
Pricing Excavation & Backfill

-
- Excavation & backfill is usually performed by specialized contractors because the work requires specialized equipment
 - Some general contractors may, instead of subcontracting, perform the work on their own when they have the equipment or by renting it.
 - The objective of this chapter is to present estimating principles of common excavation activities.
-

Common Types of Excavation

1. Cut and Fill operations:
 - A. Large projects: dozers, scrapers, rollers, and water trucks, and graders.
 - B. Small projects: grader or bobcat
2. Basement-type Excavation: track backhoe or track loader, and dump trucks
3. Trench Excavation: Trenching machines, backhoes, tractors.
4. Pit and Sump: Backhoes

Equipment Transportation Cost

- Cost of transporting small equipment (plate compactors, bobcats, small tractors) is priced within General Expenses under “Trucking & Material Handling” section.
- Large Equipment is priced individually taking into account cost of loading, unloading, trucking, and any other charges incurred during transportation.
- Transportation cost is a fixed cost. Therefore, large projects are more economical (unit rate is reduced)

Productivity

- Productivity is affected by Job Factors and Labor & Management Factors
- These factors were introduced previously (See Lecture on Pricing Generally)
- There are job factors specifically related to excavation work:
 - Type of material excavated or backfilled
 - Moisture conditions
 - Distance to haul material for disposal
 - Availability of gravel & fill material

Type of Material

- Productivity is different for various types of soil and rocks. Because of limited availability of information, risk regarding the type of material can be high. Estimators should keep notes of their assumptions about material and the basis for them. Keep in mind likelihood of negotiating for changed conditions.

Moisture Conditions

- During excavation, wet material increases the weight of the material, causes slippery and sticky conditions, thus reducing productivity
- During backfilling operations
 - moisture content is a major factor for compaction. Highest compaction level is attainable at a specific moisture content. Moisture need to be closely controlled in order to obtain optimum level of compaction.
 - In clay soil, moisture reduces the productivity of backfilling operation

MATERIAL	LOOSE		BANK		COMPACTION FACTOR
	lb./ cu. yd.	kg/ m ³	lb./ cu. yd.	kg/ m ³	
1. CLAY-Dry	2500	1483	3100	1839	24.00%
-Wet	2800	1661	3500	2076	25.00%
2. CLAY and GRAVEL-Dry	2400	1424	2800	1661	16.67%
-Wet	2600	1543	3100	1839	19.23%
3. EARTH-Dry	2500	1483	3200	1898	28.00%
-Wet	2700	1602	3400	2017	25.93%
4. LOAM	2100	1246	2600	1543	23.81 %
5. GRAVEL-Pit-run, dry	2550	1513	2850	1691	11.76%
-Pit-run, wet	3250	1928	3650	2165	12.31%
-Dry % to 2"	2850	1691	3200	1889	12.28%
-Wet % to 2"	3400	2017	3800	2254	11.76%
6. SAND-Dry	2400	1424	2700	1602	12.50%
-Damp	2850	1691	3200	1898	12.28%
-Wet	3100	1839	3500	2076	12.90%
7. SAND and GRAVEL-Dry	2900	1721	3250	1928	12.07%
-Wet	3400	2017	3750	2225	10.29%

Figure 10.2 Material Weights and Compaction Factors

Distance to haul Material & Availability of Material

- Distance to haul material and availability of material have direct impact on the cost of the operations.
-

Labor Rates for Excavation

- In order to determine the price of the excavation crew, we need the following
 1. Number of workers in the crew
 2. Wage rate for each of the workers
 3. The productivity of the crew and the equipment

Example for Pricing Labor

- Operation: Excavation by hand
- Crew composition: 3 laborers; Foreman (on 50%-time basis)
- Laborer wage: 30 SR/hr
- Foreman's wage: 40 SR/hr
- Crew previously excavated 40 m³ of similar material in 16 hours
- Crew rate = $(3 \times 30 + 0.5 \times 40) = 110$ SR/hr
- Productivity = $40/16 = 2.50$ m³/hr
- Unit Cost = $110 / 2.50 = 44$ SR/m³

Sources of Productivity Rates

- Organization's historical records
- Estimating Manuals
- Equipment Manufacturers

- Note: The most reliable of the above is the organization's own historical records.

Estimated Bucket Payload Loose Cubic Yards	Hourly Production	
	Loose cu. yd./hr. (100% Efficiency)	Loose m ³ /hr. (100% Efficiency)
0.25 (0.19 m ³)	37 to 67	28 to 51
0.50 (0.38 m ³)	75 to 135	57 to 103
0.75 (0.57 m ³)	90 to 202	69 to 154
1.00 (0.76 m ³)	120 to 270	92 to 206
1.25 (0.96 m ³)	150 to 300	115 to 229
1.50 (1.15 m ³)	154 to 360	118 to 275
1.75 (1.34 m ³)	180 to 420	138 to 321

Source: Caterpillar Inc.

Figure 10.3 Productivity of Hydraulic Excavators

PRODUCTIVITY RECORD

DATE: 22-Jul-03

JOB NUMBER:	#94128
PROJECT:	Acme Office Building
JOB SUPERINTENDENT:	J. J. Doe
LOCATION:	123 XYZ Street Seattle, Washington
DATE OF WORK:	20-22 Jul 03 (4 days)
WEATHER CONDS:	Mostly cloudy, sunny periods; rain one day
AVE. TEMP:	75°F
CREW:	NAME TRADE John A. Jones Operator William B. Smith Laborer
EQUIPMENT:	3/4 CY Backhoe (Owned)
UNIT No:	B9133
WORK ITEM:	Excav. Utility Trench
WORK QUANTITY:	1562.00 cu. yd.
WORK DURATION:	30.00 hr.
PRODUCTIVITY RATE:	52.07 cu. yd./hr.
OTHER COMMENTS:	

BY: J. J. Doe

Figure 10.4 Sample Data Record

OPERATION	EQUIPMENT	CREW	OUTPUT	
1. Hand Excavation		0.5 Foreman	3–5 cu. yd./hr.	2–4 m ³ /hr.
—Light to Medium Soil	Site tools only	3.0 Laborers		
—Heavy Soil to Rock	Site tools only	0.5 Foreman	0.5–4 cu. yd./hr.	0.4–3 m ³ /hr.
		3.0 Laborers		
2. Hand Trimming	Site tools only	0.5 Foreman	70–200 sq. ft./hr.	6.5–18.5 m ² /hr.
		3.0 Laborers		
3. Strip Topsoil				
—Lot Size Areas	Bobcat	1.0 Operators	20–50 cu. yd./hr.	15–38 m ³ /hr.
—Small Areas	105-HP dozer	1.0 Operators	40–70 cu. yd./hr.	31–54 m ³ /hr.
4. Excavate to Reduce Levels—Small Areas	105-HP dozer	1.0 Operators	40–70 cu. yd./hr.	31–54 m ³ /hr.
5. Site Grading	Motor Grader	1.0 Operators	100–250 cu. yd./hr.	9–23 m ² /hr.
6. Basement Excavations	1.5-CY loader	1.0 Operators	50–150 cu. yd./hr.	38–115 m ³ /hr.
	*Trucks	* Drivers		
		0.5 Laborer		
7. Trench Excavations	0.75-CY backhoe	1.0 Operators	15–75 cu. yd./hr.	11–57 m ³ /hr.
		0.5 Laborer		
8. Excavate Pits and Sumps	0.50-CY backhoe	1.0 Operators	12–30 cu. yd./hr.	9–23 m ³ /hr.
		0.5 Laborers		

Pricing Backfill Material

- Price of backfill material is made up of two components:
 - Price of delivering material to site including unloading
 - Price of spreading and compacting the material
 - If material from excavation can be re-used for backfill, the price of backfill will consist of spreading and compacting only

Impact of Swell & Compaction Factors

- Impact of Swell & Compaction factors are considered during pricing in one of two ways
- The price is adjusted to reflect the quantity in the takeoff (Takeoff quantity is not changed)
- The quantity in the takeoff is adjusted to reflect the actual price for the delivered material

MATERIAL	LOOSE		BANK		COMPACTION FACTOR
	lb./ cu. yd.	kg/ m ³	lb./ cu. yd.	kg/ m ³	
1. CLAY-Dry	2500	1483	3100	1839	24.00%
-Wet	2800	1661	3500	2076	25.00%
2. CLAY and GRAVEL-Dry	2400	1424	2800	1661	16.67%
-Wet	2600	1543	3100	1839	19.23%
3. EARTH-Dry	2500	1483	3200	1898	28.00%
-Wet	2700	1602	3400	2017	25.93%
4. LOAM	2100	1246	2600	1543	23.81 %
5. GRAVEL-Pit-run, dry	2550	1513	2850	1691	11.76%
-Put-run, wet	3250	1928	3650	2165	12.31%
-Dry % to 2"	2850	1691	3200	1889	12.28%
-Wet % to 2"	3400	2017	3800	2254	11.76%
6. SAND-Dry	2400	1424	2700	1602	12.50%
-Damp	2850	1691	3200	1898	12.28%
-Wet	3100	1839	3500	2076	12.90%
7. SAND and GRAVEL-Dry	2900	1721	3250	1928	12.07%
-Wet	3400	2017	3750	2225	10.29%

Figure 10.2 Material Weights and Compaction Factors

Example

- Suppose a supplier quotes the price of 100 SR/m³ (loose) for delivering 1000 m³ of dry ¼-2” gravel.
- Compaction factor of material is ~ 13%
- If we also consider a waste factor of 10%, we obtain a total factor of 23%.
- Method A (Adjust price)
 - Price in estimate is 123 SR/m³ against 1000 m³
- Method B (Adjust quantity)
 - Price in estimate is 100 SR/m³ against 1230 m³

Calculating Trucking Requirement

- Number of trucks required =
 $(\text{Unloading time} / \text{Loading Time}) + 1$
- Unloading Time =
Round trip travel + unloading
- Loading time =
Truck capacity / Loader output
- Truck capacity (bank measure) =
 $\text{Capacity (loose)} / (1 + \% \text{ Swell})$

Example: Gravel Supply Pricing

Material: Pit gravel	Swell: 12% Price: \$ 2.50 per bcy
Pit Location	16 miles from site
Equip: 1.50 cy Track loader 12-cy dump trucks Truck speed Truck offloading time	50 bcy/hr (\$425 / day) 12 lcy per trip (\$275 /day) 20 miles /hr 5 minutes
Crew: Equipment operator 2 laborers Truck drivers	\$ 30 per hr \$ 21 per hr \$ 22 per hr