

*Mr. Post.
Corrected Copy
J. S.*

~~DESCRIPTION AND DETAILS~~ SPECIFICATIONS

of the
~~UPPER~~ SAN DIEG^UITO RESERVOIR DAM
for the
VOLCAN WATER COMPANY

Describing the
~~EXISTING~~ MULTIPLE-ARCHED DAM.

*No specifications for cement
or aggregate.*

GENERAL SPECIFICATIONS.

①
LOCATION OF
STRUCTURE.

1. The structure is to be located at the site shown on the blue print map of the proposed site, on the San Diegito Rancho, as shown on the drawing No. 665 of the same accompanying these specifications. The location is the selection of the Chief Engineer of the Company, and will be on the lines laid down on the Plan Drawings.

②
GENERAL DE-
SCRIPTION OF
THE STRUCTURE.

1. This dam is to be a structural dam of the type known as the ~~Eastwood~~ Multiple-arched type, in which design, arches are used for the water face deck and buttresses are used for the support of the same, designed especially to meet the conditions prevailing at this site, and so designed as to be completed to a height of 50 feet, to contour elevation of 250. ~~This dam is to create a regulating reservoir at the end of the conduit line from the Carroll Reservoir and is to be used in regulation and distribution of the water over the adjacent lands.~~ It will consist of 15 arches supported by 14 buttresses. The structure is to be founded on a solid rock foundation, the cut-off wall at the front edges of the arch ring foundations to be cut into sound rock for a tight cut-off and the buttress foundations to be sound rock, roughened and notched.

~~SPILLWAY~~

~~As the reservoir is to be filled from the conduit,~~
~~only a small spillway need be provided, and~~ ^{spillway} a siphon ^{1 foot} will be installed to regulate the water within ~~four inches~~ ^{four} inches of the top of the ~~slope~~ ^{over} of the dam, having a capacity of about ~~500~~ ⁵⁰⁰ cu. ft. per second.

~~The principal advantages of the multiple-arched dam, stated in as few words as possible, are: (1) that the up-thrust under the foundations is practically eliminated, the water in the foundations having no continuous surface on which to act, that danger from sliding on the foundations is removed, as the load is downward on the top of the structure, the load is also evenly distributed over the entire base, and is therefore very light on the foundations: that the loading throughout the entire structure is evenly distributed, the maximum load is not permitted to exceed certain limits, so the structure in its weakest part has a strength of ten times the breaking load, and finally, the quantities and the cost are less because all of the material is so placed as to do its part of the work to the best advantage, in fact it is the thoroughly scientific structure designed to do the work of resisting the water pressure for all time without deterioration.~~

GENERAL
DIMENSIONS.

3, The general dimensions of the proposed 50 foot section for San Diegito Dam are as follows:-

Slope of crown line of arches, 8 to 12.

Slope of back edges of buttresses 4 to 10.

Spans, 50 feet from center to center of buttresses.

Arc of extrados, angle of arc 120° of sloping part.

Radius of extrados of arches, 28.85 feet.

Radius of extrados of arches vertical head, 26.70 feet.

Radius of intrados of arches, varied with thickness.

Arch rings are monolithic heavily reinforced.

The thicknesses of the arch walls are 1 foot at the top increasing to a thickness of 1.80 feet at the bottom, this giving a direct loading of 350# per square inch with the water at elevation 250.

The buttresses are to have the same loadings at the edge where they meet the arches, and less as base is approached due to the taper, the thickness at the top being 1.0 feet, and at the base 3.10 feet.

COUNTERFORT
BUTTRESSES

4 ~~The spans being wide to give greatest economy for the small height, there are no strut beams used but to give stiffness to the rear ends of the buttresses, an equivalent is made by the use of Counterfort buttresses running from top to bottom of all buttresses as shown on the drawings.~~
at the rear end of the buttresses

A Foot Walk is provided by widening the cope of the arch and buttress to 4 feet and placing a wave reacting cope along the upstream edge.

SPELLWAY.

5 A ~~small~~ siphon spillway is to be located between buttresses 3 and 4 to take care of any excess water in the reservoir and to regulate its level within ~~4 inches~~ ^{1 foot} of the top of the dam at all times. *4 inches*

The siphon spillway will be as shown on the drawings, and is to have a capacity of ~~250~~ ^{over 500} cubic feet per second to regulate the level of the water from the conduit in addition to the local storm waters.

EXCAVATIONS
FOR

FOUNDATIONS. 6 The excavations of the overburden to reach the foundations are to be so made as to enable good sound supporting bedrock to be reached for the buttress foundations and to permit the

out to be made for the out-off walls of the arch ring walls into sound and tight bedrock. In rock excavation for the foundations, only small and light shots shall be used where blasting is necessary, the shots being so placed as to disturb as little as possible the surrounding ground. The bed rock must be cleaned of all spalls or loose fragments before placing concrete.

The arch ring foundations can be excavated as a trench in all parts, and as an open cut having the general outline of the elliptic plan of the arch rings, giving the cut such slopes as the materials will lay on, as an angle of repose. The excavations for the buttresses are best made as trenches for all depths, the cuts being wide enough to permit erecting forms inside of them.

FORMS FOR
CONCRETE.

7 As the type of structure is somewhat unusual in its shapes, the forms are designed as a part of the dam to give the contractor the advantage of past experience in their construction, and to remove all uncertainty as to the best forms to adopt. The forms are of wood, those for the buttresses being of panels made to reset and use over and over, all so designed as to fit in any part as well as of such sizes and shapes as to give a complete cover for the wall in the handiest units and shapes. The forms for the undersides of the arch rings are made up as a framework of liners, giving the exact shape for the arch, these being made into a frame upon which is bent to shape lapped $\frac{1}{2}$ x 6 inch boards, making a foundation from which to space the panels used for the outside forms for the arches. The use of these forms is not arbitrary but is recommended as the result of actual experience in building and will, if used, make the form work as simple as for a straight wall.

INTENTION OF
GENERAL
SPECIFICATIONS.

It is the purpose of these general specifications to cover in a general way all such matters relating to the construction of the structure as will lead to greater economy and better work in the structure, but there is no intent to make them rigid or arbitrary. The detail specifications to follow will contain the requirements for the work to be done. Full supplementary instruction and field drawings of details and methods to advance the work to the best advantage will be furnished, as well as plans for plant layout and methods of procedure.

OUTLET WORKS.

Two ~~outlet~~ ^{will be furnished by the Company} ~~gates~~ ^{ing} consist of a pair of ~~12"~~ valve gates, set in front of a pair of ~~12"~~ butterfly gates, ~~connected to a short piece of lapwelded tubing, provided with a flange to which to bolt the butterfly gates, the valve gates being bolted to the flange of the butterfly gates, and a short length of choker pipe, flanged to be bolted to the valve gate,~~ ~~all of standard make.~~ ~~All of these to be of a standard make~~ ~~for the required pressure, and built in place in the dam.~~ ~~The~~ ~~pipes through the dam~~ ~~can be~~ ^{shall be} set at the time the arch face is built and concreted in, the gates set after the dam is completed and the bypass closure is to be closed. These gates are to be located by the ~~Chief~~ Engineer of the Company.

~~Also a main conduit outlet,~~ ^{is to be installed} ~~as directed by~~ ~~the chief engineer of the Company.~~

SAN DIEGITO RESERVOIR DAM.

Detail Specifications For ~~An Eastwood~~ Multiple-Arched Dam.

UNIT
STRESSES
IN THE
STRUCTURE.

Section 1. In the design of this dam the following unit stresses have been considered as the maximum allowable and all parts are so designed and constructed that these limits can not be exceeded when the structure is finally completed to the contour at elevation 250, and is full of water to that level.

Loading on foundations, maximum 14.0 tons per square ft.

Buttresses in compression, 350# per square inch.

Arched deck in direct compression, 350# per sq. inch.

Foundation bases in direct shear, 99# per sq. inch.

Steel reinforcement, 14,000# per sq. inch.

There is no bending, no beam shear, or tension in the structure and none of the steel is stressed at all under normal conditions of temperature, the steel being only for temperature change stresses.

All of the above named stresses are the maximum in the ~~final completed structure with water to elevation 250.~~

Reinforcement: Section 1.

Steel for reinforcement shall be in shapes and sizes called for on the detail plans and in the specifications and shall be of deformed bars, preferably corrugated bars.

The reinforcement for the arch ribs is to be of Clinton electric welded mesh or the equivalent, *in deformed rods*, as shown on the reinforcement sheet. At the bases of the arches there are to be inserted steel bars to join the arch rings to the out-off walls and also to reinforce the front in a longitudinal line at this point.

The steel shall show the following physical and chemical proportions:-

Ultimate tensile strength,	not less than	80,000	lbs. per sq. in.
Yield point	" " "	50,000	" " "
Elongation in 8 inches	" " "	10	per cent.
Phosphorus,	not more than	0.06	per cent.
Sulphur	" " "	0.06	" "
Manganese,	" less "	0.40	" "

All bars must be free from seams, flaws, and cracks and have a workmanlike finish, and before being used in concrete it shall be cleaned free from all scale, dirt, paint and oil.

All secondary reinforcement such as netting, wire, or ties shall be of the best quality obtainable.

REINFORCED CONCRETE.

PROPORTIONING AND MIXING.

Section 2. 1. In all buttresses and their footings a concrete having a mix of 1:2½:5 shall be used.

2. In the arch rings, ~~railway and rear dock and all~~ ~~at~~ and the gate settings a 1:2:4 mix shall be used.

VOLUMETRIC MEASUREMENTS.

3. Before beginning work of placing concrete, volumetric measurements shall be made to determine the exact proportions required of each element of aggregate to meet these results of the best and densest concrete, and from time to time, should there be any change in the quality of the aggregates, volumetric measurements should be made to meet the changes necessary to keep the quality of the concrete to the required standard of quality.

QUANTITIES OF MATERIALS.

4. In general these mixtures shall be substantially based on ~~gravel~~ *coarse aggregate* with 40% of voids and a barrel of 3.8 cu. ft. or 360 lbs. of Portland Cement.

<u>Mixture</u>	<u>Cement</u>	<u>Sand</u>	<u>Rock</u>	<u>Concrete</u>
1:2½:5	1 bbl.	9.5 c.f.	19.0 c.f.	23 c.f.
1:2:4	1 bbl.	7.6 c.f.	15.2 c.f.	18 c.f.

Sand and stone shall be measured when packed not more closely than by throwing it in the usual way into boxes.

MIXING.

5. The concrete shall be mixed in machine mixers and machines shall be so arranged that the materials, including the water, can be precisely and regularly proportioned in batches, which will produce a concrete of uniform consistency and color with the stones and water thoroughly mixed and incorporated with the mortar.

6. The cement, sand and stone ballast, all being perfectly clean shall be placed in the machine in the specified proportions, and be thoroughly mixed. Clean water shall then be added and the mixing continued until the mass is uniform throughout. All materials must be accurately weighed or measured and the quantities used in each batch carefully checked throughout the entire progress of the work.

CONSISTENCY.

7. The resulting concrete mixture shall be of such consistency as to move freely and be sloppy and soft when deposited. It shall be in every instance what is generally known as "wet concrete". However, care must be exercised to not add an excess of water and thereby cause separation of cement from the aggregate. Each batch must be deposited in place as quickly as possible after mixing and the entire mass must have primary set within twenty-four hours. Concrete which has commenced to set before being deposited will not be permitted to remain in the work.

DEPOSITING.

8. All concrete shall be deposited wet and sloppy and shall be thoroughly spaded and puddled to remove air and until all the interstices between the stones are thoroughly filled with mortar. When deficiency of moisture is indicated it shall be supplied by sprinkling. Each batch must be puddled and properly in place before another batch is deposited in the forms. All exposed surfaces of finished and unfinished work shall be kept moist by sprinkling with water under pressure at short intervals. No walking or handling of materials on concrete is to be permitted until it has thoroughly and completely hardened, and all finished work shall be protected as may be necessary by canvas or plank. Layers shall be formed with square ends and not sloped or tapered.

FINISHING.

9. The concrete shall be placed by skilled workmen and all stones shall be well worked back from the face of forms by spading so as to produce a smooth surface and so that no stone shall approach the face of the work.

GROUTING.

10. When new work is joined to old work or to concrete already set, the joints shall be scarified and all loose materials on the surface flushed out of the forms with water under pressure, the surface then slushed with grout of neat cement, or if still wet from the washing with neat cement dusted on the wet surface, The surface must not be grouted or dusted unless concrete is to be immediately laid on it, the grouting in all cases to immediately precede the laying of concrete.

LAYING.

11. Concrete shall be laid continuously in so far as possible and each layer incorporated with the one previously laid.

Wherever it becomes necessary to place fresh concrete upon old concrete surface, the old surface shall be cleaned of all dirt, scum and laitance and thoroughly wetted and flushed before depositing the grout and fresh concrete.

JOINTS.

12. The construction must be as nearly monolithic as possible, but if it is necessary to place the concrete in sections, key blocks in the form of an inverted truncated pyramid for ease of removal without disturbing the surrounding concrete, of proper size and arrangement shall be imbedded in the concrete where the work is stopped so that the joining work may later be properly connected to it. Vertical joints shall not be permitted in buttress walls or arch ring walls except as shown on the plans. The vertical joints in the buttresses where they are to be later joined to the new work for the completed structure shall be provided with the joining reinforcement as shown on the plans and shall also be provided with key blocks fastened to the vertical forms and imbedded in the horizontal portions of the steps to key the parts of the walls together.

CONSTRUCTION OF BUTTRESSES.

13. The buttresses and all walls are tapered uniformly from top to bottom to give the required thickness, and the wall is to be carried up with such lifts as are convenient, but in all cases must be left when ceasing work on a buttress wall so that the rear or down stream end of the wall is higher than the front by means of temporary boards placed across the forms to create steps or keys, each rising higher as the rear of the buttress is approached.

ARCH RING
CONSTRUCTION.

14. The buttresses ~~and~~ should be built first or kept at least a good distance ahead of the arch ring construction, preferably completed to the full height after which the arch rings are built in place. The forms for the under side can be carried up to a considerable distance above the place where the work is being done or completed to the top of the completed buttresses, the walls then being placed by using panel forms for the outside forms, braced to the inside forms. The steel for reinforcing the arch rings should be put in place before erecting the outside panels where the walls are thin. The outside panel forms must be properly spaced from the inside forms to give the required thickness of arch walls at the various levels. All of these dimensions will be given in field drawings.

REMOVAL OF
FORMS.

15. Forms shall not be removed before the concrete is sufficiently set. Buttress forms shall in no case be removed while the concrete is taking its set, and in not less than 24 hours after placing, for buttress forms, not less than 12 hours for outside panel forms of arches, and for inside arch forms, not less than 7 days from the date of laying.

Reinforcing bars or net must not be jarred or moved while the concrete is taking its set.

FORMS.

16. All concrete masonry shall be built in place in wooden forms of sufficient strength, properly tied and braced together so as to be practically unyielding. The forms must have close joints and for outside walls of lumber dressed on the side exposed to the concrete so as to produce a smooth surface on all showing faces. The forms shall be coated with a heavy

oil before using, and where used over, as in the case of the panels, must be cleaned of adhering concrete before re-use.

All forms shall be thoroughly wet before placing concrete against them. The forms for the arch rings need not be of dressed lumber.

All concrete is to be dense and have a smooth exterior surface and any cracks or spalling shall be repaired.

EXPOSED SURFACES. 17. All exposed surfaces of concrete in the superstructure or that portion above the natural surface of the ground and exposed to view, shall be given special attention in laying in order to produce smooth surfaces in true planes uniform in structure and appearance. The corners of all finished edges as that of the strut tie beams are to be clipped by inserting a fillet in the corners of all forms for such parts of the work.

**EXPOSED
REINFORCEMENT.**

18. All exposed reinforcement, left protruding from the buttress walls must be coated with a grout of cement after the work is completed and before leaving the work, to prevent rusting by exposure to the elements.

DETAILED SPECIFICATIONS.

CONSTRUCTION.

BUTTRESSES.

1. Buttresses are to be built of 1:2½:5 concrete and shall be built with such lifts as are most convenient but at the termination of the pouring for any day the rear or downstream end is to be left higher than the front and proper keys provided in the wall at the point of cessation of work. The foundations shall be prepared by removing all spalls, fragments, chips,

shavings or any foreign matter of any kind from the bedrock, washing it clean with a hose under pressure, dusting the surface with dry cement or slushing it with cement grout as may be directed, and placing the concrete immediately on this prepared surface. The forms for the buttress bases at the foundation should be of a frame work of studs nailed to a plate to bring the top to a level to begin the use of the panel buttress forms, leaving the boards of the forms off at the bottom to permit the spread of the concrete to form the proper footing for the buttresses. At the end of each pouring, beveled wooden blocks of convenient size are to be imbedded in the fresh concrete by pressing down into it till they are flush with the top, which are to be removed before beginning work on the surface, the surface roughened and all loose material of any kind washed out of the forms, till the surface is clean, then grouted or dusted and pouring immediately commenced. The strut-tie beam forms shall be built at the same time as the buttress forms, and all steel shown on the detail drawings wired in place in them before pouring them. These forms must be braced firmly to the buttress forms to prevent sagging.

ARCH RINGS.

The arch ring waterface of the dam shall be built of 1:2:4 concrete placed very wet and very carefully placed. The out-off wall is to be placed carefully in a trench of such depth as will place all of it in sound rock that is free from seams, the trench being perfectly clean before concrete is laid in it and the reinforcing bars shown on the reinforcement sheet, placed in it, bent to an angle to fit the slope of the arch ring wall at the point placed. The concrete in the out-off wall is to be continued up and

constitute the base of the arch ring and is a part of it. The arch rings shall be cast in longitudinal lifts of about 6 feet, the wall being so provided with key blocks as to be continuous and have no longitudinal joints.

The inside forms are to be supported on liners out to the required radius for the point placed all of which are given in the field drawings, these liners resting on the projecting ledge of the buttress. These liners are spaced 7'10" apart to make use of even length studs of 16 feet cut to fit between the liners, making a frame of studs upon which the $\frac{1}{2}$ x 6" boards are bent and nailed. Collar braces to stiffen the liners are put on at the time of erection, the liners being assembled to fit the required radius on a platform in the carpenter yard. The Clinton Mesh or other reinforcement acceptable to the engineer, is placed on the inside forms and separated from it by means of briquettes of mortar of such dimensions as to space it properly from the forms and in the proper place in the walls.

The outside forms are to consist of panels as shown on the detail sheet showing arch forms and details. These panels are to be held in place by means of dowel pins and over all a cable of light weight provided with turnbuckles and hooks at the ends to hold the row of panels in place, the ends of the cable fastening to wire loops placed in the filler of the buttress when the buttresses are poured. This arrangement obviates the tying of the outside form to the inside by means of wires left in the wall which are objectionable as cause of weeping leaks where the water follows them.

~~STRUT-TIE
BEAMS AND
FOOT WALK.~~

~~All strut tie beams including the one used for a foot walk are to be continuous from end to end of the structure till they terminate in the bedrock at the ends into which the reinforcing rods are to be run and concreted in place.~~

~~The strut-tie beams are to be reinforced with rods running continuously through the buttress walls, from end to end and all of these are to be tied to the cross reinforcement placed in the buttresses at the junction forming roots to distribute the stresses in the buttresses. The beams are so spaced as to give the structure absolute rigidity. The strut beams are to be built at the same time and as a part of the buttresses.~~

FIELD JOINTS

Field joints in the arch rings shall be thoroughly roughened by picking and the feather edges of the top and bottom of the walls broken away and cleaned out before continuing the concreting. Great care must be taken to secure a tight joining between both inside and outside forms and old concrete at the top of lifts in order that no leakage of cement may take place at this joint, as it is essential that all surfaces, both inside and outside be as nearly perfect as it is possible to make them.

FINISHING SURFACES.

All surfaces in the interior of the dam, such as the under side, deck, sides of buttresses shall be made as smooth as possible by the use of close, well made forms, but no special finishing is required after forms are removed except that any rough or porous spots shall be thoroughly cleaned and filled with a mortar to match in color and texture the concrete and be floated over with a wooden float to resemble the remainder of the walls.

The outside surface of the arch rings shall be cleaned and painted with neat cement wash as soon as possible after the outside forms are removed.

OUTLET WORKS.

The outlet works are to consist of ^{of 2 valves} ~~a trash screen~~

near the bottom and 2 service gates about elevation
~~made of light railroad rails set into the concrete of the block~~

235. All valves, pipes connections and screens will
~~of concrete constituting the bell mouth of the outlet pipes set~~
be furnished by the Company and installed by the contractor
~~on the arch in the reservoir, the rack being vertical to make~~
as directed by the Engineer,
~~it self clearing. The outlet pipes are to be of 12" lapwelded~~

~~tubing, peaned at the upstream end and flanged to fit a standard butterfly gate on the downstream end. These pipes should be dipped in asphaltum, and repainted when in place in the structure. The butterfly gates to be of standard make for the required pressure, to have bronze vanes and flange bored to fit the flange on outlet pipe, the other side to be bored to fit the standard 12" valve gate to be placed in front of it. The valve gate to be provided with a short piece of pipe bent to form a choker, unless the pipe is connected to a main, in which case it is not needed.~~

Larger sluice gates may be installed as directed by the Chief Engineer of the Company.

CLEANING UP.

After the work is finished, all materials, rubbish and debris shall be removed from the site, and the site cleaned up satisfactory to the engineer.

FIELD SERVICE.

Field drawings of all parts of the works in such detail as to make all parts of the work plain, as well as instructions as to best and most economical methods will be furnished the contractor as required.

GENERAL SPECIFICATIONS

**FOR SAN DIEGUITO DAM, TO BE BUILT
ON THE SAN DIEGUITO RANCH, NEAR
DEL MAR, CALIFORNIA, FOR
SAN DIEGUITO MUTUAL WATER COMPANY.**

GENERAL SPECIFICATIONS
FOR CONSTRUCTION OF A DAM FOR
SAN DIEGUITO MUTUAL WATER COMPANY
ON THE SAN DIEGUITO RANCH, NEAR
DEL MAR, CALIFORNIA

GENERAL

DESCRIPTION. 1. The work to be done under these specifications consists of the construction of a dam for the San Dieguito Mutual Water Company, on the San Dieguito Ranch, near Del Mar, California.

It is the object of these specifications to provide for all material (except valves as hereafter specified) and all labor, plant and equipment necessary to build the structure herein provided for.

2. Whenever the word "company" or a pronoun in place of it is used, the same is understood to mean the San Dieguito Mutual Water Company. Whenever the word "engineer" or a pronoun in place of it is used, the same is understood to mean the Engineer duly authorized by said Company acting either directly or through his properly authorized agents. Such agents acting within the scope of the particular duties entrusted to them. Whenever the word "contractor" or a pronoun in place of it is used, the same is understood to mean the person or

person or co-partnership or corporation engaged in the construction of the work herein described as the party of the second part or his or their legal representative.

The contractor will commence the work herein required to be done, within 10 days after the signing of the contract unless the engineer shall authorize or direct a further delay, and at his own proper cost and expense, and on or before July 1, 1918, shall complete all the work and furnish all the labor, machinery, tools and materials except as herein specified, to do everything required to build and put in complete working order the San Dieguito Dam, and all appurtenant structures herein described.

3. The plans and specifications are intended to be explanatory of each other; but should any discrepancy appear, or any misunderstanding arise as to the import of anything contained in either, the parties hereto further agree that the explanation and decision of the Engineer shall be final and binding on the Contractor; and all directions and explanations required, alluded to or necessary to complete any of the provisions of this contract and specifications, and give them due effect, shall be given by the Engineer. Correction of errors or omissions in drawings or specifications may be made by the Engineer when such correction is necessary for the

proper fulfillment of the intention of such drawings or specifications, the effect of such correction to date from the time that the Engineer gives due notice thereof to said contractor.

4. To prevent all disputes and litigation, the Engineer shall be referee, in all cases, to decide upon the amount, quality, acceptableness and fitness of the several kinds of work and materials which are to be paid for under this contract, and upon all questions which may arise relative to the fulfillment of the contract on the part of the Contractor, and his estimates and decision shall be final and conclusive; and such estimate and decision, in case any question shall arise, shall be a condition precedent to the right of said Contractor to receive any money under this agreement; also that said Engineer, by himself or by assistants or inspectors acting for him, shall inspect the materials furnished and the work done under this agreement, to see that the same strictly correspond with the specifications hereinafter set forth. And the Contractor also agrees that he will at all times give to the Engineer, his assistants and inspectors, ladders, tools and labor, and all facilities necessary for inspecting the materials furnished and the work done under this agreement.

5. The methods throughout this work, shall

conform to what is recognized as good practice.

6. All accepted materials delivered at or near the site of the works are to be considered the property of the Company and cannot be removed without the Company's consent.

**UNDESIRABLE
EMPLOYEES.**

7. Any incompetent, disorderly or otherwise undesirable employees shall on request of the Engineer be dismissed and not again employed on this work.

**INSPECTION OF
MATERIAL.**

8. All materials and supplies delivered at or near the site of the works are subject to inspection and if condemned at any time by the Engineer, shall be so branded, and shall upon demand be removed at once to a satisfactory distance.

9. No inspection of any work or materials shall constitute an acceptance of same prior to the final acceptance of full completion of this contract, and all work or materials rejected by the Engineer at any time prior to final acceptance shall be at once made good by the Contractor.

**SUPERVISION
OF WORK.**

10. The Contractor must give this work his personal attention and at all times have a competent foreman, experienced in this class of work, on the ground, authorized to accept orders from the Engineer.

LOCATION. 11. The character of foundation and conditions at the site as shown on the plans or indicated by the Engineer are supposed to be approximately correct, but the contractor should depend upon his own examination as the Company does not guarantee the information.

WORK TO CON-
FORM TO
LINES, GRADES
ETC. FORCE
ACCOUNT.

12. All work, during its progress and on its completion shall conform to the lines and levels given by the Engineer, and shall be built in accordance with the contract plan and directions given from time to time by him.

If any emergency demands, or if the Engineer deems it necessary for the production of suitable and safely designed structures he may make alterations in the line, grade, plan, form, position, dimensions, or material of the work herein contemplated, or of any part thereof, either before or after the commencement of construction.

If such alterations diminish the quantity of the work to be done, they shall not constitute a claim for damages or for anticipated profits on the work that may be dispensed with; if they increase the amount of work, such increase shall be paid for according to the quantity actually done and at the price established for such work under this contract; or in case there is no price estab-

lished, it shall be paid for at its actual reasonable cost, as determined by the Engineer, plus ten (10%) per cent of said cost.

In no case shall any work in excess of the requirements of the plans and specifications be paid for unless ordered in writing by the Engineer.

13. If there is anything in these specifications or in the plans or specifications as now or hereinafter furnished which is not clear and intelligible to the Contractor, he shall not proceed with such work as ordered until he shall have drawn the attention of the Engineer to the element of doubt or misunderstanding, in writing, and have had the same explained to him, but it is the duty of the Contractor to examine the plans and site of the work far enough in advance to anticipate any needed explanation, and he will not be granted extension of time for misunderstanding or failing to understand any instructions.

TEMPORARY
BRIDGES OR
CROSSING.

14. Whenever it is necessary to cross roads or railroads, the Contractor shall, at his own expense, provide suitable and safe bridges or other sufficient crossings for the accommodation of the travel on said roads; and shall maintain the same in good and safe condition until the roads can be restored, when he shall

remove all bridges and other temporary expedients, and restore said roads to a condition suitable for use all to be satisfactory to the Engineer. The Contractor shall give reasonable notice to the owners of railroads and private ways before interfering with them. He shall provide watchmen, red lights and fences at his own expense, and take such other precautions as may be necessary to protect life and property; and shall be liable for all damage occasioned in any way by his act or neglect, or that of his agents, employees or workmen,

CEMENT. 15. Riverside Portland cement shall be used. It shall be properly stored in a dry, well ventilated place, and properly protected from the weather. Cement that has become lumpy shall not be used.

All cement required hereunder shall be furnished by the contractor at his own cost, and shall fulfill the requirements of the revised and modified specifications of the American Society of Civil Engineers, the same to be tested prior to shipment, by an inspector selected by the Water Company, but at the expense of the Contractor.

**VALVES, PIPES,
ETC.** 15. All valves and pipe necessary for the service and sluice outlets will be furnished by the Company to the contractor f.o.b. cars Del Mar.

17. The contractor shall at his own expense

convey the materials from the points where they are delivered by the Company and shall at his own expense store the same in the vicinity of the work. He shall be responsible for loss incurred or damage done to materials furnished by the Company from the time of their delivery until the work is accepted.

**MATERIAL
AND WORK-
MANSHIP.**

18. All material and workmanship is to be the best of the kind specified. The Contractor shall produce and allow inspection by the Engineer of all bills, statements and vouchers showing the quality, amount and cost of all material and labor entering into extra work.

SAND.

19. The fine aggregate shall consist of sand or screenings of gravel or crushed stone, free from dust, graded from fine to coarse and passing when dry a screen having one quarter ($1/4$) inch diameter holes, it preferably shall be of siliceous material, and not more than 30% by weight shall pass a sieve having 40 meshes per linear inch, it shall be clean, and free from soft particles, lumps of clay, vegetable loam or other organic matter. If the tensile strength developed by the fine aggregate in a 1:3 mortar is less than 85 per cent of the strength of a 1:3 Ottawa-sand mortar, the material shall be rejected.

**COARSE
AGGREGATE.**

20. Coarse aggregate shall consist of gravel

or crushed stone, which is retained on a screen having one quarter ($\frac{1}{4}$) inch diameter holes, and shall be graded from the smallest to the largest particles, it shall be clean, hard, durable, and free from all deleterious matter. Aggregates containing dust and soft particles, shall be excluded. The gravel or crushed stone shall be separated into two sizes and remixed in the proper proportion, in case it is not found uniformly graded, from the min. size of quarter inch to the max. size which will pass a $2\frac{1}{2}$ inch ring.

WATER. 21. The water used in mixing concrete shall be free from oil, acid, alkali, or organic matter.

GENERAL SPECIFICATIONS

REINFORC- ING STEEL.

22. Steel used for reinforcement either in tension or compression shall comply with the following specifications, and shall be in shapes and sizes called for on the detailed plans and more detailed specifications.

1. Steel shall be made by the Open Hearth process from standard billets. Material re-rolled from T-rails or scrap of any kind will not be accepted.

2. Deformed bars of the round or square corrugated type shall be used as specified. Cold

twisted square bars will not be accepted as deformed bars.

3. The chemical and physical properties shall conform to the following specifications:-

Phosphorus, maximum, Basic process 0.04%, acid process 0.06%

Sulphur, maximum 0.05%

Ultimate strength, pounds per square inch:-

Minimum 70000

Maximum 85000

Yield Point, pounds per square inch:-

Minimum 40000

Elongation, per cent in 8 inches, minimum

$\frac{1125000}{\text{Ultimate Strength}}$

Cold Bends, without fracture:-

180 degrees

Bars under $\frac{1}{2}$ "

$d = 3T$

Bars $\frac{1}{2}$ " and over

$d = 5T$

Where $d = 3T$ signifies "around a pin whose diameter is 3 times the thickness of diameter of specimen,

4. Bending tests may be made by pressure or by blows.

All tests shall conform in method and manner to the standards prescribed by the American Society for testing materials.

5. All steel shall be free from injurious seams, flaws, cracks, defective edges or other defect, and have a smooth, uniform and workmanlike finish.

6. As far as practicable the melt, the year rolled and the name or initials of manufacturer are to be rolled or stamped on all finished steel bars.

7. Material, which subsequent to the tests at the mill and its acceptance there, develops weak spots, brittleness, cracks or other imperfections, or is found to have injurious defects, will be rejected and shall be replaced by the Contractor at his own cost.

8. Inspectors, retained by the Company, will be authorized to reject all material which does not conform to these specifications. All material shall be tested before shipment from the rolling mills or warehouse and the Contractor shall furnish the Company with evidence in writing that this has been done and that the steel complies with the specifications, guaranteeing to the Company the identical material covered by the tests and inspection.

9. Reinforcing steel shall be free from excessive rust, loose scale or other coatings of any character which would reduce or destroy the bond, and it shall be cleaned if necessary to secure this.

10. The Contractor shall furnish the inspector on the work, statements showing exact shipping weights in detail for all material covered by his inspection.

11. The Contractor shall bear the cost of any suit arising through the reinforcing material furnished being deemed to infringe other patents and shall pay such damage as may be awarded in said suit in consequence of the use of such infringing material.

PROPORTIONS. 23. The proportions of the raw materials for the concrete shall be accurately determined by density experiments made by the Engineer from time to time to ascertain the relative coarseness of the aggregate in order to fix the proportions necessary to a concrete of maximum density. The Contractor shall use such proportions until notified by the Engineer to change, due to changes in the aggregate. The Cement shall be measured by the sack as packed by the manufacturer containing approximately 94 pounds net, and considered equivalent to 95/100 cubic foot. Other aggregate shall be measured as shoveled loose into a measuring box or barrel.

HAND
MIXING.

24. If the concrete, or any part of it, is mixed by hand, the cement and aggregate must be thoroughly mixed dry until mixture is of uniform color, and the water added on a thoroughly water tight platform, the amount of mixing shall be sufficient to produce a concrete of uniform color and appearance with the stones thoroughly incorporated into the mortar and the consistency uniform

throughout.

**MACHINE
MIXING.**

25. If the concrete is mixed in a machine mixer, the machine shall be so arranged that the materials, including the water can be regularly and precisely proportioned, and which will produce a concrete of uniform consistency and color with the stones thoroughly mixed and incorporated with the mortar. The aggregate shall be turned in the mixer for the minimum length of time of one and one quarter ($1\frac{1}{4}$) minutes, if a half yard mixer, is used and one and one half ($1\frac{1}{2}$) minutes, if a one yard mixer is used, after all the ingredients are assembled in the mixer. The number of revolutions of the mixer shall be so regulated as to give at the periphery of the drum a uniform speed between 160 and 200 feet per minute. If the mixer is of two yards capacity or more, the time a batch is to be turned shall not be less than two minutes.

SURFACES.

26. Noticeable voids and stone pockets discovered when forms are struck shall be immediately filled with mortar mixed in the same proportion as the mortar in the concrete. No allowance for labor or material over and above the normal unit price will be allowed for preparation of joints or fillings of voids or stone pockets. The surfaces shall have no special treatment other than care in placing the concrete to avoid voids or stone pockets.

FORMS.

27. The lumber for the forms and the design of the forms shall be adapted to the structure. The forms shall be sufficiently tight to prevent loss of mortar. They shall be thoroughly braced or tied together so that the pressure of concrete or the movement of men, machinery or materials, shall not throw them out of place. Forms shall be left in place until in the judgment of the Engineer the concrete has attained sufficient strength.

STEEL.

28. All reinforcing steel must occupy the exact position called for on the drawings, and method of placing must be such, that the reinforcement can not be displaced by the operation of placing concrete. Length of overlapping reinforcement shall be equal to at least 24 diameters of bars.

CONCRETE.

29. All concrete allowed for as extra work will be measured in the finally completed structure and will be paid for to the amount actually placed in the structures.

QUARRIES.

30. Quarries and borrow pits may be opened only on sites where excavation, in the judgment of the Engineer, will not endanger the safety or stability of the structures contemplated.

EXTRA WORK.

31. Contractor shall make no claims for extra work unless the same shall be ordered by the

Engineer.

All claims for extra work must be filed with the Engineer by the 10th of the month following that in which the work is performed.

GENERAL RE-
QUIREMENTS.

32. In all the operations connected with the work herein specified, all laws controlling or limiting in any way the actions of those engaged on the works, or affecting the materials applied to them, must be respected and strictly complied with.

NO SPIRITUOUS
LIQUORS.

33. The Contractor shall neither bring nor allow others to bring any spirituous or fermented liquor or other intoxicant, upon the grounds occupied for the prosecution of the work; neither shall he furnish nor allow others to furnish liquors or other intoxicant, to the workmen in his employ or to any person or persons in the vicinity.

34. Grounds in the vicinity of the work and all camps in which employes are quartered shall be maintained in a proper, sanitary condition as directed by the Engineer.

35. After the work is finished, all materials, rubbish and debris shall be removed from the site, and the site cleaned up satisfactory to the Engineer.

DETAILED SPECIFICATIONS
FOR MULTIPLE ARCH DAM
ON SAN DIEGUITO RANCH
FOR
SAN DIEGUITO MUTUAL WATER COMPANY

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GENERAL SPECIFICATIONS

LOCATION OF STRUCTURE

The work to be done under these specifications consists of the construction of San Dieguito Dam on the San Dieguito Ranch, near Del Mar, California.

The drawings accompanying these specifications cover the general features of the work. Further drawings showing details of construction will be supplied by the Engineer as required.

GENERAL DE- SCRIPTION OF

THE STRUCTURE. This dam is to be of the Multiple-arched type, in which design, arches are used for the water face deck, and buttresses are used for the support of the same, and so designed as to be completed to a height of 50 feet above stream bed to contour elevation of 250. It will consist of 14 arches supported by 13 buttresses. The structure is to be founded on a solid rock foundation, the cut-off wall at the front edges of the arch ring foundations to be cut into sound rock for a tight cut-off and the buttress foundations to be sound rock, roughened and notched.

GENERAL DI- MENSIONS.

The general dimensions of the proposed 50 foot section for San Dieguito dam are as follows:-

Slope of crown line of arches, 8 to 12.

Slope of back edges of buttresses 4 to 10.

Spans, 50 feet from center to center of buttresses.

Arc of extrados, angle of arc 120 deg. of sloping part.

Radius of extrados of arches, 28.85 feet,

Radius of extrados of arches, vertical load, 26.70 feet.

Radius of intrados of arches, varied with thickness.

Arch rings are monolithic heavily reinforced.

The thicknesses of the arch walls are 1 foot at the top increasing to a thickness of 2.42 feet at the bottom, this giving a direct loading of 300# per square inch with the water at elevation 250.

The buttresses are to have the same loadings at the edge where they meet the arches, and less as base is approached due to the taper, the thickness at the top being 1.0 feet, and at the base 3.10 feet.

COUNTERFORT BUTTRESSES.

The spans being wide to give greatest economy for the small height, there are no strut beams used but to give stiffness to the rear ends of the buttresses, an equivalent is made by the use of Counterfort buttresses running from top to bottom of all buttresses as shown on the drawings.

A Foot Walk is provided by widening the cope

of the arch and buttress to 4 foot and placing a wave reacting cope along the upstream edge.

SPILLWAY. A small siphon spillway is to be located between two convenient buttresses to take care of any excess water in the reservoir and to regulate its level within 4 inches of the top of the dam at all times.

The siphon spillway will be as shown on the drawings, and is to have a capacity of 1229 cubic feet per second to regulate the level of the water from the conduit in addition to the local storm waters

**EXCAVATIONS
FOR
FOUNDATIONS.**

The excavations of the overburden to reach the foundations are to be so made as to enable good sound supporting bedrock to be reached for the buttress foundations and to permit the cut to be made for the cut-off walls of the arch ring walls into sound and tight bedrock. In rock excavation for the foundations, only small and light shots shall be used where blasting is necessary, the shots being so placed as to disturb as little as possible the surrounding ground. The bed rock must be cleaned of all spalls or loose fragments before placing concrete. The arch ring foundations can be excavated as a trench in all parts, and as an open cut having the general outline of the elliptic plan of the arch rings, giving the cut such

slopes as the materials will lay on, as an angle of repose. The excavations for the buttresses are best made as trenches for all depths, the cuts being wide enough to permit erecting forms inside of them.

FORMS FOR CONCRETE.

As the type of structure is somewhat unusual in its shapes, the forms are designed as a part of the dam to give the contractor the advantage of past experience in their construction, and to remove all uncertainty as to the best forms to adopt. The forms are of wood, those for the buttresses being of panels made to reset and use over and over, all so designed as to fit in any part as well as of such sizes and shapes as to give a complete cover for the wall in the handiest units and shapes. The forms for the undersides of the arch rings are made up as a frame work of liners, giving the exact shape for the arch, these being made into a frame upon which is bent to shape lapped $\frac{1}{2}$ x 6 inch boards, making a foundation from which to space the panels used for the outside forms for the arches. The use of these forms is not arbitrary but is recommended as the result of actual experience in building and will, if used, make the form work as simple as for a straight wall.

OUTLET WORKS.

The outlet gates are to be furnished by the Company and placed by the Contractor where, and as

directed by the Engineer of the Company.

UNIT STRESSES IN

THE STRUCTURE. Section 1. In the designs of this dam the following unit stresses have been considered as the maximum allowable and all parts are so designed and constructed that these limits can not be exceeded when the structure is finally completed to the contour at elevation 250 and is full of water to that level.

Loading on foundations, maximum 14.0 tons per square ft.

Buttresses in compression, 350# per square inch. Arched deck in direct compression, 300# per

square inch.

Foundation bases in direct shear, 99# per square inch.

Steel reinforcement, 14,000# per square inch. There is no bending, no beam shear, or tension in the structure and none of the steel is stressed at all under normal conditions of temperature, the steel being only for temperature change stresses.

All of the above named stresses are the maximum in the final completed structure with water to elevation 250.

Steel for reinforcement shall be in shapes and sizes called for on the detail plans and in the specification and shall be of deformed bars, preferably corrugated bars.

REINFORCEMENT. Steel for reinforcement shall be in shapes and sizes called for on the detail plans and in accordance with the provisions in the general specifications.

and shall be of round corrugated bars, known as rib bars.

The reinforcement for the arch rings is to be of rib bars of sizes and spacing, as shown on the Reinforcement sheet. At the bases of the arches there are to be inserted steel bars to join the arch rings to the cut off walls and also to reinforce the front in a longitudinal line at this point. Full details are shown on the Reinforcement sheet of the plans.

All secondary reinforcement such as netting, wire, or ties shall be of the best quality obtainable.

REINFORCED CONCRETE.

PROPORTIONING AND MIXING.

In all buttresses and their footing a concrete having a mix of $1:2\frac{1}{2}:5$ shall be used, containing 1.5 bbls. of cement per cubic yard.

In the arch rings and the gate settings a $1:2:4$ mix shall be used, containing 1.5 bbls. of cement per cubic yard.

Sand and stone shall be measured when packed not more closely than by throwing it in the usual way into boxes.

CONSISTENCY. The resulting concrete mixture shall be of such consistency as to move freely and be sloppy and

soft when deposited. It shall be in every instance what is generally known as "wet concrete." However, care must be exercised to not add an excess of water and thereby cause separation of cement from the aggregate.

DEPOSITING. Each batch must be deposited in place as quickly as possible after mixing and the entire mass must have primary set within twenty four hours. Concrete which has commenced to set before being deposited will not be permitted to remain in the work.

All concrete shall be deposited wet and sloppy and shall be thoroughly spaded and puddled to remove air and until all the interstices between the stones are thoroughly filled with mortar. When deficiency of moisture is indicated it shall be supplied by sprinkling. Each batch must be puddled and properly in place before another batch is deposited in the forms. All exposed surfaces of finished and unfinished work shall be kept moist by sprinkling with water under pressure at short intervals. No walking or handling of materials on concrete is to be permitted until it has thoroughly and completely hardened, and all finished work shall be protected as may be necessary by canvas or plank. Layers shall be formed with square ends and not sloped or tapered.

FINISHING. The concrete shall be placed by skilled workmen and all stones shall be well worked back from the face of

forms by spading so as to produce a smooth surface and so that no stone shall approach the face of the work.

GROUTING. When new work is joined to old work or to concrete already set, the joints shall be scarified and loose material on the surface flushed out of the forms with water under pressure, the surface then flushed with grout of neat cement, or if still wet from the washing with neat cement dusted on the wet surface. The surface must not be grouted or dusted unless concrete is to be immediately laid on it, the grouting in all cases to immediately precede the laying of concrete.

LAYING. Concrete shall be laid continuously in so far as possible and each layer incorporated with the one previously laid. Wherever it becomes necessary to place fresh concrete upon old concrete surface, the old surface shall be cleaned of all dirt, scum and liltance and thoroughly wetted and flushed before depositing the grout and fresh concrete.

JOINTS. The construction must be as nearly monolithic as possible, but if it is necessary to place the concrete in sections, key blocks in the form of an inverted truncated pyramid for ease of removal without disturbing the surrounding concrete of proper size and arrangement shall be imbedded in the concrete where the work is stopped so that the joining work may later be

properly connected to it. Vertical joints shall not be permitted in buttress walls or arch ring walls except as shown on the plans. The vertical joints in the buttresses where they are to be later joined to the new work for the completed structure shall be provided with the joining reinforcement as shown on the plans and shall also be provided with key blocks fastened to the vertical forms and imbedded in the horizontal portions of the steps to key the parts of the walls together.

CONSTRUCTION OF BUTTRESSES.

The buttresses and all walls are tapered uniformly from top to bottom to give the required thickness, and the wall is to be carried up with such lifts as are convenient, but in all cases must be left when ceasing work on a buttress wall so that the rear or downstream end of the wall is higher than the front by means of temporary boards placed across the forms to create steps or keys, each rising higher as the rear of the buttress is approached.

ARCH RING

CONSTRUCTION. The buttresses should be built first or kept at least a good distance ahead of the arch ring constructions, preferably completed to the full height after which the arch rings are built in place. The forms for the under side can be carried up to a con-

siderable distance above the place where work is being done, or completed to the top of the completed buttresses, the walls then being placed by using panel forms for the outside forms, braced to the inside forms. The steel for reinforcing the arch rings should be put in place before erecting the outside panels where the walls are thin. The outside panel forms must be properly spaced from the inside forms to give the required thickness of arch walls at the various levels. All of these dimensions will be given in field drawings.

REMOVAL OF FORMS.

Forms shall not be removed before the concrete is sufficiently set. Buttress forms shall in no case be removed while the concrete is taking its set, and in not less than 24 hours after placing, for buttress forms, not less than 12 hours for outside panels forms of arches, and for inside arch forms, not less than 7 days from the date of laying.

Reinforcing bars must not be jarred or moved while the concrete is taking its set.

FORMS.

All concrete masonry shall be built in place in wooden forms of sufficient strength, properly tied and braced together so as to be practically unyielding. The forms must have close joints and for outside walls be of lumber dressed on the side exposed to the concrete

so as to produce a smooth surface on all showing faces. The forms shall be coated with a heavy oil before using, and where used over, as in the case of panels, must be cleaned of adhering concrete before re-use. All forms shall be thoroughly wet before placing concrete against them. The forms for the arch rings need not be of dressed lumber. All concrete is to be dense and have a smooth exterior surface and any cracks or spalling shall be repaired.

**EXPOSED SUR-
FACES.**

All exposed surfaces of concrete in the superstructure or that portion above the natural surface of the ground and exposed to view, shall be given special attention in laying in order to produce smooth surfaces in true planes uniform in structure and appearance. The corners of all finished edges as that of the struttie beams are to be clipped by inserting a fillet in the corners of all forms for wuch parts of the work.

**EXPOSED REIN-
FORCEMENT.**

All exposed reinforcement, left protruding from the buttress walls must be coated with a grout of cement after the work is completed and before leaving the work, to prevent rusting by exposure to the elements.

BUTTRESSES. Buttresses are to be built of 1:2½:5 concrete and shall be built with such lifts as are most convenient but at the termination of the pouring for any day the

rear or downstream end is to be left higher than the front and proper keys provided in the wall at the point of cessation of work. The foundations shall be prepared by removing all spalls, fragments, chips shavings or any foreign matter of any kind from the ~~bedrock~~, washing it clean with a hose under pressure, dusting the surface with dry cement or slushing it with cement grout as may be directed, and placing the concrete immediately on this prepared surface. The forms for the buttress bases at the foundation should be of frame work of studs nailed to a plate to bring the top to a level to begin the use of the panel buttress forms, leaving the boards of the forms off at the bottom to permit the spread of the concrete to form the proper footing for the buttresses. At the end of each pouring, beveled wooden blocks of convenient size are to be imbedded in the fresh concrete by pressing down into it till they are flush with the top, which are to be removed before beginning work on the surface, the surface roughened and all loose material of any kind washed out of the forms, till the surface is clean, then grouted or dusted and pouring immediately commenced.

These forms must be braced firmly to the buttress forms to prevent sagging.

ARCH RINGS. The deck and arch ring waterface of the dam shall be built of 1:2:4 concrete placed very wet and very carefully placed. The cutoff wall is to be placed carefully in a trench of such depth as will place all of it in sound rock that is free from seams, the trench being perfectly clean before concrete is laid in it and the reinforcing bars shown on the reinforcement sheet, placed in it, bent to an angle to fit the slope of the arch ring wall at the point placed. The concrete in the cut off wall is to be continued up and constitute the base of the arch ring and is a part of it. The arch rings shall be cast in longitudinal lifts of about 6 feet, the wall being so provided with key blocks as to be continuous and have no longitudinal joints.

The inside forms are to be supported on liners out to the required radius for the point placed all of which are given in the field drawings, these liners resting on the projecting ledge of the buttress. These liners are spaced 7'10" apart to make use of even length studs of 16 feet cut to fit between the liners, making a frame of studs upon which the 1/2 x 6" boards are bent and nailed. Collar braces to stiffen the liners are put on at the time of erection, the liners being assembled to fit the required radius on a platform in the carpenter

yard. The reinforcement is placed on the inside forms and separated from it by means of briquettes of mortar of such dimensions as to space it properly from the forms and in the proper place in the walls.

The outside forms are to consist of panels as shown on the detail sheet showing arch forms and details. These panels are to be held in place by means of dowel pins and over all a cable of light weight provided with turnbuckles and hooks at the ends to hold the row of panels in place, the ends of the cable fastening to wire loops placed in the filler of the buttress when the buttresses are poured. This arrangement obviates the tying of the outside form to the inside by means of wires left in the wall which are objectionable as cause of weeping leaks where the water follows them.

The cope of the arch rings is to be built to serve as a foot walk across the structure, the wave cope on the up-stream side to serve as a railing and the railing to be placed on the down stream side.

FIELD JOINTS. Field joints in the arch rings shall be thoroughly roughened by picking and the feather edges of the top and bottom of the walls broken away and cleaned out before continuing the concreting. Great care must be taken to secure a tight joint between both inside and outside forms and old concrete at the top of lifts in

in order that no leakage of cement may take place at this joint, as it is essential that all surfaces, both inside and outside be as nearly perfect as it is possible to make them.

FINISHING SURFACES.

All surfaces in the interior of the dam, such as the under side, deck, sides of buttresses shall be made as smooth as possible by the use of close, well made forms, but no special finishing is required after forms are removed except that any rough or porous spots shall be thoroughly cleaned and filled with a mortar to match in color and texture the concrete and be floated over with a wooden float to resemble the remainder of the walls.

CLEANING UP. After the work is finished, all materials, rubbish and debris shall be removed from the site, and the site cleaned up satisfactory to the engineer.

FIELD SERVICE. Field drawings of all parts of the works in such detail as to make all parts of the work plain, as well as instructions as to best and most economical methods will be furnished the contractor as required.

CHANGES IN DESIGN.

Should it meet with the approval of the State Engineer, the main foot walk cope may be built to elevation 248 and the crest of the wave cope to elevation 250, in which case a reduction will be made as stated in the bid for the work.

Frank

DESCRIPTION AND DETAIL SPECIFICATIONS

of the

UPPER SAN DIEGITO RESERVOIR DAM

for the

VOLCAN WATER COMPANY

Describing the

EASTWOOD MULTIPLE-ARCHED DAM.

GENERAL SPECIFICATIONS.

LOCATION OF STRUCTURE.

The structure is to be located at the site shown on the blue print map of the proposed site, on the San Diegito Rancho, as shown on the drawing No. 665 of the same accompanying these specifications. The location is the selection of the Chief Engineer of the Company, and will be on the lines laid down on the Plan Drawings.

GENERAL DESCRIPTION OF THE STRUCTURE.

This dam is to be a structural dam of the type known as the Eastwood Multiple-arched type, in which design, arches are used for the water face deck and buttresses are used for the support of the same, designed especially to meet the conditions prevailing at this site, and so designed as to be completed to a height of 50 feet, to contour elevation of 250. This dam is to create a regulating reservoir at the end of the conduit line from the Carroll Reservoir and is to be used in regulation and distribution of the water over the adjacent lands. It will consist of 15 arches supported by 14 buttresses. The structure is to be founded on a solid rock foundation, the cut-off wall at the front edges of the arch rig foundations to be cut into sound rock for a tight cut-off and the buttress foundations to be sound rock, roughened and notched.

SPELLWAY

As the reservoir is to be filled from the conduit, only a small spillway need be provided, and a siphon will be installed to regulate the water within four inches of the top of the cope of the dam, having a capacity of about 250 cu. ft. per second.

The principal advantages of the multiple-arched dam, stated in as few words as possible, are: (1) that the up-thrust under the foundations is practically eliminated, the water in the foundations having no continuous surface on which to act, that danger from sliding on the foundations is removed, as the load is downward on the top of the structure, the load is also evenly distributed over the entire base, and is therefore very light on the foundations: that the loading throughout the entire structure is evenly distributed, the maximum load is not permitted to exceed certain limits, so the structure in its weakest part has a strength of ten times the breaking load, and finally, the quantities and the cost are less because all of the material is so placed as to do its part of the work to the best advantage, in fact it is the thoroughly scientific structure designed to do the work of resisting the water pressure for all time without deterioration.

**GENERAL
DIMENSIONS.**

The general dimensions of the proposed 50 foot section for San Diegito Dam are as follows:-

Slope of crown line of arches, 8 to 12.

Slope of back edges of buttresses 4 to 10.

Spans, 50 feet from center to center of buttresses.

Arc of extrados, angle of arc 120° of sloping part.

Radius of extrados of arches, 28.85 feet.

Radius of extrados of arches vertical head, 26.70 feet.

Radius of intrados of arches, varied with thickness.

Arch rings are monolithic heavily reinforced.

The thicknesses of the arch walls are 1 foot at the top increasing to a thickness of 1.80 feet at the bottom, this giving a direct loading of 350# per square inch with the water at elevation 250.

The buttresses are to have the same loadings at the edge where they meet the arches, and less as base is approached due to the taper, the thickness at the top being 1.0 feet, and at the base 3.10 feet.

COUNTERFORT BUTTRESSES.

The spans being wide to give greatest economy for the small height, there are no strut beams used but to give stiffness to the rear ends of the buttresses, an equivalent is made by the use of Counterfort buttresses running from top to bottom of all buttresses as shown on the drawings.

A Foot Walk is provided by widening the cope of the arch and buttress to 4 feet and placing a wave reacting cope along the upstream edge.

SPELLWAY.

A small siphon spillway is to be located between buttresses 3 and 4 to take care of any excess water in the reservoir and to regulate its level within 4 inches of the top of the dam at all times.

The siphon spillway will be as shown on the drawings, and is to have a capacity of 250 cubic feet per second to regulate the level of the water from the conduit in addition to the local storm waters.

EXCAVATIONS FOR

FOUNDATIONS. The excavations of the overburden to reach the foundations are to be so made as to enable good sound supporting bedrock to be reached for the buttress foundations and to permit the

cut to be made for the cut-off walls of the arch ring walls into sound and tight bedrock. In rock excavation for the foundations, only small and light shots shall be used where blasting is necessary, the shots being so placed as to disturb as little as possible the surrounding ground. The bed rock must be cleaned of all spalls or loose fragments before placing concrete.

The arch ring foundations can be excavated as a trench in all parts, and as an open cut having the general outline of the elliptic plan of the arch rings, giving the cut such slopes as the materials will lay on, as an angle of repose. The excavations for the buttresses are best made as trenches for all depths, the cuts being wide enough to permit erecting forms inside of them.

FORMS FOR CONCRETE.

As the type of structure is somewhat unusual in its shapes, the forms are designed as part of the dam to give the contractor the advantage of past experience in their construction, and to remove all uncertainty as to the best forms to adopt. The forms are of wood, those for the buttresses being of panels made to reset and use over and over, all so designed as to fit in any part as well as of such sizes and shapes as to give a complete cover for the wall in the handiest units and shapes. The forms for the undersides of the arch rings are made up as a framework of liners, giving the exact shape for the arch, these being made into a frame upon which is bent to shape lapped $\frac{1}{2}$ x 6 inch boards, making a foundation from which to space the panels used for the outside forms for the arches. The use of these forms is not arbitrary but is recommended as the result of actual experience in building and will, if used, make the form work as simple as for a straight wall.

INTENTION OF
GENERAL
SPECIFICATIONS.

It is the purpose of these general specifications to cover in a general way all such matters relating to the construction of the structure as will lead to greater economy and better work in the structure, but there is no intent to make them rigid or arbitrary. The detail specifications to follow will contain the requirements for the work to be done. Full supplementary instruction and field drawings of details and methods to advance the work to the best advantage will be furnished, as well as plans for plant layout and methods of procedure.

OUTLET WORKS.

The outlet gates are shown to consist of a pair of 12" valve gates, set in front of a pair of 12" butterfly gates, connected to a short piece of lapwelded tubing, provided with a flange to which to bolt the butterfly gates, the valve gates being bolted to the flange of the butterfly gates, and a short length of choker pipe, flanged to be bolted to the valve gate, all of standard make. All of these to be of a standard make for the required pressure, and built in place in the dam. The pipes through the dam can be set at the time the arch face is built and concreted in, the gates set after the dam is completed and the bypass closure is to be closed. These gates are to be located by the Chief Engineer of the Company.

SAN DIEGO RESERVOIR DAM.

Detail Specifications For An Eastwood Multiple-Arched Dam.

UNIT
STRESSES
IN THE
STRUCTURE

Section 1. In the designs of this dam the following unit stresses have been considered as the maximum allowable and all parts are so designed and constructed that these limits can not be exceeded when the structure is finally completed to the contour at elevation 250, and is full of water to that level.

Loading on foundations, maximum 14.0 tons per square ft.

Buttresses in compression, 350# per square inch.

Arched deck in direct compression, 350# per sq. inch.

Foundation bases in direct shear, 99# per sq. inch.

Steel reinforcement, 14,000# per sq. inch.

There is no bending, no beam shear, or tension in the structure and none of the steel is stressed at all under normal conditions of temperature, the steel being only for temperature change stresses.

All of the above named stresses are the maximum in the final completed structure with water to elevation 250.

Steel for reinforcement shall be in shapes and sizes called for on the detail plans and in the specifications and shall be of deformed bars, preferably corrugated bars.

The reinforcement for the arch ribs is to be of Clinton electric welded mesh or the equivalent, as shown on the reinforcement sheet. At the bases of the arches there are to be inserted steel bars to join ~~the~~ the arch rings to the cut-off walls and also to reinforce the front in a longitudinal line at this point.

The steel shall show the following physical and chemical proportions:-

Ultimate tensile strength,	not less than	80,000	lbs. per sq. in.
Yield point	" " "	50,000	" " "
Elongation in 8 inches	" " "	10	per cent.
Phosphorus,	not more than	0.06	per cent.
Sulphur	" " "	0.06	" " .
Manganese,	" less "	0.40	" " .

All bars must be free from seams, flaws, and cracks and have a workmanlike finish, and before being used in concrete it shall be cleaned free from all scale, dirt, paint and oil.

All secondary reinforcement such as netting, wire, or ties shall be of the best quality obtainable.

REINFORCED CONCRETE.

PROPORTIONING AND MIXING.

Section 2. 1. In all buttresses and their footings a concrete having a mix of 1:2½:5 shall be used.

2. In the arch rings and the gate settings a 1:2:4: mix shall be used.

VOLUMETRIC MEASUREMENTS.

3. Before beginning work of placing concrete, volumetric measurements shall be made to determine the exact proportions required of each element of aggregate to meet these results of the best and densest concrete, and from time to time, should there be any change in the quality of the aggregates, volumetric measurements should be made to meet the changes necessary to keep the quality of the concrete to the required standard of quality.

QUANTITIES OF MATERIALS.

4. In general these mixtures shall be substantially based on gravel with 40% of voids and a barrel of 3.8 cu. ft. or 380 lbs of Portland Cement.

<u>MIXTURE</u>	<u>CEMENT</u>	<u>SAND</u>	<u>ROCK</u>	<u>CONCRETE</u>
1:2½:5	1 bbl.	9.5 c.f.	19.0 c.f.	23 c.f.
1:2:4	1 bbl.	7.6 c.f.	15.2 c.f.	18 c.f.

Sand and stone shall be measured when packed not more closely than by throwing it in the usual way into boxes.

MIXING.

5. The concrete shall be mixed in machine mixers and machines shall be so arranged that the materials, including the water, can be precisely and regularly proportioned in batches, which will produce a concrete of uniform consistency and color with the stones and water thoroughly mixed and incorporated with the mortar.

6. The cement, sand and stone ballast, all being perfectly clean shall be placed in the machine in the specified proportions, and be thoroughly mixed. Clean water shall then be added and the mixing continued until the mass is uniform throughout. All materials must be accurately weighed or measured and the quantities used in each batch carefully checked throughout the entire progress of the work.

CONSISTENCY.

7. The resulting concrete mixture shall be of such consistency as to move freely and be sloppy and soft when deposited. It shall be in every instance what is generally known as "wet concrete". However, care must be exercised to not add an excess of water and thereby cause separation of cement from the aggregate. Each batch must be deposited in place as quickly as possible after mixing and the entire mass must have primary set within twenty-four hours. Concrete which has commenced to set before being deposited will not be permitted to remain in the work.

DEPOSITING.

8. All concrete shall be deposited wet and sloppy and shall be thoroughly spaded and puddled to remove air and until all the interstices between the stones are thoroughly filled with mortar. When deficiency of moisture is indicated it shall be supplied by sprinkling. Each batch must be puddled and properly in place before another batch is deposited in the forms. All exposed surfaces of finished and unfinished work shall be kept moist by sprinkling with water under pressure at short intervals. No walking or handling of materials on concrete is to be permitted until it has thoroughly and completely hardened, and all finished work shall be protected as may be necessary by canvas or plank. Layers shall be formed with square ends and not sloped or tapered.

FINISHING.

9. The concrete shall be placed by skilled workmen and all stones shall be well worked back from the face of forms by spading so as to produce a smooth surface and so that no stone shall approach the face of the work.

GROUTING.

10. When new work is joined to old work or to concrete already set, the joints shall be scarified and all loose materials on the surface flushed out of the forms with water under pressure, the surface then slushed with grout of neat cement, or if still wet from the washing with neat cement dusted on the wet surface, The surface must not be grouted or dusted unless concrete is to be immediately laid on it, the grouting in all cases to immediately precede the laying of concrete.

LAYING.

11. Concrete shall be laid continuously in so far as possible and each layer incorporated with the one previously laid.

Wherever it becomes necessary to place fresh concrete upon old concrete surface, the old surface shall be cleaned of all dirt, scum and laitance and thoroughly wetted and flushed before depositing the grout and fresh concrete.

JOINTS.

12. The construction must be as nearly nonolithic as possible, but if it is necessary to place the concrete in sections, key blocks in the form of an inverted truncated pyramid for ease of removal without disturbing the surrounding concrete, of proper size and arrangement shall be imbedded in the concrete where the work is stopped so that the joining work may later be properly connected to it. Vertical joints shall not be permitted in buttress walls or arch ring walls except as shown on the plans. The vertical joints in the buttresses where they are to be later joined to the new work for the completed structure shall be provided with the joining reinforcement as shown on the plans and shall also be provided with key blocks fastened to the vertical forms and imbedded in the horizontal portions of the steps to key the parts of the walls together.

CONSTRUCTION OF BUTTRESSES.

13. The buttresses and all walls are tapered uniformly from top to bottom to give the required thickness, and the wall is to be carried up with such lifts as are convenient, but in all cases must be left when ceasing work on a buttress wall so that the rear or down stream end of the wall is higher than the front by means of temporary boards placed across the forms to create steps or keys, each rising higher as the rear of the buttress is approached.

ARCH RING
CONSTRUCTION.

14. The buttresses should be built first or kept at least a good distance ahead of the arch ring construction, preferably completed to the full height after which the arch rings are built in place. The forms for the under side can be carried up to a considerable distance above the place where the work is being done or completed to the top of the completed buttresses, the walls then being placed by using panel forms for the outside forms, braced to the inside forms. The steel for reinforcing the arch rings should be put in place before erecting the outside panels where the walls are thin. The outside panel forms must be properly spaced from the inside forms to give the required thickness of arch walls at the various levels. All of these dimensions will be given in field drawings.

REMOVAL OF
FORMS.

15. Forms shall not be removed before the concrete is sufficiently set. Buttress forms shall in no case be removed while the concrete is taking its set, and in not less than 24 hours after placing, for buttress forms, not less than 12 hours for outside panel forms of arches, and for inside arch forms, not less than 7 days from the date of laying.

Reinforcing bars or net must not be jarred or moved while the concrete is taking its set.

FORMS.

16. All concrete masonry shall be built in place in wooden forms of sufficient strength, properly tied and braced together so as to be practically unyielding. The forms must have close joints and for outside walls of lumber dressed on the side exposed to the concrete so as to produce a smooth surface on all showing faces. The forms shall be coated with a heavy

oil before using, and where used over, as in the case of the panels, must be cleaned of adhering concrete before re-use.

All forms shall be thoroughly wet before placing concrete against them. The forms for the arch rings need not be of dressed lumber.

All concrete is to be dense and have a smooth exterior surface and any cracks or spalling shall be repaired.

EXPOSED SURFACES. 17. All exposed surfaces of concrete in the superstructure or that portion above the natural surface of the ground and exposed to view, shall be given special attention in laying in order to produce smooth surfaces in true planes uniform in structure and appearance. The corners of all finished edges as that of the strut tie beams are to be clipped by inserting a fillet in the corners of all forms for such parts of the work.

EXPOSED

REINFORCEMENT.

18. All exposed reinforcement, left protruding from the buttress walls must be coated with a grout of cement after the work is completed and before leaving the work, to prevent rusting by exposure to the elements.

DETAILED SPECIFICATIONS.

CONSTRUCTION.

BUTTRESSES.

1. Buttresses are to be built of 1:2½:5 concrete and shall be built with such lifts as are most convenient but at the termination of the pouring for any day the rear or downstream end is to be left higher than the front and proper keys provided in the wall at the point of cessation of work. The foundations shall be prepared by removing all spalls, fragments, chips,

shavings or any foreign matter of any kind from the bedrock, washing it clean with a hose under pressure, dusting the surface with dry cement or slushing it with cement grout as may be directed, and placing the concrete immediately on this prepared surface. The forms for the buttress bases at the foundation should be of a frame work of studs nailed to a plate to bring the top to a level to begin the use of the panel buttress forms, leaving the boards of the forms off at the bottom to permit the spread of the concrete to form the proper footing for the buttresses. At the end of each pouring, beveled wooden blocks of convenient size are to be imbedded in the fresh concrete by pressing down into it till they are flush with the top, which are to be removed before beginning work on the surface, the surface roughened and all loose material of any kind washed out of the forms, till the surface is clean, then grouted or dusted and pouring immediately commenced. The strut-tie beam forms shall be built at the same time as the buttress forms, and all steel shown on the detail drawings wired in place in them before pouring them. These forms must be braced firmly to the buttress forms to prevent sagging.

ARCH RINGS.

The arch ring waterface of the dam shall be built of 1:2:4 concrete placed very wet and very carefully placed. The cut-off wall is to be placed carefully in a trench of such depth as will place all of it in sound rock that is free from seams, the trench being perfectly clean before concrete is laid in it and the reinforcing bars shown on the reinforcement sheet, placed in it, bent to an angle to fit the slope of the arch ring wall at the point placed. The concrete in the cut-off wall is to be continued up and

constitute the base of the arch ring and is a part of it. The arch rings shall be cast in longitudinal lifts of about 6 feet, the wall being so provided with key blocks as to be continuous and have no longitudinal joints.

The inside forms are to be supported on liners cut to the required radius for the point placed all of which are given in the field drawings, these liners resting on the projecting ledge of the buttress. These liners are spaced 7'10" apart to make use of even length studs of 16 feet cut to fit between the liners, making a frame of studs upon which the $\frac{1}{2}$ x 6" boards are bent and nailed. Collar braces to stiffen the liners are put on at the time of erection, the liners being assembled to fit the required radius on a platform in the carpenter yard. The Clinton Mesh or other reinforcement acceptable to the engineer, is placed on the inside forms and separated from it by means of briquettes of mortar of such dimensions as to space it properly from the forms and in the proper place in the walls.

The outside forms are to consist of panels as shown on the detail sheet showing arch forms and details. These panels are to be held in place by means of dowel pins and over all a cable of light weight provided with turnbuckles and hooks at the ends to hold the row of panels in place, the ends of the cable fastening to wire loops placed in the filler of the buttress when the buttresses are poured. This arrangement obviates the tying of the outside form to the inside by means of wires left in the wall which are objectionable as cause of weeping leaks where the water follows them.

**STRUT-TIE
BEAMS AND
FOOT WALK.**

All strut-tie beams including the one used for a foot walk are to be continuous from end to end of the structure till they terminate in the bedrock at the ends into which the reinforcing rods are to be run and concreted in place.

The strut-tie beams are to be reinforced with rods running continuously through the buttress walls, from end to end and all of these are to be tied to the cross reinforcement placed in the buttresses at the junction forming roots to distribute the stresses in the buttresses. The beams are so spaced as to give the structure absolute rigidity. The strut beams are to be built at the same time and as a part of the buttresses.

FIELD JOINTS

Field joints in the arch rings shall be thoroughly roughened by picking and the feather edges of the top and bottom of the walls broken away and cleaned out before continuing the concreting. Great care must be taken to secure a tight joining between both inside and outside forms and old concrete at the top of lifts in order that no leakage of cement may take place at this joint, as it is essential that all surfaces, both inside and outside be as nearly perfect as it is possible to make them.

FINISHING

SURFACES. All surfaces in the interior of the dam, such as the under side, deck, sides of buttresses shall be made as smooth as possible by the use of close, well made forms, but no special finishing is required after forms are removed except that any rough or porous spots shall be thoroughly cleaned and filled with a mortar to match in color and texture the concrete and be floated over with a wooden float to resemble the remainder of the walls.

The outside surface of the arch rings shall be cleaned and painted with neat cement wash as soon as possible after the outside forms are removed.

OUTLET WORKS. The outlet works are to consist of a trash screen made of light railroad rails set into the concrete of the block of concrete constituting the bell mouth of the outlet pipes set on the arch in the reservoir, the rack being vertical to make it self clearing. The outlet pipes are to be of 12" lapwelded tubing, peaned at the upstream end and flanged to fit a standard butterfly gate on the downstream end. These pipes should be dipped in asphaltum, and repainted when in place in the structure. The butterfly gates to be of standard make for the required pressure, to have bronze vanes and flange bored to fit the flange on outlet pipe, the other side to be bored to fit the standard 12" valve gate to be placed in front of it. The valve gate to be provided with a short piece of pipe bent to form a choker, unless the pipe is connected to a main, in which case it is not needed.

CLEANING UP. After the work is finished, all materials, rubbish and debris shall be removed from the site, and the site cleaned up satisfactory to the engineer.

FIELD SERVICE. Field drawings of all parts of the works in such detail as to make all parts of the work plain, as well as instructions as to best and most economical methods will be furnished the contractor as required.

Ed Fletcher Papers

1870-1955

MSS.81

Box: 48 Folder: 1

**Business Records - Water Companies - Volcan Land
and Water Company - San Dieguito System - San
Dieguito Mutual Water Company - San Dieguito/
Pamo Dam - San Dieguito Dam Specifications**



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