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मानक

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IS 14749 (2000): Proforma for Analysis of Unit Rate of Underground Excavation by Cyclic Drilling and Blasting [WRD 23: Measurement and Cost Analysis of Works For River Valley Projects]



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“Knowledge is such a treasure which cannot be stolen”



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भारतीय मानक

समकेंद्रित छिद्र और विस्फोटन द्वारा भूमिगत उत्खनन की  
इकाई दर के विश्लेषण के लिए मुक्त प्रपत्र

*Indian Standard*

PROFORMA FOR ANALYSIS OF UNIT RATE OF  
UNDERGROUND EXCAVATION BY CYCLIC DRILLING  
AND BLASTING

ICS 93.020;17.020

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**BUREAU OF INDIAN STANDARDS**  
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NEW DELHI 110002

## FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Cost Analysis and Cost Estimates Sectional Committee had been approved by Water Resources Division Council.

Underground excavation by cyclic drilling and blasting is very often resorted to during construction of River Valley Projects. As very large areas are involved in such operations, it becomes necessary that a proper methodology is available for rate analysis of the same. This would be helpful in integrating the economics of the project.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## *Indian Standard*

# PROFORMA FOR ANALYSIS OF UNIT RATE OF UNDERGROUND EXCAVATION BY CYCLIC DRILLING AND BLASTING

### 1 SCOPE

This standard lays down proforma for analysis of unit rate of underground excavation by cyclic drilling and blasting. This standard does not include provisions for underground lining.

### 2 CLASSIFICATION

For case of comparison of unit rates of various underground excavations, the following classification for underground excavation may be adopted:

- a) Based on geological consideration:
  - 1) Underground excavation in competent rock
  - 2) Underground excavation in incompetent rock
- b) Based on method of excavation adopted:
  - 1) Full face
  - 2) Heading and benching
  - 3) Multi-drift.

Unit cost for underground excavation by adopting heading and benching method may be the average of unit cost of heading and unit cost of benching. The average will be weighted average depending upon the area of heading and benching.

### 3 TECHNICAL INFORMATION

The following technical information would be helpful in framing the unit rate of underground excavation:

- 1) Name of the project.
- 2) Layout plan of the project.
- 3) Location with plan and longitudinal section of the underground component.
- 4) Purpose of the underground excavation.
- 5) Construction agency:
  - i) Departmental or contractor
  - ii) Name of department/contractor
- 6) Shape of the underground work (circular, horse shoe, elliptical, vertical walled with arch roof, vertical excavation of various shapes, etc).
- 7) Excavation size of the underground component (excavated dimensions to the pay-line).
- 8) Type of final lining.
- 9) Location plan and longitudinal section of adits and shafts.
- 10) Description of alignment including mention of bends, transitions, approach adit/tunnel.
- 11) Type of rock bored (igneous, sedimentary or metamorphic) and physical properties such as compressive strength, abrasive value and modulus of elasticity.
- 12) Orientation of excavation with respect to dip, strike joint pattern.
- 13) Description of rock cover, depressions and *khuds* crossing over the underground cavity along its alignment.
- 14) Physical defects of rock formations (joints, faults, etc).
- 15) Ground water conditions, locations and quantity of seepage water at various periods of the year.
- 16) Inflammable and obnoxious gases, if encountered (brief description).
- 17) Methods adopted for tackling underground excavation (full face, heading and benching, multiple drifting, pilot tunnel/shaft, forepoling, providing double steel ribs and invert struts etc):
  - i) Reaches of competent rock strata,
  - ii) Reaches of incompetent rock strata (sheared and fractured),
  - iii) Reaches with inadequate rock cover and adverse ground water conditions,
  - iv) Reaches showing rock distress,
  - v) Reaches of bad rock strata which may lead to causing break through conditions, and
  - vi) Any other adverse geological conditions.
- 18) Equipment at each underground heading :
  - i) Drill jumbo
    - Type
    - Overall dimensions
    - Number of drills/booms
    - Motive power
  - ii) Drilling machines
    - (hydro-booms, ladder drilling system with fast rock drills, other drills)
    - Number and type.
  - iii) Drill steel and drill bits (a brief description)
  - iv) Mucking machine : Make, model and capacity, number of machines

- v) Haulage equipment
  - Locos (diesel/ : Number, make, model electrical) and capacity
  - Mine cars :
  - Rubber tyred : Model and capacity carriers
- vi) Ventilation
  - a) Ventilation duct : Diameter and type
  - b) Main blowers : Make, model, type, capacity and spacing
- vii) Pumping arrangements (underground)
  - Number of pumps — main/feeder
  - Type of pumps : Type and capacity
  - Spacing of pumps
  - Length, size and nature of pipelines — main/feeder
- viii) Supporting arrangement
- ix) Communication arrangement inside and outside
- x) Instruments for monitoring
- xi) Location and lead of dump yard from portal
- 19) Air supply — Installed capacity of compressors, pipe size.
  - Water supply — Capacity of tank, pipe size, length, etc
- 20) Electrification
  - Main supply voltage
  - Transformer details
  - Lighting voltage
- 21) Excavation data (in reaches of competent rock strata)
  - i) Type of strata for drilling and blasting:
    - a) Average number of drill holes and size of holes per round/cycle,
    - b) Type of cut holes pattern,
    - c) Number and size of cut holes,
    - d) Average depth of drill holes,
    - e) Average actual advance,
    - f) Type of explosive and detonators used,
    - g) Quantity of explosive used for round/cycle, and
    - h) Explosive factor (kg.cum)
  - ii) Time cycle
    - a) Moving drill jumbo up to — (h/min) the face and drilling cycle
    - b) Average drilling rate — (cm/min)
    - c) Loading cycle, removing — (h/min) drill jumbo from the muck pile, scaling down loose rocks and mucking out
    - f) Time for secondary blasting — (h/min)
- g) Time for installation — (h/min) support system (shot-creting, rockbolting, structural steel support, lagging, backfilling)
- h) Description of support system including spacing, etc
- j) Average time lost due to hold ups/derailments in case rail mounted equipment is used
- k) Average cycle time — (h)
- m) Average advance/ — (m or m<sup>3</sup>) excavation in one cycle
- n) Overall advance/ — (m or m<sup>3</sup>) excavation in a month
- p) Percentage of overbreak of the excavation up to payline
- 22) Date of commencement and completion of underground excavation
- 23) Monthly progress from the date of start of excavation to completion of excavation as per the following format:
 

Year	Month	Progress (m or m <sup>3</sup> )	Underground excavation condition
			a brief description
- 24) Incentive payment — a brief description schemes for underground crews and results obtained (if any)
- 25) Industrial disputes — a brief description (if any) and their effect on progress
- 26) Safety arrangements including first aid, medical and rescue operations.
- 27) Accidents during underground excavation
 

Fatal accidents	—	No. of persons dead
Major accidents	—	No. of persons disabled
Reasons of accidents	—	A broad split up be given
- 28) Geological forecast of strata and that actually obtained during underground excavation — Current forecast A brief description outlining the major variations be given
- 29) Lessons learnt

#### 4 PROFORMA FOR ANALYSIS OF UNIT RATE OF COST FOR UNDERGROUND EXCAVATION

4.1 The proforma recommended for use in the analysis of unit rate of underground excavation is as given in Table 1.

**Table 1 Proforma for Analysis of Unit Rate of Cost for Underground Excavation**  
(Clause 4.1)

Volume of rock excavated per cycle	=
No. of cycle per day (depending upon cycle time)	=
Volume of rock excavated per day	=

**A CYCLE OF OPERATIONS**

Sl No.	Item of Operation	No. of Working Hours
a)	Survey and marking profile/holes	
b)	Positioning of jumbo and drilling	
c)	Charging and blasting	
d)	Defuming	
e)	Scaling	
f)	Mucking	
g)	Mapping	
h)	Average time for shotcreting, rock bolting/rib erection and backfill concreting	

Total cycle time = \_\_\_\_\_

**B CHARGES****B-1 Labour Charges\*:**

i)	Foreman/Supervisor (No. × Wage)	
	@ Rs per day	Rs
ii)	Blaster (No. × wage)	
	@ Rs per day	Rs
iii)	Electrician (No. × wage)	
	@ Rs per day	Rs
iv)	Helper to Electrician/Blaster	
	@ Rs per day	Rs
v)	Beldars (No. × wage)	
	@ Rs per day	Rs
vi)	.....	Rs
vii)	.....	Rs
	Add for indirect charges of labour =	Rs
	Total labour charges :	Rs
	Rate of labour per cum =	Rs

\* Other than those employed for operation and maintenance of equipment as the same are covered under unit rate cost of equipment.

**B-2 Machinery Charges :**

Sl No.	Equipment	Number	Working hours per cycle	Total working hours per cycle	Unit rate cost per hour, Rs	Amount in Rs
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Drilling Equipment (Drill Jumbo/Jack hammer/.....)					
ii)	Mucking Machine (Mucker/wheel loader/.....)					
iii)	Hauling Equipment (locos/dumpers/.....)					
iv)	Mucking Equipment (Mine cars/.....)					
v)	Miscellaneous Equipment (Dozer/loader/excavator/.....)					

Total machinery charges per cycle: \_\_\_\_\_ Rs

Quantity of rock excavated per cycle = \_\_\_\_\_

Rate per cum =  $\frac{\text{Total machinery charges}}{\text{Quantity of rock excavated}}$  = \_\_\_\_\_ Rs



Table 1 (Continued)

**B-3 Material Charges****B-3.1 Drilling :**

Cross-sectional area of tunnel	=
No. of holes required per face	= 100, say
Depth of holes	= L
Total drilling length	= 100 L
Cost of drilling accessories	

Item	No. Regd.	Cost of	Life	Cost/metre
a) Shank adapter				
b) Drill steel/ Drifter rod				
c) Couplings				
d) Bit				
Total cost per metre of drilling		= Rs x, say		

Total cost of drilling per cycle = Rs 100 L x

Quantity of rock excavated per cycle = .....cum

Rate for drilling per cum =  $\frac{\text{Total cost of drilling (100 Lx)}}{\text{Quantity of rock excavated}}$

**B-3.2 Blasting**

i) Cost per cycle	
gelatine	= Rs
AN/FG	= Rs
PVC pipes	= Rs
Total	= Rs

ii) Cost of detonators/fuse coils = Rs

iii) Cost of consumables = connecting wires, cordex fuse, blasting cable, etc – per cycle = Rs

Hence rate per cum =  $\frac{(i) + (ii) + (iii)}{\text{Quantity of rock excavated}}$  = Rs

**B-3.3 Timber for Supports, Not Measured and Accounted for Separately Rate per cum, Lumpsum** = Rs

**B-3.4 Miscellaneous Supplies**

Such as wire ropes, manila ropes, v-clamps, rubber gloves, shackles and artificial respirators, etc rate per cum, lumpsum = Rs

Total material charges per cum [(B-3.1 + B-3.2 + B-3.3 + B-3.4)] = Rs. .... + Rs. .... + Rs. .... + Rs. .... = Rs

**B-4 Charges for Ventilation**

Unit rate cost of blower(s) per working hour = Rs

No. of working hours of blowers per cycle =

Total charges of blower per cycle = Rs

Cost of ventilation duct including erection charges per cycle = Rs

(Total cost of vent pipes and accessories/No. of cycles in full length of tunnel)

Total ventilation charges per cycle = Rs

Quantity of rock excavated per cycle =

Hence rate per cum =  $\frac{\text{Total ventilation charges}}{\text{Quantity of rock excavated}}$  = Rs

**B-5 Shop Charges**

i) Machine shop including four dry and emithy,	lumpsum	= Rs
ii) Structural shop,	lumpsum	= Rs
iii) Steel metal shop,	lumpsum	= Rs
iv) Air and water pipe shop,	lumpsum	= Rs
v) Carpentry shop,	lumpsum	= Rs
Total shop charges per cum		= Rs

Table 1 (Concluded)

<b>B-6</b>	<b>Electrical Material Charges per cum Covering</b>	= Rs
	i) Electric cables/wires	
	ii) Electrical consumables	
	iii) Electrical accessories	
	iv) Booster/Step-down transformer	
<b>B-7</b>	i) Railway track and accessories charges per cum	lumpsum = Rs
	ii) Road charges per cum	lumpsum = Rs
<b>B-8</b>	Water supply system charges per cum	lumpsum = Rs
<b>B-9</b>	Surveying charges per cum (Control survey and day-to-day)	lumpsum = Rs
<b>B-10</b>	Communication charges per cum to include walkie telephones, etc	lumpsum = Rs

**C ABSTRACT OF CHARGES**

1	Labour charges	= Rs
2	Machinery charges	= Rs
3	Material charges	= Rs
4	Ventilation charges	= Rs
5	Shop charges	= Rs
6	Electrical materials charges	= Rs
7	Track/road charges	= Rs
8	Water supply charges	= Rs
9	Surveying charges	= Rs
10	Communication facilities	= Rs
	<b>Total</b>	<b>= Rs</b>

**C-1 Add for****C-1.1 Ancillaries incidentals:**

- 1 Provision of:
  - i) Labour and staff quarters
  - ii) Service roads
  - iii) Electric power supply
  - iv) Water supply system
  - v) Sanitation system
  - vi) Drainage system
  - vii) Other amenities including first aid, medical facilities and safety arrangements and rescue operation
- 2 Maintenance/Operation of items mentioned above
- 3 Supervisory works establishment

**C-1.2 Quality control****C-1.3 Contingencies**

NOTE -- Item C-1.1 to C-1.3 above need to be accounted for and suitable allowance made.

**C-1.4 Overhead and profit**

This would include establishment, office stationery, general tools and plant, staff cars, their running and maintenance, insurance, workman's compensation, statutory benefits, telephone and telecommunication facilities, interest, liabilities on borrowings from the owner and bank guarantee charges

NOTE — All items mentioned above shall include depreciation, installation, operation, repairs and maintenance, mobilization and demobilization and dismantling of machinery where used. All items of labour mentioned above shall include indirect statutory and other benefits payable to the labour.

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