Postgraduate Certificate in Hydroelectric Power Engineering and Dams

Dam Design and Construction

Dam Design and Construction Key Terms

1. Dam: A dam is a barrier that impounds water or underground streams, creating a reservoir. Dams are typically built to store water for irrigation, drinking water supply, flood control, or hydroelectric power generation.

2. Embankment Dam: An embankment dam is a type of dam constructed by compacting layers of earth, rock, or other materials. It is typically used to impound water in a valley or other low-lying area.

3. Concrete Dam: A concrete dam is a type of dam constructed using concrete as the primary material. Concrete dams are often used for high-head hydroelectric projects due to their strength and durability.

4. Gravity Dam: A gravity dam is a type of dam that relies on its weight to resist the horizontal thrust of the impounded water. Gravity dams are typically constructed using concrete or masonry and are well-suited for narrow canyons or gorges.

5. Arch Dam: An arch dam is a type of dam that curves upstream, directing water pressure into the abutments that support the structure. Arch dams are commonly built in narrow canyons or gorges where the natural rock formations provide additional support.

6. Buttress Dam: A buttress dam is a type of dam that consists of a solid wall with buttresses on the downstream side to support the structure. Buttress dams are often used in areas with soft foundation soils or where the reservoir is located in a wide valley.

7. Spillway: A spillway is a structure built into a dam to safely release excess water from the reservoir. Spillways are designed to prevent overtopping of the dam and to control the flow of water downstream.

8. Outlet Works: Outlet works are structures built into a dam to control the release of water from the reservoir for various purposes, such as irrigation, municipal water supply, or hydroelectric power generation.

9. Abutment: An abutment is a support structure at the ends of a dam that resists the horizontal thrust of the impounded water. Abutments provide stability to the dam and help distribute the load into the surrounding rock or soil.

10. Foundation: The foundation of a dam is the natural ground or rock on which the dam is built. The foundation must be strong enough to support the weight of the dam and resist the pressures exerted by the impounded water.

11. Seepage: Seepage is the movement of water through or under a dam. Excessive seepage can weaken the dam structure or erode the foundation, leading to potential failure.

12. Upstream Face: The upstream face of a dam is the side that faces the reservoir. The upstream face is typically designed to be impermeable to prevent water from seeping through the dam.

13. Downstream Face: The downstream face of a dam is the side that faces away from the reservoir. The downstream face is usually sloped to allow for the safe dissipation of water pressure.

14. Crest: The crest of a dam is the top edge or surface that forms the barrier across the river or valley. The crest is where the water level is maintained in the reservoir.

15. Freeboard: Freeboard is the vertical distance between the water level in the reservoir and the top of the dam. Freeboard provides a safety margin to prevent overtopping of the dam during floods.

16. Reservoir: A reservoir is a man-made lake created by impounding water behind a dam. Reservoirs are used to store water for various purposes, including irrigation, drinking water supply, and hydropower generation.

17. Hydrostatic Pressure: Hydrostatic pressure is the pressure exerted by a fluid (such as water) due to the weight of the fluid above a specific point. In dams, hydrostatic pressure is a critical factor in design and construction.

18. Grouting: Grouting is the process of injecting a cementitious material into the foundation or cracks in a dam to seal leaks and improve stability. Grouting is essential for controlling seepage and enhancing the integrity of the dam.

19. Instrumentation: Instrumentation refers to the monitoring devices installed in and around a dam to measure various parameters, such as water level, seepage, foundation movement, and dam deformation. Instrumentation helps engineers assess the performance and safety of the dam.

20. Overtopping: Overtopping occurs when water flows over the top of a dam, potentially leading to dam failure. Proper spillway design and maintenance are essential to prevent overtopping and protect the integrity of the dam.

21. Reservoir Sedimentation: Reservoir sedimentation is the process by which sediment carried by rivers accumulates in the reservoir behind a dam. Sedimentation reduces the storage capacity of the reservoir and can impact the efficiency of hydropower generation.

22. Dam Safety: Dam safety refers to the measures and practices implemented to ensure the structural integrity and operational reliability of a dam. Regular inspections, maintenance, and emergency preparedness are essential for ensuring dam safety.

23. Environmental Impact Assessment (EIA): An environmental impact assessment is a study conducted to evaluate the potential environmental consequences of a dam project. EIA helps identify and mitigate potential impacts on ecosystems, wildlife, water quality, and local communities.

24. Turbine: A turbine is a machine that converts the energy of flowing water into mechanical energy, which can be used to generate electricity. Turbines are a key component of hydroelectric power plants.

25. Penstock: A penstock is a large pipe or conduit that carries water from the reservoir to the turbines in a hydroelectric power plant. Penstocks are designed to withstand high pressures and deliver water efficiently to the turbines.

26. Powerhouse: The powerhouse is the building or structure that houses the turbines, generators, and other equipment used to generate electricity in a hydroelectric power plant. The powerhouse is where the mechanical energy of flowing water is converted into electrical energy.

27. Spillway Capacity: Spillway capacity refers to the maximum flow rate that a spillway can safely pass without causing overtopping of the dam. Proper sizing and design of spillways are crucial to ensure the safe operation of the dam.

28. Dam Decommissioning: Dam decommissioning is the process of removing a dam and restoring the river or ecosystem to its natural state. Decommissioning may be necessary for safety reasons, environmental concerns, or changes in the use of the dam.

29. Riprap: Riprap is a layer of large rocks or concrete blocks placed along the downstream face of a dam to protect against erosion and scour. Riprap helps dissipate the energy of flowing water and prevent damage to the dam structure.

30. Rockfill Dam: A rockfill dam is a type of dam constructed using a core of compacted earth or rock covered with layers of rockfill. Rockfill dams are commonly used for medium to large reservoirs where suitable materials are available nearby.

31. Toe Drain: A toe drain is a drainage system installed at the base of a dam to collect and remove seepage water. Toe drains help prevent saturation of the foundation soils and reduce the risk of internal erosion.

32. Settlement: Settlement is the downward movement of a dam or its foundation due to the compression of soils or other factors. Settlement can affect the stability and performance of a dam and must be monitored and managed accordingly.

33. Abutment Seepage: Abutment seepage refers to the seepage of water through or around the abutments of a dam. Abutment seepage can lead to erosion, instability, and other issues that may compromise the safety of the dam.

34. Cut-off Wall: A cut-off wall is a vertical barrier constructed in the foundation of a dam to prevent the seepage of water. Cut-off walls are typically made of concrete, steel sheet piles, or other impermeable materials.

35. Conduit: A conduit is a pipe or channel used to convey water within a dam or hydroelectric power plant. Conduits may carry water from the reservoir to the turbines, between different levels of the powerhouse, or for other purposes.

36. Turbulence: Turbulence is the chaotic flow of water characterized by irregular fluctuations in velocity, pressure, and direction. Turbulence can impact the performance of turbines and other hydraulic structures in a dam.

37. Headrace: The headrace is the channel or conduit that carries water from the reservoir or intake to the turbines in a hydroelectric power plant. The headrace is designed to maintain a steady flow of water and maximize the energy output of the turbines.

38. Tailrace: The tailrace is the channel or conduit that carries water away from the turbines in a hydroelectric power plant and discharges it back into the river. The tailrace is designed to safely release the water and prevent erosion downstream.

39. Intake Structure: The intake structure is the component of a dam or hydroelectric power plant that captures water from the reservoir or river and directs it into the penstocks. Intake structures are designed to control the flow of water and prevent debris from entering the turbines.

40. Siltation: Siltation is the accumulation of fine sediment or silt in the reservoir behind a dam. Siltation reduces the storage capacity of the reservoir, affects water quality, and can damage turbines and other equipment in a hydroelectric power plant.

41. Climate Change Adaptation: Climate change adaptation refers to the strategies and measures implemented to minimize the impacts of climate change on dams and other water infrastructure. Adaptation may include changes in design, operation, and maintenance practices to enhance resilience to changing environmental conditions.

42. Emergency Action Plan (EAP): An emergency action plan is a comprehensive document outlining the procedures and protocols to be followed in the event of a dam failure or other emergency. EAPs are essential for ensuring the safety of downstream communities and minimizing the consequences of a potential disaster.

43. Geotechnical Investigation: Geotechnical investigation is the process of assessing the physical properties and stability of the soils, rocks, and foundations at a dam site. Geotechnical data is critical for designing a safe and resilient dam structure.

44. Dam Rehabilitation: Dam rehabilitation involves the repair, upgrade, or modification of an existing dam to improve its safety, performance, or functionality. Rehabilitation may be necessary due to aging infrastructure, changing regulatory requirements, or other factors.

45. Rockfill Material: Rockfill material is a mixture of rocks, gravel, and soil used in the construction of rockfill dams and other hydraulic structures. The selection and placement of rockfill material are critical for ensuring the stability and integrity of the dam.

46. Seismic Design: Seismic design is the process of designing a dam to resist the forces and deformations generated by earthquakes. Seismic design considerations are essential for dams located in seismically active regions to ensure their safety and resilience.

47. Sluice Gate: A sluice gate is a gate or valve installed in a dam or spillway to control the flow of water. Sluice gates can be opened or closed to regulate the discharge of water and manage the water level in the reservoir.

48. Fish Ladder: A fish ladder is a structure built into a dam to help fish migrate upstream past the barrier. Fish ladders are designed to provide a series of steps or pools that allow fish to swim upstream and reach their spawning grounds.

49. Inflow Design Flood: The inflow design flood is the maximum flood event expected to occur at a dam site during its design life. The inflow design flood is used to size spillways, outlet works, and other hydraulic structures to safely pass floodwaters without overtopping the dam.

50. Arch-gravity Dam: An arch-gravity dam is a combination of an arch dam and a gravity dam, with the arch providing additional support to the structure. Arch-gravity dams are often used for high dams with significant water pressure.

51. Roller Compacted Concrete (RCC) Dam: A roller-compacted concrete dam is a type of concrete dam constructed using a dry mix that is compacted with rollers. RCC dams are cost-effective and fast to build, making them suitable for certain dam projects.

52. Settlement Monitoring: Settlement monitoring involves the measurement of vertical movements in a dam or its foundation over time. Monitoring settlement is essential for assessing the performance and safety of the dam and identifying potential issues early.

53. Remote Sensing: Remote sensing refers to the use of satellite imagery, drones, and other technologies to monitor and assess dams and other infrastructure remotely. Remote sensing can provide valuable data for dam management, maintenance, and emergency response.

54. Reservoir Operation: Reservoir operation refers to the management of water levels and releases from a reservoir to meet various objectives, such as flood control, water supply, and hydropower generation. Optimal reservoir operation requires balancing competing demands and considering changing conditions.

55. Dam Monitoring: Dam monitoring involves the continuous observation and measurement of various parameters, such as water levels, seepage rates, and structural movements, to assess the condition and performance of a dam. Monitoring data is used to detect potential issues and inform decision-making.

56. Dam Inspection: Dam inspection is the periodic assessment of a dam's condition, safety, and compliance with regulatory requirements. Inspections are conducted by qualified engineers and inspectors to identify deficiencies, recommend corrective actions, and ensure the continued safe operation of the dam.

57. Grout Curtain: A grout curtain is a barrier constructed within the foundation of a dam using grouting techniques to reduce seepage and improve stability. Grout curtains are used to control seepage paths and enhance the performance of the dam.

58. Dam Foundation Treatment: Dam foundation treatment involves the improvement or stabilization of the natural ground or rock on which a dam is built. Foundation treatment may include grouting, cut-off walls, or other techniques to enhance the strength and integrity of the foundation.

59. Dam Safety Guidelines: Dam safety guidelines are established by regulatory agencies or industry organizations to define recommended practices for designing, constructing, operating, and maintaining

dams. Adhering to dam safety guidelines is essential for ensuring the integrity and safety of dams.

60. Reservoir Drawdown: Reservoir drawdown is the deliberate lowering of the water level in a reservoir to release sediment, improve water quality, or perform maintenance on dam structures. Proper planning and coordination are required to minimize impacts on downstream users and ecosystems.

61. Turbine Efficiency: Turbine efficiency is a measure of how effectively a turbine converts the energy of flowing water into mechanical energy. High turbine efficiency is essential for maximizing the power output of a hydroelectric power plant and optimizing its performance.

62. Dam Failures: Dam failures are catastrophic events in which a dam breaches or collapses, leading to flooding, loss of life, and extensive damage. Understanding the causes of dam failures and implementing preventive measures are essential for ensuring the safety and reliability of dams.

63. Climate Resilience: Climate resilience refers to the ability of dams and other infrastructure to withstand and adapt to changing climate conditions, such as increased precipitation, extreme weather events, and rising temperatures. Building climate resilience into dam projects is crucial for long-term sustainability.

64. Tailwater Elevation: The tailwater elevation is the water level downstream of a dam or hydraulic structure. Tailwater elevation affects the flow conditions, energy dissipation, and overall performance of the dam and associated water infrastructure.

65. Dam Operation Manuals: Dam operation manuals are comprehensive documents that outline the procedures, protocols, and guidelines for operating a dam safely and efficiently. Operation manuals provide instructions for reservoir management, flood control, power generation, and emergency response.

66. Dam Safety Audit: A dam safety audit is an independent review of a dam's safety performance, design, construction, operation, and maintenance practices. Safety audits help identify potential risks, deficiencies, and opportunities for improvement to enhance the safety of the dam.

67. Downstream Impact Assessment: Downstream impact assessment is the evaluation of the potential effects of a dam on the downstream environment, ecosystems, communities, and water resources. Understanding downstream impacts is essential for sustainable dam planning and management.

68. Seismic Hazard Analysis: Seismic hazard analysis is the evaluation of the likelihood and potential consequences of earthquakes at a dam site. Seismic hazard analysis helps engineers design dams to withstand seismic forces and minimize the risk of failure during an earthquake.

69. Dam Ownership: Dam ownership refers to the entity or organization responsible for the design, construction, operation, and maintenance of a dam. Clear ownership and accountability are essential for ensuring the long-term safety and performance of dams.

70. Public Safety Zones: Public safety zones are designated areas downstream of a dam where restrictions or evacuation orders may be implemented in the event of a dam failure or emergency. Public safety zones help protect downstream communities and infrastructure from potential hazards.

71. Dam Security: Dam security involves measures and protocols implemented to prevent unauthorized access, vandalism, terrorism, or other security threats to a dam. Securing dams is essential for protecting critical infrastructure and ensuring public safety.

72. Sediment Management: Sediment management involves strategies and practices to control, remove, or mitigate the accumulation of sediment in reservoirs and downstream of dams. Effective sediment management is essential for maintaining reservoir capacity, water quality, and ecosystem health.

73. Dam Upgrading: Dam upgrading refers to the process of enhancing or modifying an existing dam to meet current safety standards, operational requirements, or environmental regulations. Upgrading may involve structural improvements, instrumentation installation, or other enhancements to optimize dam performance.

74. Spillway Design Flood: The spillway design flood is the flood event used to size and design spillways to safely pass the maximum anticipated flow without overtopping the dam. Spillway design floods are based on hydrological analyses and risk assessments.

75. Dam Operation Training: Dam operation training provides operators, engineers, and other personnel with the knowledge and skills needed to safely and effectively manage dam operations. Training programs cover reservoir management, emergency response, maintenance procedures, and regulatory compliance.

76. Dam Safety Legislation: Dam safety legislation consists of laws, regulations, and standards that govern the design, construction, operation,