

Sustainability in Engineering Design and Construction
Second Half of Book (Chapters 9—17)
Sample Exam Solutions

Part One: True or False Questions

Answers to Part One:

- | | |
|-------|-------|
| 1. F | 26. T |
| 2. F | 27. T |
| 3. T | 28. F |
| 4. F | 29. F |
| 5. T | 30. T |
| 6. F | 31. T |
| 7. T | 32. T |
| 8. T | 33. T |
| 9. T | 34. F |
| 10. F | 35. F |
| 11. F | 36. F |
| 12. T | 37. F |
| 13. T | 38. T |
| 14. T | 39. T |
| 15. F | 40. T |
| 16. F | 41. T |
| 17. T | 42. F |
| 18. T | 43. T |
| 19. F | 44. F |
| 20. T | 45. T |
| 21. T | 46. T |
| 22. T | 47. T |
| 23. T | 48. F |
| 24. F | 49. T |
| 25. T | 50. T |

Part Two—Short Answers

Answers to Part Two:

1. What are the primary responsibilities of project team members related to sustainable implementation strategies?

Some of the primary responsibilities related to sustainable implementation strategies of project team members are (Kibert, 2008, p. 309):

- Ensuring stringent erosion control and sedimentation control measures are

instituted on projects.

- Improving materials handling and storage to reduce construction waste.
- Making provisions for installing products and materials to reduce the potential for indoor air quality problems.
- Minimizing the impact of construction operations, such as compaction and unnecessary destruction of trees, on the site.
- Paying attention to moisture control in all aspects of construction to prevent future mold problems.
- Recycling site materials such as topsoil, lime rock, asphalt, and concrete into new building projects.

2. How does using diesel fuel in heavy construction equipment help increase the sustainability of heavy construction equipment?

Reducing heavy construction equipment emissions is one method for increasing the sustainability of the construction industry. Diesel engines emit lower levels of hydrocarbons (HC), carbon monoxide (CO), and other toxic air pollutants than gasoline engines. Using diesel engines on heavy construction equipment also increases fuel economy; however, diesel engines have the disadvantage of emitting significant amounts of particulate matter (PM) and nitrogen oxide (NO_x).

3. What is the major concern related to using nuclear power and how is it being addressed in the nuclear power industry?

One of the main concerns related to nuclear power generation is the disposal of the radioactive nuclear fuel rods at the end of their useful life after they are used in nuclear power plants. Fuel rods are tubes filled with uranium pellets and located at the core of nuclear reactors. The uranium is part of the nuclear fission process generating

the heat used to boil water and create the steam powering the turbines and generating electricity. The fuel rods are used for approximately 18 months and then the spent rods are submerged in circulating water in cooling ponds to help cool the rods. It takes approximately ten years for the rods to cool down, although the fuel rods continue to be radioactive for approximately 10,000 years. If the fuel rods are no longer surrounded by circulating water the temperature of the fuel rods climbs to thousands of degrees and there is the possibility of them melting and releasing high levels of radiation. In 2011, there were over 71,000 tons of nuclear fuel rods in containment ponds at nuclear power plant sites throughout the United States (The Week April 15, 2011, p. 13).

One alternative to storing spent fuel rods at nuclear power plant sites in cooling ponds is to entomb them in containers of steel and concrete and this method is being used in some locations in the United States and Germany but the cost is in the tens of billions of dollars. A second alternative is to bury the rods and in the 1980s the U.S. government attempted to prepare a burial site at Yucca Mountain in Nevada where the rods were to be stored 1,000 feet below the mountain in special nickel-alloy chambers at a cost of approximately 20 billion dollars. But there was a chance the nuclear waste would leach down into the water table located 1,000 feet below the storage area; therefore, the Yucca Mountain project was terminated in 2008 after having been on hold for numerous years (The Week, April 15, 2011, p. 13).

Both Sweden and Finland are building underground nuclear storage facilities at Forsmark and Onkalo. These two facilities are projected to be available by 2020. At these sites, nuclear fuel rods will be sealed inside “corrosion-resistant canisters, bedrock, and bentonite” and as the bentonite is exposed to water it swells and seals the

spent fuel rods, and protects the fuel rods from earthquakes and underground water flow (The Week April 15, 2011, p. 13).

4. What types of materials or products help minimize environmental impacts?

Sometimes the choice of materials or products helps to minimize environmental impacts and suggestions on materials and products accomplishing this are (Calkins 2009, pp. 6–7):

- Local materials
- Low embodied energy materials
- Low water-use and low water-polluting materials
- Low chemical-emitting materials or products
- Low-polluting materials
- Materials or products without toxic chemicals or by-products
- Materials produced with energy from renewable sources
- Minimally processed materials

5. How is Germany addressing the issue of air pollution around industrial plants?

In 2008, the government implemented environmental zones in locations where industrial pollutants were the highest. Every car entering an environmental zone must have a sticker identifying the level of exhaust pollution emitted by the vehicle. The stickers are either green, yellow, or red and vehicles with the highest level of exhaust pollution are prohibited from entering the environmental zones. Throughout Germany there are 54 environmental zones and 42% of the measuring stations have measured excessive levels of particulate pollutants and 57% have measured excessive amounts of nitrogen dioxide. “Excessive levels mean more than 35 days a year of particulate

matter exceeding 50 micrograms per cubic meter or 30 micrograms for nitrogen dioxide” (Deutsche Welle February 6, 2012 p. 2).

6. What alternative sustainable practice is helping reduce the greenhouse gas emissions caused by cement production?

One alternative helping to reduce the level of GhG emissions caused by cement production is replacing some of the cement in concrete with coal fly ash (a residual produced during the burning of coal) or granulated blast furnace slag (waste matter separated from metals during the smelting or refining of iron ore). Fly ash is sometimes used to replace 15% to 30% of the cement, and large structures such as girders, road bases, major walls, and dams sometimes consist of up to 70% fly ash. Many state departments of transportation have built concrete road systems using 30% fly ash. Although fly ash is a viable alternative to cement, it contains natural radioisotopes (isotopes with an unstable nucleus; therefore, radioactive); therefore, its use should be monitored by radio analytic laboratories to determine if there is any residual radioactivity (Los Alamos National Laboratory 2002). Another product being developed is ashcrete, which is created by using almost 100% fly ash.

7. What constitutes construction waste and what is demolition waste?

Construction waste includes concrete, tiles, brick, soil, mortar, plaster, insulation, carpets, and paper. Demolition waste includes wood, plastic, steel, metal, wire, concrete, cardboard, brick, insulation, asphalt, tar, paving stones, gravel, ballast (small crushed stones), soil, rock and buried materials (OIA—EPA 2012).

8. According to the U.S. Green Building Council what are some of the benefits of green structures?

According to the U. S. Green Building Council, some of the benefits of green structures are (Kibert 2008, p. 330):

- Achieve more predictable results
- Benefit the community
- Boost employee productivity
- Create value for tenants
- Designed for cost effectiveness
- Increase property value
- Recover higher first costs, if there are any
- Reduce liability
- Take advantage of incentive programs

The U. S. Green Building Council has also suggested green structures help address other issues, such as (Kibert 2008, pp. 330–331):

- Deteriorating power grid problems, such as power quality and availability
- Global warming
- High electric power costs
- Increases in operating and maintenance costs for state facilities
- Possible water shortages and waste disposal issues
- Rising incidence of allergies and asthma, especially in children
- State and federal pressure to reduce criteria pollutants
- The effect of school environments on children's ability to learn
- The health and productivity of workers

9. What is involved in the Sustainable Sites Initiative?

The Sustainable Sites Initiative Guidelines and Performance Benchmark—2009 is the first green rating system for landscapes developed by a team comprised of members of the American Society of Landscape Architects, lead by the Dean of the School of Architecture at the University of Texas at Austin, with participation by members of the Lady Bird Johnson Wildflower Garden and the United State Botanic Garden. This system was designed to encourage development, design, construction, and operation of eco friendly landscapes. The Sustainable Sites Initiative provides a 233 page SSI: Guidelines for Performance Benchmarks 2009 and The Case for Sustainable Landscapes (Sustainable Sites Initiative 2009).

Sustainable sites have lower requirements for energy use; they do not consume as much water and natural resources; they generate less waste; and minimize the impact on land compared to conventional design, construction, and maintenance techniques. In addition to social and economic benefits sustainable sites help to clean the air and water, they sequester carbon, reduce pollution, and help restore habitat and biodiversity.

The Sustainable Sites v2 Rating System is a complete set of prerequisites and credits used for measuring site sustainability. It contains the intent and requirements of each prerequisite and credit, the associated point levels for credits, recommended strategies, and key definitions. The 18 prerequisites and 48 credits total 200 points and four certification levels are distinguished by the percentage of credit points achieved. Additionally, projects employing innovative

strategies and exemplary performance may receive bonus points
(Sustainable Sites Initiative 2015).

The areas the Sustainable Sites Initiative covers are (Sustainable Sites Initiative 2015):

- Predesign assessment and planning
- Site design—water
- Site design—soil and vegetation
- Site design—materials selection
- Site design—human health and well being
- Construction
- Operations
- Monitoring and Innovation

10. Explain how to use the Sustainability Quick Start Guide.

The Sustainability Quick Start Guide is used by members of the engineering and construction industry to help them implement sustainability practices. The Quick Start Guide provides a tool for preparing a sustainability program for construction projects and it includes specific steps to be followed during the front-end planning, design, and construction stages.

During the front-end planning phase, project personnel work with senior management to determine their commitment to sustainability and the current level of sustainability. The sustainability objectives are established in the design phase then they are integrated into the project execution plan as a sustainability plan. During the construction phase the sustainability project execution plan is implemented, monitored,

and when necessary adjustments are made to sustainable practices to help increase the sustainability of construction operations.