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Continuing Education Course #080
Gravity Flow in Pipes
The Manning Formula - Part 1

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. Given:

Quantity of Flow = 1,000 Liters/Minute

Roughness Coefficient = 0.010

Hydraulic Gradient = 0.004 Meters per Meter

Pipe flowing 80% full

What is the approximate pipe diameter?

- a. 147.6 Millimeters
 - b. 168.4 Millimeters
 - c. 192.3 Millimeters
 - d. 210.9 Millimeters
2. Using the given data from the previous question, what is the velocity of flow?
- a. 2.86 Meters/Second
 - b. 2.64 Meters/Second
 - c. 0.87 Meters/Second
 - d. 6.6 Meters/Second
3. What is the Hydraulic Radius of a 96-inch diameter pipe with a depth of flow of 48-inches?
- a. 2.00 Feet
 - b. 2.65 Feet
 - c. 4.80 Feet
 - d. 6.65 Feet
4. What is the Hydraulic Radius of a 96-inch diameter pipe flowing full?
- a. 2.00 Feet
 - b. 2.65 Feet
 - c. 4.80 Feet
 - d. 6.65 Feet
5. What is the Hydraulic Radius of a 48-inch diameter pipe flowing full?
- a. 0.5 Feet
 - b. 0.85 Feet
 - c. 1.00 Feet
 - d. 2.00 Feet
6. What is the approximate roughness coefficient of a 12-inch diameter pipe flowing full at 1,000 US Gallons per Minute?

- a. .009
- b. .010
- c. .011
- d. .012
- e. .013
- f. More data is needed

7. What is the approximate roughness coefficient of a 12-inch diameter pipe flowing full at 1,000 US Gallons per Minute and with a hydraulic gradient of .002 Feet/Foot?

- a. .009
- b. .010
- c. .011
- d. .012
- e. .013
- f. More data is needed

8. Two existing 8 inch gravity sewer lines flow into a terminal manhole where the combined flow runs 300 feet through an existing 8 inch PVC gravity line to the wet well of a pump station. The flow through the 300 foot pipe is 300 gpm and the slope is 0.4%. Using $n=0.010$, what is the percentage full for this pipe?

- a. 30%
- b. 45%
- c. 60%
- d. 75%
- e. 100%

9. Continuing the previous question, what is the 100% full capacity of the 300 foot pipe?

- a. 395 gpm
- b. 446 gpm
- c. 489 gpm
- d. 509 gpm

10. Continuing the previous questions, a developer wants to connect a third pipe to the same terminal manhole resulting in a doubling of the flow and requiring the replacement of the 300 foot 8 inch pipe. What nominal size pipe will be required to meet this requirement using the same slope and roughness coefficient and without surcharging the system (exceeding capacity).

- a. 8 inch diameter
- b. 10 inch diameter
- c. 12 inch diameter
- d. 16 inch diameter

11. A new water treatment plant design provides for a gravity pipeline to transfer 100 million gallons per day from a collection tank at the plant softeners to distribution chamber at the filter galleries. The pipe will run 100% full (submerged inlet and outlet) and at a constant rate of flow for 24 hours a day. It will run underground for a total pipe length of 220 feet. The available head (the difference between the water surface elevation of the collection tank at the upper end of the pipeline and the receiving water at the lower end of the system) is exactly 0.25 feet. Ignoring entrance and exit losses and using concrete pipe with $n=0.013$, what is the calculated pipe size?

- a. 72.74 inches diameter
- b. 74.20 inches diameter
- c. 76.23 inches diameter
- d. 77.91 inches diameter

12. Continuing the previous question, the designers select a 78 inch nominal diameter pipe. What is the calculated capacity of the pipeline?

- a. 97 million gallons per day
- b. 111 million gallons per day
- c. 114 million gallons per day
- d. 119 million gallons per day

13. Continuing the previous questions, what is the total head loss through the 78 inch pipeline when the system is operating at the design quantity of flow of 100 MGD?

- a. 0.19 ft
- b. 0.20 ft
- c. 0.22 ft
- d. 0.24 ft

14. A farmer is building a small prefabricated millhouse and waterwheel on his property to crack corn for use as chicken feed. The source of water for the waterwheel is a lake 1000 feet from the millhouse with a water surface elevation just 4 feet above the elevation of the sluice gate that feeds the waterwheel. The water will be conveyed from lake to mill through a 100% full, 1000 foot long PVC pipe ($n=0.010$). The manufacturer's instructions for the waterwheel call for a quantity of flow of 750 Liters per Minute. What nominal size pipe will deliver the quantity needed?

- a. 4 inch diameter
- b. 5 inch diameter
- c. 6 inch diameter
- d. 8 inch diameter
- e. 10 inch diameter

15. Continuing the previous questions, what is the quantity of flow in gallons per minute?

- a. 0.44
- b. 198.13
- c. 0.29
- d. 0.012

16. The city utility department has been wrestling with a problem pre-civil war gravity sewer line for several years. The 12 inch handmade clay pipe runs for 1100 feet under a river and a 20 story building making it all but impossible to replace. The pipe was built on a slope of 0.3% and has deteriorated so badly that the pipe is operating at velocity of only 1.7 feet per second when flowing full. What is the manning roughness coefficient of the pipe?

- a. 0.013
- b. 0.014
- c. 0.015
- d. 0.017
- e. 0.019

17. Continuing the previous questions, with the pipe flowing full, what is the quantity of flow in gallons per minute?

- a. 599
- b. 625
- c. 653
- d. 677

18. Continuing the previous questions, one proposal under consideration is an insitu pipe liner that reduces the pipe diameter to 11 inches but reduces the roughness coefficient to 0.009. What would be the full pipe quantity of flow with the liner?

- a. 717 US Gallons/Minute
- b. 814 US Gallons/Minute
- c. 954 US Gallons/Minute
- d. 1003 US Gallons/Minute
- e. 1156 US Gallons/Minute

19. A contractor uses a 20-foot length of 24-inch diameter PVC pipe to build his children a waterslide into his backyard swimming pool. He erects the slide on a 30% slope and uses an 80 Gallon/Minute pump to supply the slide water. Using a roughness coefficient of 0.010, what is the depth of water flow for the slide?

- a. 0.4-inches
- b. 0.6-inches
- c. 0.8-inches
- d. 1.2-inches
- e. 1.5-inches

20. Continuing the previous questions, what quantity of flow would he need to get a 4-inch depth of flow?

- a. 533 Gallons/Minute
- b. 1287 Gallons/Minute
- c. 2897 Gallons/Minute
- d. 3651 Gallons/Minute
- e. 4365 Gallons/Minute

21. A 24 inch diameter concrete pipe with roughness coefficient =0.013 is laid on a slope of 0.2%. When the pipe is flowing at 3.5 feet per second what is the approximate depth(s) of flow? (Round to the nearest whole unit.)(Hint: More than one answer may be correct. Choose the BEST answer.)

- a. 15 inches
- b. 585 Millimeters
- c. 23 inches
- d. 381 Millimeters
- e. All of the above are correct

22. Hydraulic slope is always the same as the slope of the pipe.

- a. True
- b. False

23. Robert Manning developed his formula prior to the invention of the slide rule.

- a. True
- b. False

24. A quantity of flow of one million gallons per day is equal to approximately ___ cubic feet per second.

- a. 0.94
- b. 1.55
- c. 1.95
- d. 2.02

25. An engineer inspects a simple catch basin and outfall storm sewer following a rainstorm. Both ends of the 200-meter long, 1200-Millimeter diameter pipe have a depth of flow of 250-Millimeters. She drops a float into the catch basin at the upper end of the system, which takes exactly 5-minutes to travel the length of the pipe. What is the approximate quantity of flow in cubic meters per second?

- a. 0.11
- b. 2.6

- c. 4.02
- d. 6.65

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