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UNITED STATES
DEPARTMENT OF THE INTERIOR
Bureau of Reclamation
Coulee Dam, Washington
February 21, 1947

Memorandum for the Supervising Engineer

Subject: Report on conferences February 17, 1947 to February 21, 1947, regarding Miter Gates, emergency bulkhead and floating caisson--Maintenance of Spillway Bucket--Grand Coulee Dam--Columbia Basin Project.

1. In conformance with the request in paragraph 6 of your letter of February 3, 1947 on the subject: "Maintenance of Spillway Bucket, drydock miter gate, Grand Coulee Dam", a field study was made and the matters discussed with project engineers B. A. Hall, A. P. Newberry, L. V. Downs, F. J. Sharkey, C. J. Nielson, J. E. Hill and C. A. Cramer. The results of these discussions are reported in the following for the miter gate, the emergency bulkhead, the floating caisson and related subjects.

2. Miter Gate

a. First and major concern was the determination of the causes of failure of the temporary ties between miter gate and tilting section of the drydock. After a thorough investigation it can be stated that failure could have occurred by a static unbalanced pressure equivalent to a height of 4.5' of water or by a combination of static pressure and velocity head pressure for heights less than 4.5', the latter combination of forces occurring when the elevation of tailwater is a few feet above the top of concrete of the tilting section. It was also found that unbalanced pressures, half of the above-mentioned amounts would stretch the cable tie backs as much as 1/2" permitting vibration of the gates when subjected to the action of fast-moving waves. As such vibration will exert forces far in excess of static forces, it is our opinion that failure of the cable ties was caused by dynamic rather than by static forces. Designs of a device holding the gate while submerged should be so prepared that the deflections of members of the device are very small, preventing vibration of the gate.

b. The failure of the anchor bars holding the top of miter gate was due to bending moments caused by high friction on the gudgeon pins. Calculations made of the forces causing failure of the keeper plate of the pin indicates friction coefficients as high as 40%. This in turn produced stresses in the anchor bars as high as the yield point of the material. Reversal of stresses of such magnitude occurring

innumerable times when gates were swinging free after ties were broken caused fatigue failure. It is recommended that the bronze bushings for the gudgeon pins be replaced with lubrite (graphited bronze) bushings and that the anchor bars be increased in size sufficient to be safe for a friction coefficient double the normal amount. As there is some uncertainty of the friction between gudgeon pins, which have been surfaced with stainless steel, and lubrite bushings the Denver laboratories will be consulted. Designs for the increased anchor bars and lubrite bushings will be prepared by the Chief Engineer's office. It is recommended that the new anchor bars be X-rayed before acceptance.

c. Concerning the blocking of the miter gate for the 1947 high water, the method proposed by project engineers using six timber struts wedged tight between gate and tipping section of the drydock is considered safe. In order to reduce the deflections in the timber struts it is recommended that the struts be 14" x 14" rather than 10" x 10". Also it is advisable that bolts holding the timber struts in place be arranged so as to avoid going through the struts and that holding plates be tapered as discussed with project engineers.

d. Concerning the permanent holding device for the miter gate, project engineers have prepared a design using stock material. Project designs will soon be submitted to the Chief Engineer for review. However, it will be desirable to withhold final decision regarding these designs until results of pressure tests, outlined in paragraph "e" become available.

e. Since there is uncertainty regarding the pressure distribution on the miter gate and floating caisson due to wave action during large floods when the caisson is submerged in the drydock and as the uncertainty of the magnitude of these pressures makes it very difficult to determine the size of a permanent holding device for the miter gate that will give satisfactory service, the pressure measurements suggested by project engineers are highly recommended. A teletype to the Denver Office has been prepared concerning the construction of twenty pressure cells to permit installation by April 15. Detail instructions for the location and installation of the cells are to be furnished by the Denver office. Also, it is advisable that an engineer from the Denver laboratories familiar with the cells and recording devices be made available to the project during installation and testing. Velocities of waves and currents should be observed. The locations for these devices should be as follows:

Miter gate:

A total of six cells, placed inside and outside of gate leaf No. 1, approximately at elevations 923, 942 and 958 in a vertical line 15 feet from the miter, measured parallel to leaf.

Drydock tipping section.

A total of six cells, placed inside and outside of the concrete section, at the same elevations and directly opposite those in the gate.

Caisson Access Shaft.

A total of eight cells in access shaft No. 4, two rings of cells with four each at elevations 955 and 970. For each ring three cells on outside and one on inside.

f. Concerning the matter of loose rivets at various places on the miter gate it is believed that loosening of rivets was caused by swinging of the gate and high torsional stresses set up under these conditions but was not caused by alternating pressures on outside and inside of skin plate. Since the width of skin plate acting effectively with the beam is somewhat uncertain and so as to check the tightness of the rivets between plates and beams, measurements of deflections of the miter gate as suggested by project engineers are very desirable.

Measurements are suggested for beams 3, 4, 9, 10, 13 and 14 with water between gate and tipping section at elevations 922.33, 937.42 and 959.50. The distance between concrete abutments at the top of the gate should be measured before and during tests. Calculated deflections will be furnished by the Chief Engineer's office.

Miter gates should be kept closed except for passage of vessels and drydock water elevation shall be kept about 5' below tailrace elevation.

3. Emergency Bulkhead.

a. Partly completed designs prepared in Denver for the emergency bulkheads were discussed and appear satisfactory. Detail drawings will be submitted to your office for review as soon as completed. Weights of various sections together with centers of gravity will also be furnished. Location of handling hooks will be determined by project engineers. Use of divers is planned during placing and removal of bulkhead sections.

4. Floating Caisson.

a. Reference is made to paragraph A of "Instructions for Operation of Floating Caisson", transmitted with letter of October 20, 1944, from Assistant Chief Designing Engineer to Supervising Engineer on the subject: "Operation of floating caisson--Maintenance of spillway bucket".

Measurements in addition to those listed in paragraph A should be made as follows: The vertical distance from the water surface to the top of the cover plate of the side girders opposite the ends of the barge well (37.5' from the transverse center line of the caisson) both sides of the caisson.

b. Concerning possible damage to caisson due to waves while submerged in the drydock during the highwater season, it is believed that on account of the large weight and rigidity of shafts and bracing no damage will occur. To safeguard against a possibility of shifting of the caisson on the concrete supports, installation of a temporary bracing between caisson and concrete supports is advisable. The designs will be prepared by the project forces. Bracing from the concrete supports to the side girders or to brackets welded to the bottom skin plate of the tanks will be satisfactory.

c. Testing Puller Machines.

The braking test on the No. 4 puller was mentioned. As it is more convenient to pair this puller which is rated at 56,000 pounds with puller No. 2 which is rated at 33,000 pounds, a 2 to 1 reeving will be required on the No. 2 puller. The maximum braking speed will therefore be 10 f.p.m. for the No. 4 puller. The maximum braking effort can be readily checked at 10 f.p.m. and the brake heating capacity at full speed can be judged from the tests on the other pullers.

The overload relays are set at 125% of normal load and it may be desirable to change the setting so as to permit a heavier loading.

The permanent installation of ammeters as load indicators for each puller machine is recommended and will be provided by the project.

d. Regarding construction of caisson seats in bucket, the method proposed by project engineers, using an auxiliary steel frame, will materially expedite repairs and is considered highly desirable. Preliminary plans prepared by project engineers will be submitted to Chief Engineer's office for final designs. Due to the unusual features of such a frame, it will be desirable for one or several project engineers, to consult with the engineers in Denver during the preparation of final designs.

In repairing the bucket, the 1-1/2" offsets at the construction joints should be retained as the caisson has been constructed to fit the offsets.

Along the upstream side of the bucket the transition from non-repaired to repaired concrete should be made so that the final surface is tangent to the curve of the bucket.

e. Concerning spare cables for caisson hoists and puller machines and rubber seal sections it is considered advisable to have on hand sufficient stock to insure minimum loss in time of repairs. Project will initiate purchase.

f. Overflow pipes between trim and air tanks should be changed to prevent undesirable flow to air tanks when caisson lists. The Chief Engineer's office will furnish plans for changes.

g. Regarding maneuvering of caisson in bucket, lines 1 and 4 may be disconnected and a pendant line from work barge to caisson used in their place. Lines 7 and 9 can be run directly to sheaves on gantry platform when caisson is at distance in excess of 300' from training wall. It is desirable that the 1:60 model be operated as a means of acquainting caisson operating forces with maneuvering problems previous to moving floating caisson to dam.

5. General related problems.

a. The repair of damage to the bases of the spillway training walls and erosion in the tailrace slopes and river channel below were discussed. Plans for making the repairs to the right training wall are to be submitted to the Chief Engineer's office for comments. If the plans for this operation are not changed materially from those proposed by the project, complete designs will be prepared in the field, otherwise by the Denver Office.

In the discussion it was suggested that some consideration be given to alterations which would correct the conditions causing the damage. Altering the walls, making the spillway sides vertical so as to converge the flow slightly, was mentioned. The damage to the left training wall during the 1946 flood, which was caused by the movement of river bed material, reported by divers a few days ago, makes it imperative that the problem of repairs of alterations be given immediate consideration.

Considerable movement of materials in the tailraces and river bed downstream has occurred in the past year from operation of the powerhouse units and from flow conditions during the peak discharge of the 1946 flood season and slide movements have occurred on both sides of the river.

The consolidation of riprap surfaces in the critical areas, suggested by project engineers, has merits, but such treatment should not be done until the tailrace surfaces and river banks downstream are resloped in accordance with the plans evolved from studies on the 1 to 60 model. Field studies will be continued and will later be submitted to the Chief Engineer's office.

b. An inspection of the temporary by-pass outlet in bay R9, after operation at 80 percent opening for approximately 178 hours, was made during the afternoon of February 18. Although slight damage was noted the results were considered satisfactory.

On February 20 the unit was observed during operation at 80 percent and full opening. The operation was comparatively quiet with very little indication of cavitation at 80 percent opening. The operation seemed smoother at full opening with indication of less cavitation. The outlet is to be operated for a long period with intermittent inspections. A report of the findings will be submitted to the Chief Engineer at an early date. The completion of the installation of units in bays R4 through R8 will depend on the results of the tests now being conducted.

c. The control of the river flow during repair operations in the spillway bucket was discussed and it appears that no difficulty will be had in meeting the restrictions of flow over the spillway. A letter from the Chief Engineer's office in reply to project letter of January 21 on the subject "Installation of spillway by-pass needle valves--right powerhouse--Grand Coulee Dam", will cover this matter.

Robert Sailer

H. W. Benton

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