**Chapter Four**

**Construction Equipment cost**

Total equipment costs comprise two separate components: ownership costs and operating costs. Except for the one-time initial capital cost of purchasing the machine, ownership costs are fixed costs that are incurred each year, regardless of whether the equipment is operated or idle. Operating costs are the costs incurred only when the equipment is used. Each cost has different characteristics of its own and is calculated using different methods. None of these methods will give exact costs of owning and operating equipment for any given set of circumstances. This is because of the large number of variables involved, which is because of the uncertain nature of the construction business. One should consider these estimates as close approximations while calculating ownership and operating costs.

**OWNERSHIP COST**  
Ownership costs are fixed costs. Almost all of these costs are annual in nature and include:  
. Initial capital cost  
. Depreciation  
. Investment (or interest) cost  
. Insurance cost  
. Taxes  
. Storage cost

**INITIAL COST**  
On an average, initial cost makes up about 25% of the total cost invested during the equipment’s useful life. This cost is incurred for incurred for getting equipment into the contractor’s yard, or construction site, and having the equipment ready for operation. Many kinds of ownership and operating costs are calculated using initial cost as a basis, and normally this cost can be calculated accurately. Initial cost consists of the following items:

* Price at factory þ extra equipment þ sales tax
* Cost of shipping
* Cost of assembly and erection

**DEPRECIATION**  
Depreciation represents the decline in market value of a piece of equipment due to age, wear,  
deterioration, and obsolescence. Depreciation can result from:

* Physical deterioration occurring from wear and tear of the machine
* Economic decline or obsolescence occurring over the passage of time

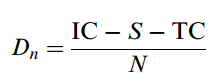
In the appraisal of depreciation, some factors are explicit while other factors have to be  
estimated. Generally, the asset costs are known which include:

* Initial cost: The amount needed to acquire the equipment
* Useful life: The number of years it is expected to be of utility value
* Salvage value: The expected amount the asset will be sold at the end of its useful life

However, there is always some uncertainty about the exact length of the useful life of the asset  
and about the precise amount of salvage value, which will be realized when the asset is disposed. Any assessment of depreciation, therefore, requires these values to be estimated. Among many depreciation methods, the straight-line method, double-declining balance method, and sum-of-years’-digits method is the most commonly used in the construction equipment industry and will be discussed below. At this point, it is important to state that the term depreciation as used in this chapter is meant to represent the change in the assets value from year to year and as a means of establishing an hourly ‘‘rental’’ rate for that asset. It is not meant in the same exact sense as is used in the tax code. The term ‘‘rental rate’’ is the rate the equipment owner charges the clients for using the equipment, i.e., the project users ‘‘rent’’ the equipment from its owner.

In calculating depreciation, the initial cost should include the costs of delivery and startup, including transportation, sales tax, and initial assembly. The equipment life used in  
calculating depreciation should correspond to the equipment’s expected economic or useful  
life. It can be calculated the different methods.

1. **Straight-Line Depreciation**

Straight-line depreciation is the simplest to understand as it makes the basic assumption that  
the equipment will lose the same amount of value in every year of its useful life until it reaches  
its salvage value. The depreciation in a given year can be expressed by the following equation:  
 

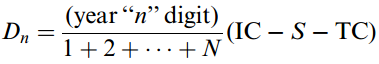
where Dn is the depreciation in year n,

IC the initial cost ($),

S the salvage value ($),

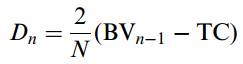
TC the tire and track costs ($),

N the useful life (years), and D1= D2 =… = Dn.

**2. Sum-of-Years’-Digits Depreciation**  
The sum-of-years’-digits depreciation method tries to model depreciation assuming that it is  
not a straight line. The actual market value of a piece of equipment after 1 year is less than the  
amount predicted by the straight-line method. Thus, this is an accelerated depreciation  
method and models more annual depreciation in the early years of a machine’s life and less  
in its later years. The calculation is straightforward and done using the following equation:  
  
where Dn is the depreciation in year n, year

n digit is the reverse order: n if solving for D1 or 1 if solving for Dn,

IC the initial cost ($), S the salvage value ($), TC the tire and track costs ($), and N the useful life (years).

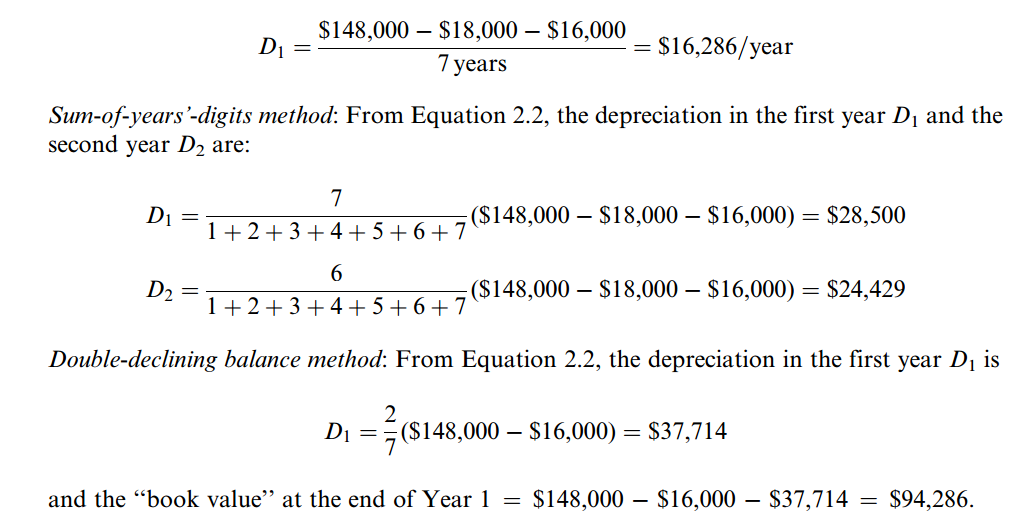
**3. Double-Declining Balance Depreciation**  
The double-declining balance depreciation is another method for calculating an accelerated depreciation rate. It produces more depreciation in the early years of a machine’s useful life than the sum-of-years’-digits depreciation method. This is done by depreciating the ‘‘book value’’ of the equipment rather than just its initial cost. The book value in the second year is merely the initial cost minus the depreciation in the first year. Then the book value in the next year is merely the book value of the second year minus the depreciation in the second year, and so on until the book value reaches the salvage value.   
  
where Dn is the depreciation in year n

TC the tire and track costs ($),

N the useful life (years),  
BVn-1 the book value at the end of the previous year, and BVn-1 > S.

**Example 2.1** Compare the depreciation in each year of the equipment’s useful life for each of  
the above depreciation methods for the following wheeled front-end bucket loader:

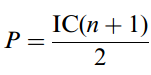
* Initial cost: $148,000 includes delivery and other costs
* Tire cost: $16,000
* Useful life: 7 years
* Salvage value: $18,000.

Straight-line method: From Equation 2.1, the depreciation in the first year D1 is equal to  
the depreciation in all the years of the loader’s useful life:  
  
  
However, in Year 6, this calculation would give an annual depreciation of $7,012 which  
when subtracted from the book value at the end of Year 5 gives a book value of $17,531 for  
Year 6. This is less than the salvage value of $18,000; therefore, the depreciation in Year 6 is reduced to the amount that would bring the book value to be equal to the salvage value or  
$6,543, and the depreciation in Year 7 is taken as zero, which means that the machine was  
fully depreciated by the end of Year 6.  
TABLE  
Depreciation Method Comparison for Wheeled Front-End Loader Year

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Method | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| SL (Dn) | $16,286 | $16,286 | $16,286 | $16,286 | $16,286 | $16,286 | $16,286 |
| SOYD (Dn) | $28,500 | $24,429 | $20,357 | $16,286 | $12,214 | $8,143 | $4,071 |
| DDB (Dn) | $37,714 | $26,939 | $19,242 | $13,744 | $9,817 | $6,543 | $0 |
| DDB (BV) | $94,286 | $67,347 | $48,105 | $34,361 | $24,543 | $18,000 | $18,000 |

Selecting a depreciation method for computing ownership cost is a business policy decision. Thus, this book will method any particular.

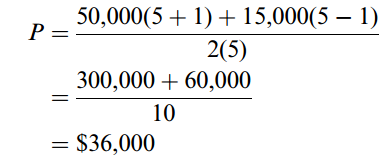
**INVESTMENT (OR INTEREST) COST**  
Investment (or interest) cost represents the annual cost (converted into an hourly cost) of capital invested in a machine [2]. If borrowed funds are utilized for purchasing a piece of equipment, the equipment cost is simply the interest charged on these funds. However, if the equipment is purchased with company assets, an interest rate that is equal to the rate of return on company investment should be charged. Therefore, investment cost is computed as the product of interest rate multiplied by the value of the equipment, which is then converted into cost per hour of operation.  
The average annual cost of interest should be based on the average value of the equipment during its useful life. The average value of equipment may be determined from the following equation:



where IC is the total initial cost, P the average value, and n the useful life (years).  
This equation assumes that a unit of equipment will have no salvage value at the end of its useful life. If a unit of equipment has salvage value when it is disposed of, the average value during its life can be obtained from the following equation:



where IC is the total initial cost, P the average value, S the salvage value, and n the useful life (years).  
**Example** Consider a unit of equipment costing $50,000 with an estimated salvage value of $15,000 after 5 years. Using Equation (2.5), the average value is



**INSURANCE TAX AND STORAGE COSTS**Insurance cost represents the cost incurred due to fire, theft, accident, and liability insurance for the equipment. Tax cost represents the cost of property tax and licenses for the equipment. Storage cost includes the cost of rent and maintenance for equipment storage yards, the wages of guards and employees involved in moving equipment in and out of storage, and associated direct overhead.  
The cost of insurance and tax for each item of equipment may be known on an annual basis. In this case, this cost is simply divided by the hours of operation during the year to yield the cost per hour for these items. Storage costs are usually obtained on an annual basis for the entire equipment fleet. Insurance and tax costs may also be known on a fleet basis. It is then necessary to prorate these costs to each item. This is usually done by converting the total annual cost into a percentage rate, then dividing these costs by the total value of the equipment fleet. By doing so, the rate for insurance, tax, and storage may simply be added to the investment cost rate for calculating the total annual cost of investment, insurance, tax, and storage.

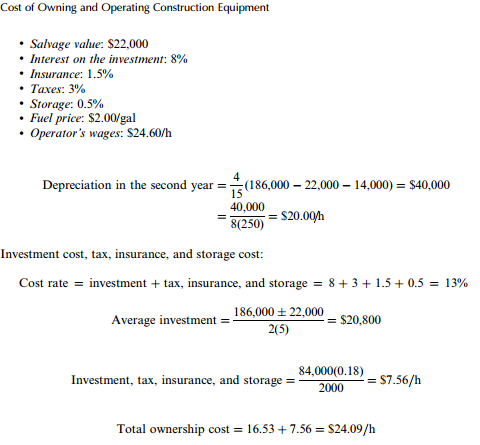
* **Total owning equipment cost is found as the sum of:**
  + - * **depreciation,**
      * **investment,**
      * **insurance,**
      * **tax, and storage**

Example 2.3 Calculate the hourly ownership cost for the second year of operation of a 465hp twin-engine scraper. This equipment will be operated 8 h/day and 250 days/year in average conditions. Use the sum-of-years’-digits method of depreciation as the following information

* Initial cost: $186,000
* Tire cost: $14,000
* Estimated life: 5 years

TABLE Average Rates for Investment Costs

|  |  |
| --- | --- |
| Item | Average Value (%) |
| Interest | 3–9 |
| Tax | 2–5 |
| Insurance | 1–3 |
| Storage | 0.5–1.5 |



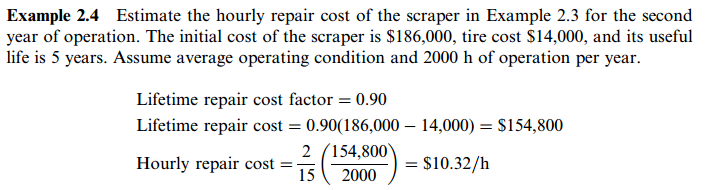
**COST OF OPERATING CONSTRUCTION EQUIPMENT**  
Operating costs of the construction equipment, which represent a significant cost category and should not be overlooked, are the costs associated with the operation of a piece of equipment. They are incurred only when the equipment is actually used. The operating costs of the equipment are also called ‘‘variable’’ costs because they depend on several factors, such as the number of operating hours, the types of equipment used, and the location and working condition of the operation.

***Major elements of operating cost:***

* Fuel cost
* Service cost
* Repair cost
* Tire cost
* Cost of special items
* Operators’ wages

**MAINTENANCE AND REPAIR COST**  
The cost of maintenance and repairs usually constitutes the largest amount of operating expense for the construction equipment. Construction operations can subject equipment to considerable wear and tear, but the amount of wear varies enormously between the different items of the equipment used and between different job conditions. Generally, the maintenance and repair costs get higher as the equipment gets older. Equipment owners will agree that good maintenance, including periodic wear measurement, timely attention to recommended service and daily cleaning when conditions warrant it, can extend the life of the equipment and actually reduce the operating costs by minimizing the effects of adverse conditions.

The annual cost of maintenance and repairs may be expressed as a percentage of the annual cost of depreciation or it may be expressed independently of depreciation. The hourly cost of maintenance and repair can be obtained by dividing the annual cost by its operating hours per year. The hourly repair cost during a particular year can be estimated by using the following formula:  
  
The lifetime repair cost is usually estimated as a percentage of the equipment’s initial cost deducting the cost of tires.

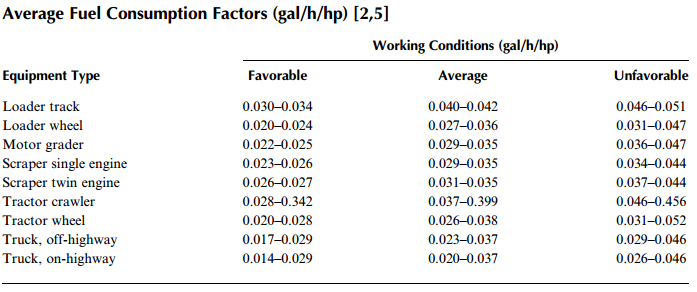
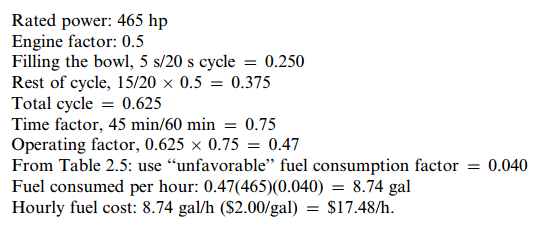


**TIRE COST**  
The tire cost represents the cost of tire repair and replacement. Because the life expectancy of rubber tires is generally far less than the life of the equipment on which they are used on, the depreciation rate of tires will be quite different from the depreciation rate of the rest of the vehicle. The repair and maintenance cost of tires as a percentage of their depreciation will also be different from the percentage associated with the repair and maintenance of the vehicle.

The best source of information in estimating tire life is the historical data obtained under similar operating conditions.   
Tire repair cost can add about 15% to tire replacement cost. So, the following equation may be used to estimate tire repair and replacement cost:



**CONSUMABLE COSTS**  
Consumables are the items required for the operation of a piece of equipment that literally gets consumed in the course of its operation. These include, but are not limited to, fuel, lubricants, and other petroleum products. They also include filters, hoses, strainers, and other small parts and items that are used during the operation of the equipment.

**Fuel Cost**  
Fuel consumption is incurred when the equipment is operated. When operating under standard conditions, a gasoline engine will consume approximately 0.06 gal of fuel per flywheel horsepower hour (fwhp-h), while a diesel engine will consume approximately 0.04 gal/fwhp-h. A horsepower hour is a measure of the work performed by an engine.  
The hourly cost of fuel is estimated by multiplying the hourly fuel consumption by the unit cost of fuel. The amount of fuel consumed by the equipment can be obtained from the historical data. When the historical data is not available, Table gives approximate fuel consumption (gal/h) for major types of equipment.  
  
  
  
Example 2.5 Calculate the average hourly fuel consumption and hourly fuel cost for a twin engine scraper in Example 2.3. It has a diesel engine rated at 465 hp and fuel cost $2.00/gal. During a cycle of 20 s, the engine may be operated at full power, while filling the bowl in tough ground requires 5 s. During the balance of the cycle, the engine will use no more than  
 0% of its rated power. Also, the scraper will operate about 45 min/h on average. For this condition, the approximate amount of fuel consummated during 1 h is determined as follows:  
  
**Lubricating Oil Cost**  
The quantity of oil required by an engine per change will include the amount added during the change plus the make-up oil between changes. It will vary with the engine size, the capacity of crankcase, the condition of the piston rings, and the number of hours between oil changes. It is a common practice to change oil every 100 to 200 h . The quantity of oil required can be estimated by using the following formula:  
  
   
where q is the quantity consumed (gal/h), hp the rated horsepower of engine, c the capacity of  
crankcase (gal), f the operating factor, t the number of hours between changes, the consumption rate 0.006 lbs/hp-h, and the conversion factor 7.4 lbs/gal.  
  
The consumption data or the average cost factors for oil, lubricants, and filters for their  
equipment under average conditions are available from the equipment manufacturers.

**MOBILIZATION AND DEMOBILIZATION COST**  
This is the cost of moving the equipment from one job site to another. It is often overlooked because of the assumption that the previous job would have already paid for it. Regardless of  
these calculations, the costs of equipment mobilization and demobilization can be large and are always important items in any job where substantial amounts of equipment are used. These costs include freight charges (other than the initial purchase), unloading cost, assembly or erection cost (if required), highway permits, duties, and special freight costs (remote or emergency).

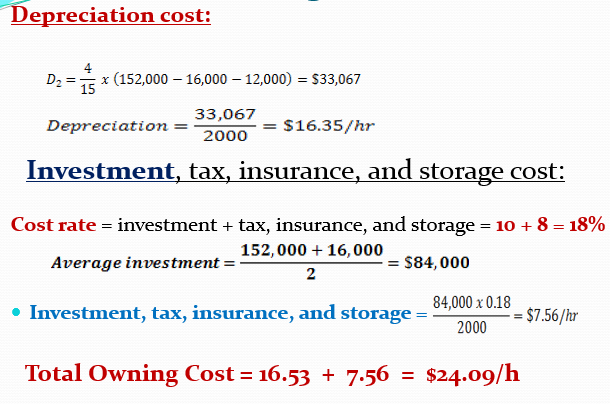
For a $3-million earthmoving job, it is not unusual to have a budget from $100,000 to $150,000 for move-in and move-out expenses. The hourly cost can be obtained from the total cost divided by the operating hours. Some public agencies cap the maximum amount of mobilization that will be paid before the project is finished. In these instances, the estimator must check the actual costs of mobilization against the cap. If the cap is exceeded, the unrecovered amount must be allocated to other pay items to ensure that the entire cost of mobilization is recovered.  
**EQUIPMENT OPERATOR COST**  
Operator’s wages are usually added as a separate item and added to other calculated operating costs. They should include overtime or premium charges, workmen’s compensation insurance, social security taxes, bonus, and fringe benefits in the hourly wage figure.

**SPECIAL ITEMS COST**  
The cost of replacing high-wear items, such as dozer, grader, and scraper blade cutting and end bits, as well as ripper tips, shanks, and shank protectors, should be calculated as a separate item of the operating cost. As usual, unit cost is divided by the expected life to yield cost per hour.

***Total Owning and Operating Costs***

* After owning cost and operating cost have been calculated.
* **Example Problem:**
* Calculate the expected hourly owning and operating cost for the second year of operation of the twin-engine scraper described below.
  + - * Cost delivered = $152,000
      * Tire cost = $12,000
      * Estimated life = 5 years
      * Salvage value = $16,000
      * Depreciation method = sum-of-the-year’s-digit
      * Investment (interest) rate = 10%
      * Tax, insurance, and storage rate = 8%
      * Operating conditions = average
      * Rated power = 465 hp
      * Fuel price = $1.30/gal
      * Operator’s wages = $32.00/h
      * Operation hour =2000h

Solution **Owning Cost**



* **Operating cost**
* **Fuel cost:**
* Estimated consumption = **0.035** x 465 = **16.3 gal/hr** (**constant for fuel consumption factor of table 1.)**
* Fuel cost = 16.3 x 1.30 = **$21.19/h**
* **Service cost:**
* Service cost = **0.33** x 21.19 = **$7.06/h** (table 2)

Where : **0.33** is service cost factor

* **Repair cost:**

Lifetime repair cost = 0.90 x (152,000 – 12,000)

= $126,000



