Open Channel & Box Culvert Flow

The Manning Formula - Part 2

PDH902

Note: The calculation of entrance and exit losses is beyond the scope of this course and has been ignored in all of the questions on this test.

1. The Manning formula has been in use since 1890.
   - a. True
   - b. False

2. When the velocity of flow "V" and the quantity of flow "Q" are known, it is possible to calculate a value for:
   - a. Roughness Coefficient "n"
   - b. Hydraulic Gradient "S"
   - c. Hydraulic Radius "R"
   - d. Area of Flow "a"

3. A US manufacturer develops a rain gutter for commercial buildings that is capable of discharging 600 GPM(US). When she advertises the gutter in England how should she rate the discharge capacity?
   - a. 500 GPM
   - b. 600 GPM
   - c. 720 GPM
   - d. 820 GPM

4. There are two formulae for calculating the value of the coefficient of roughness "n".
   - a. True
   - b. False

5. Post installation factors that affect the value of the roughness coefficient include:
   - a. Solids collecting in the bottom of the channel or on its walls.
   - b. Uneven settlement.
   - c. Vegetation growth.
   - d. Erosion of the walls and floor of the channel.
   - e. All of the above

6. A grassy swale (n=0.024) has a hydraulic capacity of 100 US gallons per minute. If the swale is paved with concrete (n=0.012) what will be the new capacity?
   - a. 50 GPM
   - b. 100 GPM
   - c. 160 GPM
   - d. 200 GPM
   - e. More data is needed to solve this problem

7. The hydraulic radius of a rectangular box culvert flowing full is _____ that of the same culvert flowing half full.

- a. half
- b. the same as
- c. double
- d. More data is needed to solve this problem

8. From the standpoint of maximizing quantity of flow and velocity, it is generally best to keep the cross-section as compact as possible.
- a. True
- b. False

9. The end area of a channel is a good proxy for the quantity of excavation.
- a. True
- b. False

10. A 100% increase in the hydraulic gradient will result in a doubling of the quantity and velocity of flow.
- a. True
- b. False

11. In using The Manning Formula, it is possible to calculate the value of the roughness coefficient if the velocity, hydraulic gradient and hydraulic radius are known.
- a. True
- b. False

12. Discharge "Q" is inversely proportional to Velocity "V" and area of flow "a".
- a. True
- b. False

13. In sample problem 1, what is the **flowing full** capacity "Q" of the final design if the hydraulic gradient is set to the full **0.10 %** and the **velocity is unrestricted**?
- a. 18 CFS
- b. 22CFS
- c. 29 CFS
- d. 32CFS

14. Continuing the previous question, what is the velocity?
- a. 1.0 feet/second
- b. 1.2 feet/second
- c. 1.5 feet/second
- d. 1.9 feet/second

15. Continuing the previous questions, if poor maintenance increased the roughness coefficient to 0.055 would the new flowing full capacity still be sufficient to meet the 13 CFS demand (with velocity unrestricted)?
- a. Yes
- b. No

16. In sample problem 2, when bids were taken one contractor offered a corrugated metal box culvert alternative to the reinforced concrete design. The proposal was for twin culverts each measuring 5-feet high and 6-feet wide and with a Manning roughness coefficient of 0.022. The contractor claimed that the alternate exceeded the hydraulic capacity of the original design and would save 20%. Using the same assumptions that Mr. Mapleton used in his original design (see figure 25), what was the actual hydraulic capacity of the twin pipe alternate? (Be Sure to use the BOX CULVERT results)
- a. 66 CFS x 2 = 132 CFS
- b. 71 CFS x 2 = 142 CFS

○ c. 79 CFS x 2 = 158 CFS
○ d. 97 CFS x 2 = 194 CFS

17. Continuing the previous question, does the proposed alternative provide the hydraulic equivalent of the John Mapleton design?
○ a. Yes
○ b. No

18. In sample problem 4, Enzo Como's research revealed that the calcium-carbonate rich water of the Aqua Marcia created a calcium buildup as much as 6 cm (.06 m) thick on the aqueduct channel walls and floor. Using the same 2/3 depth of flow and a coefficient of 0.014, what is the capacity of Aqua Marcia when the dimensions are reduced to 0.48m x 1.29m?
○ a. 44,447 m^3/day
○ b. 51,443 m^3/day
○ c. 55,534 m^3/day
○ d. 65.874 m^3/day

19. An engineer inspects a 5-foot by 5-foot box culvert following a rainstorm. Both ends of the 100-foot long culvert have a depth of flow of 4-feet. He drops a float into the water at the upper end of the system and clocks the travel time to the other end of the culvert at exactly 25-seconds. What is the quantity of flow in cubic feet per second?
○ a. 69.9
○ b. 77.9
○ c. 80.0
○ d. 91.1

20. Continuing the previous question, what is the velocity in feet per second?
○ a. 2.5
○ b. 3.8
○ c. 4.0
○ d. 5.6

21. Continuing the previous question, if the roughness coefficient is 0.014, what is the hydraulic gradient?
○ a. 0.07%
○ b. 0.08%
○ c. 0.09%
○ d. 0.10%

22. An engineer designing a water treatment plant uses a 4-foot wide by 6-foot high rectangular flume to transfer 100 million gallons per day from a collection tank at the plant softeners to a distribution chamber at the filter galleries. The flume will run 90% full and at a constant rate of flow for 24 hours a day. Ignoring entrance and exit losses and using a roughness coefficient of 0.012, what is the slope of the hydraulic gradient?
○ a. 0.20%
○ b. 0.22%
○ c. 0.24%
○ d. 0.26%

23. Continuing the previous question, what is the velocity of flow?
○ a. 1.3 feet per second
○ b. 4.5 feet per second
○ c. 5.7 feet per second
○ d. 7.2 feet per second

24. Continuing the previous question, if the dimensions of the flume were reversed (6-foot wide by 4-foot high), how would the slope of the hydraulic gradient be changed?

- a. The hydraulic gradient would reduced to 0.17%
- b. The hydraulic gradient be unchanged
- c. The hydraulic gradient would increase to 0.27%
- d. None of the above

25. Continuing the previous question, what effect would reversing the dimensions have on the velocity of flow?

- a. The velocity would be reduced to 3.95 feet per second
- b. The velocity would be unchanged
- c. The velocity would be increased to 7.95 feet per second
- d. None of the above