charge shall frequently check the contractor's compliance with the precautions. In case where blasting is done departmentally without the services of a contractor, the engineer-in-charge shall himself see that all the precautions are observed.

Indian Explosive Act.

2. The Explosives Rules, 1940 or any other rules made under Indian Explosives Act, 1884 shall be strictly observed.

Magazines for explosives.

3. Magazines for storage of explosives shall strictly conform to applicable rules under the Indian Explosive Act. Design for such magazines shall be based on the standard plans. General rules for construction of explosive magazines and precautions to be observed in them (adopted from Explosive Rules, 1940) are given in appendix XII for guidance.

General instructions for blasting operations.

4. Blasting operations shall be in charge of a competent person appointed by the contractor. In these specifications, he shall be referred to as the contractor's supervisor.

Blasting operations shall only be carried out at certain specified times as directed by the engineer-in-charge in writing. No lighting of blasts shall be permitted by the contractor except in the presence and under the personal supervision of such competent person.

Red danger flags shall be prominently displayed and all the people, except those who have actually to light the fuses, shall be made to stand at a safe distance from the blast, not less than 200 yards (60 metres) as a rule. In special cases, suitable extra precautions shall be taken.

All fuses shall be cut to the lengths required before being inserted into the holes.

The contractor shall be responsible for the safe custody and storage of powder, dynamite or other explosives brought for use on the work, and shall keep such explosives separate from the fuses and detonators until being actually placed in the blast holes.

The depth of the bore hole shall be about the same as the line of least resistance, that is the distance of the hole from the nearest rock face, but the bottom of the hole should not descend below the face of the rock.

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Cracks and fissures in rock to be blasted should be carefully studied to ascertain the best position for the boreholes. The charge should always be placed in a sound piece of rock, and if possible not nearer to a crack than 1 foot (30 cm.).

If it is desired to shatter rock, close connection between explosive and the rock is essential, and points of contact should be multiplied as much as possible. For this reason, several boreholes of moderate diameters are preferable to one hole of a larger diameter.

5. (a) **General.**—Gunpowder is a mixture of 75% potassium nitrate, 15% charcoal and 10% sulphur. Blasting powder is frequently made with the sodium nitrate, which produces a cheaper and less powerful powder than that made from potassium nitrate. Sodium nitrate, however, has the disadvantage of absorbing moisture from the air, and powder made from it can not be kept too long or stored in a damp place. The composition of blasting powder is generally as follows :

Blasting with
gun powder.

73% sodium nitrate, 16% charcoal and 11% sulphur,

(b) **Blasting.**—The powder shall be enclosed in a water-proof cartridge and introduced into each borehole by a funnel or a copper tube. The bore hole shall be dried before being charged. Safety fuse shall then be passed into the powder and taken outside to the required distance.

A wadding of hay or dry turf shall be placed on the powder and around the fuse. An inch or two of the wadding shall be pressed down on the powder and the remainder of the hole shall be filled in with tamping materials e.g. dry clay. The filling material shall be rammed or tamped with a copper or brass rod until it becomes compact. Care shall be taken to avoid any possibility of an air hole around the fuse.

(c) **Unexploded charge.**—The number of blasts to be fired and the actual number of shots heard shall be compared and the person responsible shall satisfy himself by examination that all the blasts have exploded before workmen are permitted to approach the scene. The withdrawal of a charge which has not exploded shall, under no circumstances, be permitted but the tamping and charge shall be flooded with water and the hole marked in a distinguishing manner. Another hole shall be jumped at a distance of about 18 inches (45 cm.) from the hole, and fired in the usual way. The results shall be carefully examined by the persons in charge of the blasting and the operation continued until the original blast is exploded.

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Blasting with dynamite.

6. (a) General.—Dynamite is an explosive mixture of nitroglycerin and a granular absorbent. It has a yellowish colour and is packed in waterproof paper in the form of cylindrical cartridges.

(b) Quantity of explosive required.—The quantity of explosive needed for each blast hole may be obtained from the following formula :—

$$W=A(LLR)^2 \text{ plus } B(LLR)^3$$

where

W=Quantity of explosive in ounces.

A & B=Co-efficients to be determined by experience.

LLR=Line of least resistance.

If the explosive is properly proportioned to the amount of work it has to do, the blast will make very little noise. A loud explosion indicates either too heavy charge or that the holes are not spaced properly to give the dynamite a maximum amount of work to do. Heavy loads break the rock into small pieces and if it is desired to break the rock in large pieces, light charges should be used.

(c) Boreholes.—The following are the diameters of drills generally used for different depths of borehole :—

From 3 to 6 feet (1 to 2 metres)—1 inch (25 mm) in diameter.

From 6 to 11 feet (2 to 3.5 metres)—1½ inches to 2 inches
(38 mm to 50 mm) in diameter.

From 11 to 15½ feet (3.5 to 4.75 metres)—2 to 2½ inches (50 mm to 63 mm) in diameter.

The boreholes should generally be not more than 5 feet (1.5 metres) deep, and their distances apart should be from one, and a half to twice their depth.

If the required charge is so great that it cannot be held in a hole 5 feet (1.5 metres) deep, two or more holes should be made close together, the total charge being slightly increased, and exploded simultaneously.

(d) Preparation of charge.—The required length of safety fuse shall be cut from the coil, clean and straight across. All the saw dust shall be slackened out of the detonator and the freshly cut end of the fuse shall be pushed in till it touches the white fulminate inside the detonator. The

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fuse shall not be twisted or screwed to the detonator. The open end of the detonator shall then be crimped with pinches to attach it to the fuse, care being taken not to break the powder core of the fuse by pinching too tightly. If the detonator is to be used in a damp or wet place, this junction shall be made watertight with grease, white lead or tar thickened with quick lime. The end of a cartridge shall then be opened and a hole made in the explosive with a small stick. The detonator shall be pushed into this hole leaving one third of the detonator projecting. The paper of the cartridge shall then be tied firmly round the detonator.

In cold weather, explosives are liable to "freeze" and should be "thawed" before they are used. This can safely be done by putting them in an empty, watertight tin, into a vessel of hot water till they have resumed their normal condition. The temperature of the water should not exceed 130° F (55° C). Open boxes of dynamite and gelatinous compounds shall never be exposed to the direct rays of the sun.

(e) **Charging borehole.**—The hole shall be thoroughly cleaned, a spoon being used for removing the dust. Dynamite cartridges shall then be inserted one at a time and each shall be squeezed home gently with a wooden rod. The primer cartridge prepared as specified in the sub-para (d) shall be inserted last and shall not be squeezed home. The hole shall then be filled loosely with sand or clay to a depth of at least 8 inches (20 cm.) and the sand or clay gently pressed home with a wooden or copper rod. The rest of the hole shall then be filled with sand or clay which shall be rammed hard with a wooden or copper rod.

(f) **Precautions.**—These precautions are applicable, primarily to operations in open cutting as opposed to tunneling :

(1) Where blasting operations are let on contract, explosives should be issued to the contractor only in quantities determined strictly by requirement of the work actually in progress, and should in no case exceed a week's supply.

(2) Boxes of dynamite or blasting gelatine, when required to be opened or closed, will be placed on a clean wooden table or plank free from grit or metal nails. Two wooden wedges will then be driven under the lid with a wooden mallet till the lid is raised sufficiently to be forced up with a wooden lever. The water-proof lining can then be torn along the joint and the packets of cartridges removed. If neither a table nor a plank is available, the box can be opened on a level piece of ground free from rock or stone.

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- (3) To refasten the box, all brass nails shall be withdrawn from the lid; the lid replaced in position and brass nails again driven with a wooden mallet.
- (4) Metal tools shall not be used for opening or reclosing, and the contractor is responsible that a suitable mallet wedges and wooden levers are kept in every magazine in his charge.
- (5) Boreholes shall be of such a size that the cartridges can easily pass down. The position of all holes to be drilled shall be marked out with white paint thus “.” and the contractor's supervisor shall take particular note of these positions.
- (6) The drilling operations being finished, the contractor's supervisor shall make a second inspection and satisfy himself that the boreholes marked out by him have been drilled.
- (7) The contractor's supervisor himself shall prepare all charges necessary for the boreholes.
- (8) The contractor shall instruct his supervisor regarding the number of holes to be loaded and fired at one time. This number shall in no case be more than ten.
- (9) The loading of boreholes shall be done by the contractor's supervisor himself.
- (10) Immediately before firing a blast, due warning shall be given and the contractor's supervisor shall see that all the workmen have retired to safety.
- (11) The safety fuses of the charged holes shall be lighted in the presence of the contractor's supervisor, who shall see that the fuses of all the holes charged have properly ignited.
- (12) Careful count shall be kept by the contractor's supervisor and others of each blast as it explodes.
- (13) After the blast, the contractor's supervisor shall carefully inspect the work and satisfy himself that all the charges have exploded.
- (14) In case of misfired holes, the contractor's supervisor shall first examine the same and at once mark a red cross over the holes thus “X”.
- (15) None of the driller shall work near this hole until one

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of the two following operations has been done by the contractor's supervisor :—

- (i) Either the contractor's supervisor shall very carefully (when the tamping is of damp clay), extract the tamping with a wooden scraper and withdraw the fuse with the primer and detonator attached, after which a fresh primer and detonator with fuse shall be placed in the misfired hole and fired ; or
- (ii) The hole shall be cleared of one foot (30 cm.) of tamping and the direction then ascertained by placing a stick in the misfired hole. Another hole shall then be drilled 6 inches (15 cm.) from the misfired hole and parallel to it ; this hole shall then be charged and fired, when the misfired hole should explode at the same time.

(16) Before leaving his work, the contractor's supervisor shall inform his successor in the next shift of any case of misfire and shall point out the position of the red cross stating what action, if any, he has taken in the matter.

(17) The contractor's supervisor shall also promptly report to the contractor and the engineer all cases of misfire, the cause of the misfire and the steps that were taken in connection therewith.

(18) No one shall approach a misfire for at least half an hour.

(19) If a misfire has been found to be due to defective fuse, detonators or dynamite, the whole quantity of box from which the defective article was taken shall be returned to the office for inspection.

(g) **Blasting with electric detonators.**—If blasting is done with electric detonators, the following additional specifications shall also be followed :—

The ends of the detonator wires shall be scraped clean and bright and care shall be taken to see that they do not twist or kink when the charge are placed in position.

The circuit through the detonators shall then be tested with a galvanometer. The cables of the exploder shall then be added to that circuit and the new circuit tested with a galvanometer. The cable of the exploder shall be of sufficient length to permit the man using it to stand at least 200 yards (60 metres) from the charges unless he can obtain suitable shelter nearer them.

7. Destruction of explosives will be carried out as laid down in appendix XIII.

Destruction of
explosives.