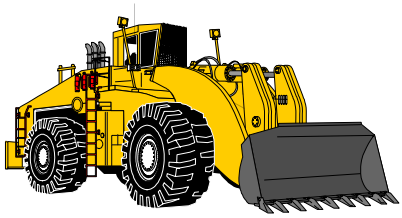
King Abdulaziz University, Jeddah
Department of Civil Engineering
CE 327 – Construction Engineering



Solution to Midterm Exam
(Closed Book & Notes, 8.5 X 11-sheet is permitted)

Saturday, May 30, 2009
8:00 AM – 9:00 AM, EGR H101

Instructor: Dr. I. Assakkaf

"*Show your work & state all your assumptions*"
Select only a total of three problems; Problem 1 must be included.

Student Name: SAMPLE

SSN: 123-45-6789

Grade: 100 ☺

Problem 1 (25 points)

I. True or False (10 points)

If each of the following statements is true, circle T, otherwise circle F:

(1) Under the tax system of the U.S., an owner can reduce his company's tax burden. (T) F

(2) Capacity in construction contracts means that at least one of the parties must be of sufficient age to enter into a contract. T (F)

(3) Equipment costs rank second to labor cost in terms of uncertainty. (T) F

(4) The optimum moisture content is the percent of water, at a given compaction effort, which corresponds to the maximum void ratio of the soil. T (F)

(5) In situ is a term that refers to soil in its original or undisturbed condition. (T) F

(6) Diesel engines have longer service lives than gasoline engines. (T) F

(7) A bulldozer has no set volumetric capacity. (T) F

(8) Nuclear compaction test is nondestructive in that it does not require the removal of soil samples from the site of the tests. (T) F

(9) Hydraulic front shovels are used primarily to excavate above the natural surface of the ground. T (F)

(10) Regardless of how much a machine is used, the owner must pay owning cost. (T) F

II. **Fill in the blanks** (15 points)

a. List two general types of construction contracts:

i. Lump-sum contract (LSC).
ii. Unit-price contract (UPC)
iii. *Also*, Cost-plus-fee contract (CPFC).

b. In addition to purchase, equipment may be employed by the following two means:

i. Lease.
ii. Rent.

c. Name two types of soil:

i. Gravel.
ii. Sand.
iii. *Also*, silt.
iv. Clay.
v. Organic matter.

d. ASTM stands for: American Society for Testing and Materials.

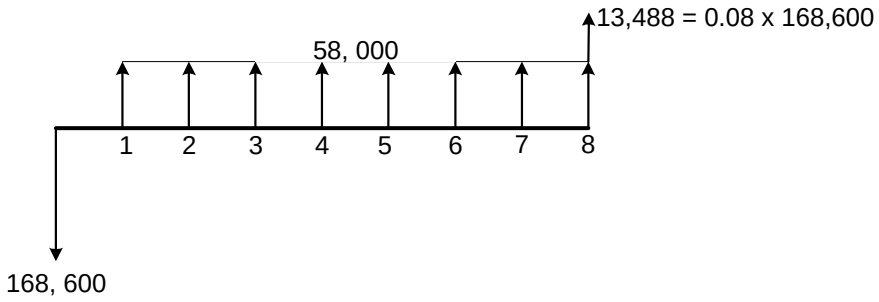
e. Dozers are mainly classified into two types:

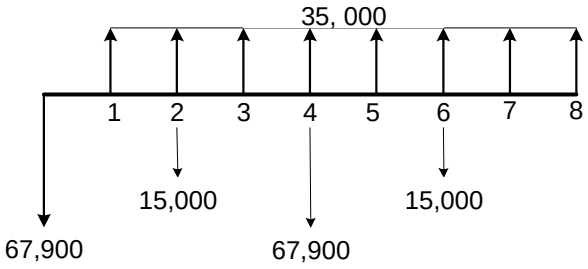
i. Crawler (track laying) type tractor.
ii. Wheel type tractor.

f. Hydraulic power is the key to the utility of many excavators.

Problem 2 (25 points)
A construction company is considering the purchase of either a new scraper for $168,600, which has an 8-year life with an estimated net annual income of $58,000 and a salvage value of 8% of the purchase price, or a used excavator for $67,900, with an estimated life of 4 years and no salvage value and an estimated net annual income of $35,000. Major repairs of $15,000 for the used scraper are expected after two years of use. Based on the net present worth (NPW) analysis and equal replacement conditions (costs and incomes), which scraper should the company choose if its MARR is 25%? Draw the cash flow diagrams and justify your answer.

***** SOLUTION *****





$$NWP_{new} = -168{,}600 + 58000\left(\frac{P}{A},25,8\right) + 13{,}488\left(\frac{P}{F},25,8\right)$$
$$= -168{,}600 + 58{,}000(3.328911) + 13{,}488(0.1677722)$$
$$= -168{,}600 + 193{,}076.84 + 2{,}262.91$$
$$= \underline{\$26{,}739.75}$$

$$\text{NPW}_{\text{used}} = -67{,}900 + 35{,}000\left(\frac{P}{A},25,8\right) - 15{,}000\left(\frac{P}{F},25,2\right) - 67{,}900\left(\frac{P}{F},25,4\right) - 15{,}000\left(\frac{P}{F},25,6\right)$$
$$= -67{,}900 + 35{,}000(3.328911) - 15{,}000(0.64) - 67{,}900(0.4069) - 15{,}000(0.262144)$$
$$= \underline{\$7{,}267.89}$$

Since $26,739.75 > 7,267.89 $\Rightarrow$ **Choose New Scraper**

Note that:

$$P = A\left[\frac{(1.25)^8 - 1}{0.25(1.25)^8}\right] = A(3.328911)$$

$$P = F\frac{1}{(1.25)^4} = F(0.4096)$$

$$P = F\frac{1}{(1.25)^4} = F(0.1677722)$$

$$P = F\frac{1}{(1.25)^6} = F(0.262144)$$

$$P = F\frac{1}{(1.25)^2} = F(0.64)$$

Problem 3 (25 points)
A wheel-tractor scraper, whose performance chart is provided in Fig. 1, is operating on a level grade. Suppose that this scraper weighs 50,000 lb when fully loaded, and that the rolling resistance for the surface is 100 lb/ton, determine:

(a) The operating speed of this grader,
(b) The rimpull developed between the wheel and the surface, and
(c) The time required for this scraper to travel a distance of 2,500 ft, when it is fully loaded.

***** SOLUTION *****

$$G\% = \frac{\text{Rolling Resistance Expressed in lb/ton}}{20\,\text{lb/ton}} = \frac{100}{20} = 5$$

Because the scraper is operating on level grade, the grade resistance (GR) = 0
Total Resistance = RR + GR = 5 + 0 = 5
From the Figure 1, for 50, 000 lb and total resistance of 5:

(a) Speed = 19 mph

(b) Rimpull = 17,000 lb

$$\text{The time required} = \frac{Distance}{speed} = \frac{\dfrac{2{,}500\,\text{ft}}{5280\ \text{ft/mile}}}{19\,\text{mile/hr}} = 0.02492\,\text{hr} = 1.5\,\text{min}$$

Problem 4 (25 points)
A power-shift track type tractor with 240 HP and weighing 48,650 lb will be used to push wet sand 300 ft.

(a) Using the International Harvester (IH) formula, estimate the bcy production rate (bcy/hr) of this tractor when it operates at an efficiency of 45-min hour and a job condition factor of 0.75 for an average operator.
(b) Based of the result of Part (1) and assuming that the owing and operating (O&O) cost for this tractor is $70.2 per hour and the operator's wage is $17.5 per hour (including fringes and workman's compensation), what would be the direct cost of the proposed earth moving operation in dollars per bcy.
(c) Suppose that the tractor is powered by a four-cycle diesel engine. What would be the probable horsepower of this tractor when it operates at an altitude of 8,000 ft above sea level and at an average temperature of 85^0 F? Briefly explain how the change in horsepower due to elevation affects the direct cost.

***** SOLUTION *****

(a) International Harvest (IH) Formula):

$$\text{Ideal Production} = \frac{\text{net hp} \times 330}{D+50} = \frac{250(300)}{300+50} = 226.29 \frac{\text{lcy}}{\text{hr}}$$

$$\text{Production} = 226.29\left(\frac{45}{60}\right)(0.75)(0.87) = \underline{110.74 \frac{\text{bcy}}{\text{hr}}}$$

Note: To convert to bank cubic yard (bcy), Table 2 was used for wet sand to give the swell factor of 0.87 that was applied in the above equation.

(b) Total Cost = 70.2 + 17.5 = $87.7 per hour

$$\text{Direct Cost} = \frac{87.7}{110.74} = \$0.79 \text{ per bcy}$$

(c) The following equation applies: $\text{HP} = \text{rated hp} \times \frac{P_{actual}}{P_{std}} \sqrt{\frac{T_{std}}{T_{actual}}}$

P_{std} = 29.29 in Hg
T_{std} = 460 + 60 = 520^0 R
P_{actual} = 22.21 in Hg (Table 1, for 8000 ft)
T_{actual} = 85 + 460 = 545^0 R
Therefore,

$$\text{HP} = 240\left(\frac{22.21}{29.29}\right)\sqrt{\frac{520}{545}} = 174 \text{ hp}$$

The change in hp by elevation will affect the production. The production in this case will be less, making the direct cost go higher.