CHAPTER X. Design—CARL HAYDEN VISITOR CENTER

117. GENERAL. The visitor center at Glen Canyon Dam is a joint facility of the Bureau of Reclamation and the National Park Service and serves as a focal point for visitors to the Glen Canyon Dam and National Recreation Area. The center was dedicated by the Secretary of the Interior, Stuart L. Udall, on September 26, 1968.

The center was named the Carl Hayden Visitor Center in honor of the Arizona Senator who retired in 1968 at the end of the 90th Congress after 56 years of service as either a Representative or a Senator. While the name has been changed on the outside of the center and at similar locations, no effort has been made to make this name change on the numerous drawings associated with the center, and the numerous references to the Glen Canyon Visitor Center will continue on most official drawings.

118. ARCHITECTURE. The primary functional considerations for the design of the Carl Hayden Visitor Center included the following provisions:

(1) Central orientation center.
(2) Place of beginning for the visitor tour.
(3) Public restrooms.
(4) Public parking areas.
(5) Concession to dispense sundries and light refreshments.
(6) Space for displays provided by the National Park Service.
(7) View windows and terraces.

The building has a rectangular wing and a rotunda and is surrounded by entrance and view terraces (figs. 229 and 230). There is a part basement under the rectangular portion of the building. By cantilevering the 86-foot-diameter rotunda 10 feet over the canyon rim for about half of its diameter, a spectacular overlook was provided of the dam, powerplant, reservoir, highway bridge, and Glen Canyon and the Colorado River below the dam.

Elevators in the building convey the visitors down through the canyon wall to a rock cut tunnel which leads to the crest of the dam. From this point visitors may walk to the dam elevator which carries them down to the powerplant level where they can take a self-guided tour.

The exterior of the building expresses interior functions through the circular form of the exhibit-observation room, the raised block of the audiovisual room, and the projection of the elevator tower through the roof. Exterior surfaces (figs. 231 and 232) are of exposed aggregate precast concrete panels and columns in tan and white. Interior finishes were selected for appropriateness to their use and to provide long life, low maintenance, and pleasing appearance. An overall coordinated color design is provided through use of colored materials and painting.

Appropriate landscaping with an automatic sprinkler system has been provided in the building and parking areas.

119. SUBSTRUCTURE BUILDING DESIGN. The configuration of the visitor center building has been described in the previous section. The building foundation, basement, and first floor are of reinforced concrete. The reinforced concrete foundation and framing plans are shown on figures 233, 234, and 235. Except for the reinforced concrete elevator shaft and stairwell, the building superstructure is a structural steel frame with precast concrete wall panels.

(a) Substructure.—The rotunda was considered to act in two segments for design of the reinforced concrete foundation and frame. The semicircular portion farthest from the canyon rim consists of a circular perimeter foundation wall, intermediate beams and columns, and the circular core wall at the center of the rotunda. The portion adjacent to the canyon rim consists of beams extending radially from the circular core in the center to columns near the canyon rim and 10-foot cantilever beams beyond the columns.

Three radial stub walls in the rotunda were designed to carry the three main structural steel roof girders. Two of these walls extend into rock and the third wall supported from one of the cantilever beams. Structurally, the core wall in the center of the rotunda was the most efficient structural approach due to the many beams framing into a central vertical element. The circular wall also serves as a return air duct for the air-conditioning system.

All walls, pilasters, and columns (except those supporting the rotunda cantilever beams) extend a minimum of 6 inches into unweathered rock. Columns
Figure 230.—Visitor center—Basement and machinery room architectural plans.
Figure 231.—Visitor center outside architecture—South and east elevations.
Figure 232.—Visitor center outside architecture—North and west elevations.
Figure 233.—Visitor center—Concrete outline, footing and foundation plan.
Figure 235.—Visitor center—Concrete outline, first floor framing plan.
supporting the cantilever beams were designed to rest on spread footings. These footings extend into rock a minimum of 12 inches. From each of these footings, four 1-3/8-inch reinforcing bars were embedded into rock a minimum distance of 8 feet for the two bars nearest the canyon rim and a minimum of 15 feet for the other two bars. These bars develop the maximum strength in the bedrock by "stitching" through possible fissures in the rock.

(b) Structural Floors, Stairwell, and Shaft.—The design of the structural floor was based on dead loads and the following live loads:

100 p.s.f. for rotunda, corridors and lobby, and concession and storage room.

50 p.s.f. for office, toilet rooms, first aid room, guides room, and stairwell.

Floors in the audiovisual room and in the basement were placed on grade.

The combined stairwell and elevator shaft were designed for dead and live loads, the weight of the elevator equipment, that portion of the room framing into the shaft, and seismic loadings.

(c) Design Codes and Data.—The following data and codes were used in designing the visitor center substructure:

(1) "Reinforced Concrete Design Data," Engineering Monograph No. 10, Bureau of Reclamation.

(2) "Moments and Reactions for Rectangular Plates," Engineering Monograph No. 27, Bureau of Reclamation.

(3) "Design Standards No. 9, Buildings," Bureau of Reclamation.

(4) "Design Standards No. 11, Housing and Community Facilities," Bureau of Reclamation.

(5) "Building Code Requirements for Reinforced Concrete," American Concrete Institute (ACI 318-56).

(6) "Influence Lines for Horizontally Curved Fixed-End Beams of Circular-Arc Plan," University of Missouri, Bulletin No. 35.

(d) Allowable Unit Stresses.—The visitor center substructure was designed for concrete having an ultimate compressive strength of 3,000 pounds per square inch at 28 days, and an allowable working stress in the reinforcement of 20,000 pounds per square inch in flexure and 16,000 pounds per square inch in web reinforcement.

120. SUPERSTRUCTURE BUILDING DESIGN. The building is a steel frame structure of welded and bolted construction, having in plan a 133-by 60-foot auditorium and utility wing, and an attached 92-foot-diameter rotunda (this diameter includes the exterior concrete panels). The auditorium and utility wing is a beam and column semirigid frame structure designed for vertical and lateral loads as noted below. Three intersecting welded plate roof girders, with clear spans of 81 feet 6 inches, form the main framework for the rotunda and were designed to carry all the vertical loads. The lateral loads are carried through a horizontal truss system into the three large concrete piers.

(a) Loads.—The auditorium and utility wing was designed for a roof dead load of 20 pounds per square foot and a roof live load of 30 pounds per square foot. The rotunda was designed for a live load of 35 pounds per square foot and a dead load of 35 pounds per square foot plus the weight of the overhanging precast concrete panels. Windloads used in design were a compression load of 20 pounds per square foot plus a tension of 10 pounds per square foot acting on exposed vertical surfaces; earthquake forces are 10 percent of gravity loads.

A 3-inch tongue-and-groove wood deck secured by nails and bolts to the supporting steel beams supports the roof loads and acts as a diaphragm for support and distribution of lateral loads.

(b) Outside Platform.—A platform which rides on an upper and lower track on the outside of the rotunda is provided for cleaning and servicing the windows overlooking the canyon rim. The designs provided that the wheels be inspected and maintained in free-running order before the platform is put to use, and that the tracks should be kept free of dirt and debris.

(c) Codes.—The code of the American Institute of Steel Construction Manual was used in the design of members and connections.

121. AIR-CONDITIONING SYSTEM. The air-conditioning system is a three-zone, constant-volume, variable-temperature, all-air system with supplemental electric convection heaters installed under windows and in vestibules to prevent cold drafts.
The central system consists of air-handling units with water-cooling coils, electric heaters, filters, outdoor and return air connections, electric reheaters, supply air ducts, outlets, ventilating ceiling, fans, and hermetic refrigeration machine. Air conditioning of the visitor center was provided for comfort and protection of personnel and visitors, the distribution and removal of heat, the relief of dampness, and the disposal of contaminated air.

The heating load design temperatures were an outside ambient temperature of 0°F and an inside temperature of 72°F. The cooling load design conditions were an outside ambient temperature of 95°F dry bulb and 65°F wet bulb, and an inside temperature of 75°F. The heating and cooling loads were calculated in accordance with the methods outlined by the American Society of Heating, Refrigeration, and Air-conditioning Engineers.1

The system is designed to automatically provide required ventilation, remove contaminated air, and maintain nominal room temperatures of 75°F for cooling and 72°F for heating.

122. TOP OF DAM AND ENTRANCE STRUCTURE. The entrance structure is located in block 26 at the top of the dam. A concrete slab was placed on top of the existing top of dam and parapets were placed with the slab. Epoxy-bonded concrete was used to connect the walkway slab to the existing walkways and top of dam. The entrance structure consists of canopy and roof for sheltered entrance to the tunnel, and end-of-dam parapets. A 4- by 4-foot shaft was provided to connect the pipe chase to the existing service adit in the top of the dam. The exposed canyon wall around the portal entrance was rock bolted prior to tunnel excavation. One row of 3/4-inch expansion-type anchor bolts at 5-foot centers was used to stabilize the concrete lining. The anchor bars were spaced at 5-foot centers and embedded 8 feet into the rock. Three rows of 1-inch rock bolts spaced at 5-foot centers were installed at the junction of the elevator shaft and tunnel lobby. The rock bolts were embedded 10 feet into the rock.

The roof of the tunnel was designed as a simply supported beam with a 3-foot rock load. The tunnel was reinforced using 3/4-inch bars at 12-inch centers horizontally and 3/4-inch bars at 24-inch center vertically. One and one-eighth-inch anchor bars were installed on the centerline of the shaft on each side to stabilize the concrete lining. The anchor bars were spaced at 5-foot centers and embedded 8 feet into the rock. Three rows of 1-inch rock bolts spaced at 5-foot centers were installed at the junction of the elevator shaft and tunnel lobby. The rock bolts were installed in the roof of the tunnel as required.

123. ELEVATOR SHAFT AND TUNNEL. An 8- by 8-foot 6-inch lined tunnel from the end of the dam in block 26 and a 10-foot 6-inch by 20-foot 4-inch lined elevator shaft connect the top of the dam with the visitor center complex. A pipe chase below the floor of the tunnel was provided to carry utility lines for the visitor center. Minimum thickness of lining for the tunnel and shaft was 9 inches. The details and reinforcement of elevator shaft and tunnel are shown on figures 238 and 239.

(a) Structural Design.—The design was based on concrete having a compressive strength of 3,000 pounds per square inch at 28 days. The allowable working stresses are shown on figure 71.

The elevator shaft was reinforced using 3/4-inch bars at 12-inch centers horizontally and 3/4-inch bars at 24-inch center vertically. One and one-eighth-inch anchor bars were installed on the centerline of the shaft on each side to stabilize the concrete lining. The anchor bars were spaced at 5-foot centers and embedded 8 feet into the rock. Three rows of 1-inch rock bolts spaced at 5-foot centers were installed at the junction of the elevator shaft and tunnel lobby. The rock bolts were installed in the roof of the tunnel as required.

The retaining walls were designed as gravity structures and located to conform to the existing rock surface along the canyon side of the visitor center. The base of each wall has a maximum slope of 5 to 1 with a 24-inch minimum bench. A 5-foot-wide walkway and a parapet were provided at the top of the retaining walls. The sidewalk has a minimum thickness of 18 inches. The parapet is 12 inches wide and 3 feet 4 inches high. The details of the retaining walls are shown on figure 240.

(a) Structural Design.—The design was based on concrete having a compressive strength of 3,000 pounds per square inch at 28 days. The allowable working stresses are shown on figure 71.

Figure 236.—Visitor center—Top of dam and entrance structure.
Figure 237.—Visitor center—Reinforcement for top of dam and entrance structure.
Figure 238.—Visitor center—Elevator shaft and tunnel.
Figure 239.—Visitor center—Reinforcement for elevator shaft and tunnel.
Figure 240.—Visitor center—Retaining walls.
A lateral load of 150 pounds per lineal foot was assumed acting at the top of the parapet. Horizontal temperature reinforcement (5/8-inch bars at 6-inch centers) and expansion joints were provided to minimize cracking in the parapet. The walkway was also reinforced to minimize cracking using 5/8-inch bars at 9-inch centers each way. One and one-eighth-inch anchor bars at 5-foot centers each way were required when the depth of the bench was greater than 2 feet.

125. PASSENGER ELEVATORS. Two passenger elevators provide a means of vertical transportation for visitors between the first floor lobby and the tunnel lobby, and vertical transportation for operation and maintenance personnel from the first floor lobby or tunnel lobby to the equipment rooms at elevation 3810 (landing B). The two elevators were manufactured by Montgomery Elevator Co., San Diego, Calif., and furnished under invitation No. DS-6276.

(a) Description.—Each elevator conforms to the following specifications:

- **Type:** Passenger
- **Capacity:** 7,000 pounds
- **Speed:** 350 feet per minute
- **Machine:** Geared traction
- **Landings:** Three
- **Openings:** Three
- **Travel in floors:** Three
- **Travel in feet:** 102 feet 6 inches
- **Control:** Generator field control with leveling device
- **Operation:** Duplex, free car, selective collective, with independent service. (Keyed landing switch, see explanation below.)
- **Signals:** Electric car position indicator. Electric corridor position indicators at each opening.
- **Call buttons:** Up and down type, illuminated direction indication.
- **Car platform:** 7 feet 11 inches by 9 feet
- **Car doorway:** 4 by 7 feet
- **Car doors (power):** Single-speed center operated
- **Car accessories:** Exhaust blower and switch, 120 volts.
- **Car heater:** 2,000 watts, 208 volts, heater switch single-phase
- **Car fixtures and fittings:** Stainless steel handrails, padhooks, and entrance column returns, recessed telephone cabinet complete with dial telephone. Full area of ceiling is of luminous plasticgrid. (For lighting system see explanation below.)
- **Car floor covering:** 1/8-inch thick, homogeneous vinyl tile (9 by 9 inches)
- **Car and counter weight guides:** Manufacturer's standard, with roller guides.
- **Hoistway door operation:** Power operated.
- **Compensation:** Chain
- **Power Supply:** Power: 440 volts, 3 phase 60 cycles
  - Lights: 120 volts, single phase, 60 cycles
  - Heater: 208 volts, single phase, 60 cycles.

An additional keyed switch is installed on each car control panel that will prevent the cars from stopping at landing B when the key is removed from the switch. This additional keyed switch does not prevent calling cars from landing B call button.

Lighting systems employed in the cars are the manufacturer's standard system and are adequate to provide a uniform horizontal illumination level of not less than 20 foot-candles at a height of 30 inches above the car floors. The system employed facilitates easy replacement of lamps. In addition to the normal lighting system in the elevator cars, an auxiliary automatic, battery-operated-type, emergency lighting unit is installed in each car. The emergency lighting provides approximately 5 foot-candles of illumination and is automatically energized upon failure of normal lighting service and deenergized upon restoration of normal lighting service. The type of battery furnished is readily available from normal commercial sources and is located in a readily accessible position.

The car operates between machined steel guides and is equipped with safety devices, operating unit, and lights. Hoisting machinery and control panels are installed in the machine room. Control pushbuttons are on the cars and at each landing.
Figure 241.—Visitor center and right abutment passenger elevators—Installation.
Figure 242.—Visitor center—Grading and plot plan.
(b) **Elevator Design.**—The elevators were designed, equipped, and manufactured in accordance with the latest edition of the "American Standard Safety Code for Elevators, Dumbwaiters, Escalators, and Moving Walks," published by the American Society of Mechanical Engineers. They were installed in accordance with figure 241.

126. **PROMENADE, LANDSCAPING, AND PARKING AREAS.** These areas are shown on figure 242. They are large concrete-paved promenades on both the canyon rim side and parking area side of the visitor center building. The promenades include planting areas, concrete benches, a lighting installation, and a fountain pool. Areas adjacent to the building and parking areas are landscaped. There is an irrigation system with automatic controls for the landscape areas and for most of the promenade planting areas.

Parking area is available for 150 cars, 8 trailers, and 5 buses adjacent to the visitor center. The parking area is surfaced and provided with drainage installations, curbs and gutters, sidewalks, and lighting standards for illumination. Sufficient area is available for future additional parking, if required. U.S. Highway No. 89 is adjacent to the parking areas and at the access road intersection. Divided traffic lanes are provided to facilitate access to and from the highway.

127. **BUILDING WATER SUPPLY SYSTEM, SANITARY SYSTEM, AND DRAIN SYSTEM.** Water for domestic use, service use, irrigation, and fire protection is pumped from the Glen Canyon Powerplant domestic water installation. The water treatment includes chlorination only. The water is pumped to an exposed 30,000-gallon steel storage tank on a rock bench near the visitor center building and about 85 feet higher in elevation.

Sewage from the visitor center building flows by gravity to the sewage treatment plant located in the powerplant. This is an activated-sludge, extended aeration-type plant designed for a maximum daily flow of 15,300 gallons, of which 12,000 gallons are from the visitor building. The plant also treats sewage from the powerplant and dam.

The drainlines from the roof drains, floor drains, condenser in the mechanical equipment room, and fountain pool floor drains connect to the storm water drainage installation for the promenade and parking areas.
CHAPTER XI. Design—ROADS

128. MAIN HIGHWAY. The main road to Glen Canyon Dam and Page, Ariz. is discussed in subsection 4(h).

129. SERVICE ROADS. Specifications No. DC-4825 provided for the construction of approximately 2 miles of service road and access highway, excavation of approximately 9,000 feet of road tunnel and its approaches, and construction of the highway approach embankments for the Glen Canyon Bridge. The bridge is described in the report “Glen Canyon Bridge—Technical Record of Design and Construction.” The powerplant service road and the right and left abutment service roads were built 30 feet wide shoulder to shoulder with a 4-inch crushed-rock base and a 24-foot-wide bituminous surface treatment. The powerplant service road tunnel was constructed on a maximum 8 percent grade with a 20-foot wall-to-wall roadway. The road has a 6-inch crushed-rock base and a bituminous surface treatment. Part of this service road was designed to be in open cut traversing a talus area between two tunnel sections. Owing to the unstable condition of the rock face in this area, it was decided to realine the road farther into the rock cliff and make it a continuous tunnel road. Adits 12 feet wide were constructed normal to the centerline of the tunnel on approximately 500-foot centers and extended from the tunnel to the face of the canyon wall. The left abutment service road was connected directly to the end of the dam. The right abutment service road was connected to the dam by a short steel girder bridge 30 feet wide designed for a H20-S16 loading in accordance with AASHO, 1957 edition. Short service roads were also constructed to the spillway intakes.

130. ACCESS ROADS. The access highway joining Glen Canyon damsite with U.S. Highway No. 89 was constructed in two reaches. Under specifications No. DC-4730 the first 4.5 miles of access highway, beginning at U.S. Highway No. 89, was constructed to the roadway subgrade which is 42 feet wide (fig. 242). At Echo Cliffs an unusually heavy cut approximately 280 feet deep was required. The original design at Echo Cliffs called for an 800-foot-long tunnel, but the open cut was finally selected as more desirable. The surfacing and guardrail for the entire access highway was built under specifications No. DC-4887.

The second reach of access highway, ending at the Glen Canyon bridge approach, was constructed under specifications No. DC-4756. The work consisted of constructing approximately 20 miles of roadway to a 42-foot-wide subgrade. A 140-foot reinforced concrete bridge was constructed across Waterholes Canyon. The bridge is a reinforced concrete rigid-frame structure with inclined legs. The design was based on H20-S16 loading in accordance with “Standard Specifications for Highway Bridges,” of the American Association of State Highway Officials, 1953 edition; and for H20-S16 loading plus a 75-ton trailer load at normal unit stresses and H20-S16 loading plus a 100-ton trailer load at 120 percent of normal unit stresses.

Specifications No. DC4887 provided for the surfacing and guardrail for the entire access highway from U.S. Highway No. 89 to the Glen Canyon bridge, a distance of approximately 25 miles. A 6-inch crushed-rock base was placed on the subgrade prepared under the other specifications, and 4 inches of plant-mix bituminous surfacing was then added. The finished road surface width is 34 feet. Beam-type guardrail was erected where necessary. Plant-mix bituminous curbs and spillways were placed on the roadway where required. Through supplemental notice No. 1, specifications No. DC-4887 was revised to include the construction of Manson Mesa airstrip. The runway is 4,500 feet long and 500 feet wide shoulder to shoulder. The 150-foot surfaced landing strip consists of 3 inches of plant-mix bituminous surfacing placed on a 6-inch crushed-rock base. An airplane parking area and 50-foot taxiways were also constructed using the same surfacing section.

Specifications No. DC-4896 provided for the construction of access roads to the community of Page, Ariz. (fig. 243). The connecting road, community to dam, approximately 1.7 miles long, was constructed with a 30-foot width shoulder-to-shoulder and with 1-1/2 inches of plant-mix bituminous surfacing over a 6-inch crushed-rock base. The north community access road, approximately 0.5 mile long, was built using the same roadway section as the connecting road. Both roads had a stone-chip seal coat. The south community access road was also of similar roadway section, except the bituminous surfacing was not required. This road is approximately 1.1 miles in length.

Under specifications No. 400C-83 an existing road was reshaped, a new road and a parking area were constructed, and all were surface treated. This construction provided access from the Arizona-Utah State line to the vista point and parking area at the right abutment of the Glen Canyon damsite. Approximately 7 miles of 6-inch crushed-rock surfacing 20 feet wide was reshaped by scarifying, blading, and rolling. The 0.75 mile of new road, with a 24-foot roadway and 3-foot shoulders, and the 4,200-square-yard parking area have 6-inch crushed-rock bases. To the 7.75 miles of road and the parking area was applied a modified penetration treatment of RC-5 cutback asphalt.
Figure 243.—Town of Page, Ariz.—General plan.