Augmentation of Hatton Water Supply, by the construction of a new 600,000 gallon reservoir.

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Previous to 1934 the water supply of Hatton was obtained from a small reservoir in the Kotagala Forest reserve above the town.

This reservoir had an impounding capacity of only 112,000 gallons. This amount was found to be insufficient to meet the growing needs of the town satisfactorily, especially during the dry months of the year, January, February, March and April and it was decided to augment the supply. The manner in which the water supply of the town should be increased was very carefully considered.

Gaugings were taken during dry weather of the inflow into the reservoir and also at points below the reservoir at the confluence of minor streams with a view to ascertaining whether the yield was sufficiently greater down stream to warrant the consideration of providing additional storage by means of an impounding dam.

The observations did not establish the practicability of such a proposal also the situation and environments of Hatton do not afford any additional source of supply for augmentation. The solution of the problem therefore appeared to lie in conserving the surplus water available during the months preceding a drought. Although the mean annual rainfall of Hatton, for 35 years, is 143 inches, the fall in January and February is far from satisfactory. The conditions are sometimes aggravated by a poor rainfall in December.

Examination of the rainfall and run-off during the eight years December, 1920—November,
1928, indicates that periods of absolute drought occurred as follows:—

1921
Feb 2—March 8... 35 days
1922
Jan 12—Jan 26... 15
1923
Jan 27—March 1... 34...
1924
Jan 15—Feb 2... 19
Feb 4—Feb 19... 16
1925
Jan 16—Feb 3... 19
1926
Jan 7—Jan 22... 16
Jan 31—March 5... 34
1927
March 28—April 20... 24
1928
Feb 13—March 14... 31

Further examination of rainfall data shows that during the decade considered, dry periods with a total rainfall not exceeding one inch occurred as follows:—

1921
Jan.—March... 94"... 47 days
1923
Jan.—March... 99"... 47
1924
Jan.—Feb... 87"... 43
1926
Jan.—March... 39"... 39
1928
Feb.—March... 87"... 46

From the above observations it will be seen that in order to avoid any risk of shortage, the scheme should provide sufficient storage to cover the maximum period of dry spell recorded in the figures.

Considering the limited resources of the town and the necessity for some immediate augmentation the scheme approved at the end of 1932 was for an additional storage of only 600,000 gallons of water.

It was estimated that the average minimum yield from the stream during drought would be about 2,000 gallons per day.

Neglecting however, any yield from the stream during drought the two reservoirs would together form a reserve storage supply of about 700,000 gallons.

This would mean, provided the supply to the town is controlled, a reserve of 6 gallons per head per day for a period of about 47 days for a population of 2,500.

The control of the supply, however, is necessary as soon as the water stops spilling over the overflow.
Owing to the fact that the new system provides for collecting the whole of the water available from sudden showers of short duration instead of only a portion of it as in the old scheme it is probable that in practice the quantity available per head over the dry season will be increased.

**NEW STORAGE RESERVOIR.**

The reservoir is of the open type, with sloping sides. The internal size is 110' long × 94' wide at the top and 62' long × 46' wide at the bottom. Depth of water 16'. Capacity 600,000 gallons. The general arrangement of reservoir and pipe line is shown on the accompanying drawings. It was decided to construct the new reservoir on the slope above the balance tank close to the existing pipe line and to divert the water so that the normal flow would be through the new reservoir.

In order to control the supply a ball valve was fitted at the inlet chamber.

There is also another ball valve at the connection of the out-let pipe with the balance tank.

The slope of the reservoir sides is 1 4/5 horizontal to 1 vertical. This was decided upon as being the maximum at which the concrete could conveniently be laid without shuttering also in order that there should be no earth pressure at the back of the sloping sides.

No springs were encountered during the excavation.

Due to the sloping nature of the ground on each side, there would not be any upward pressure on the sides or bottom due to ground water.

The reservoir is lined with two thicknesses of concrete, the first 6" thick and the second 4" thick with 1/2" layer of asphalt in between. Each lining consists of a number of slabs or sections (average size 15' × 7') separated by asphalt joints 1/2" thick, the joints in the upper layer covering the joints in the lower layer (see sketch). Joints were put in to allow for the contraction of the concrete in drying out and also for expansion due to changes of temperature.

Taking the contraction due to drying out of 4:2:1, concrete as .0005 of the length, the number
of inches contraction due to drying out in a 15' slab = \(0.0005 \times 15 \times 12 = 0.09\)\.

The co-efficient of expansion per degree Fahrenheit for 4:2:1 concrete is \(0.00007\). Allowing for a range of temperature of 100\(^\circ\), number of inches expansion = \(0.00007 \times 100 \times 15 \times 12 = 12\)\.

From practical considerations the joints were made \(\frac{1}{2}\)\.

**EXCAVATION.**

The ground was first cleared of trees and a start made on the excavation.

Due to the sloping nature of the ground a good deal of excavation was necessary in order to level the site to the level of the top of the reservoir.

The site was then fixed so that the reservoir and the surrounding path should be on solid ground.

Much difficulty was encountered during the excavation due to the large amount of rock, met with—this was in the nature of large boulders surrounded by hard cabook and was very hard to break up.

The excavation was not taken down to the full depth at first but a trench was dug along the line of the outlet pipe to drain the surface water.

Both in the sides and in the bottom spaces were filled up with rough concrete (6:3:1), where inequalities occurred, and the sides were thus shaped to the correct lines and levels before the first layer of concrete was laid.

A paved stone drain was constructed along the upper bank of the excavation in such a way as to drain the surface wash and prevent this from running into the reservoir.

**CONCRETING OF FIRST LINING.**

After the sides had been trimmed and prepared, and pegs defining the finished levels of concrete placed in position, preparations were made to lay the first lining.

Great care was taken to ensure that the concrete should be properly graded and mixed so that a thoroughly water tight structure should be constructed. The aggregate was graded in the proportion of 3 parts of broken stone 1" to \(\frac{1}{2}\)" to one part of broken stone \(\frac{1}{4}\)" to \(\frac{1}{8}\).
The sand was best river sand. It was stacked on special platforms constructed with rough concrete (1: 12) and rubble sides. Precautions were taken to see that all materials were clean before using.

"Red hand" brand cement was used. It was transported to the site in paper bags. The paper bags proved very satisfactory and this was the most practicable method due to the steep nature of the approach.

The cement was not kept long at the site before being used and while it was there, it was adequately protected from the weather.

Mixing Platforms constructed of rough concrete (1: 12) were erected in various positions so that the distance for carrying the concrete should be as short as possible, the buckets containing the concrete being passed along from hand to hand.

The materials were thoroughly washed and graded through screens erected in convenient positions.

Separate gauge boxes were made for the sand and the cement. A pipe was laid from the stream to provide for a supply of water.

All the concrete was mixed by hand in the proportion of 4 parts of broken stone, 2 of sand and 1 of cement.

The unit was a bag of cement.

The amount of water used was about $5\frac{1}{2}$ gallons per cubic foot of cement.

This produced a concrete which was workable and suitable to the conditions under which it was laid.

Great care was taken during the curing to see that the concrete was properly protected from the sun and that it was kept wet for at least 21 days. Gunny bags were placed over the concrete and kept wet for this period, being constantly sprinkled with water. This was considered very important as the permeability for concrete kept moist during the period of curing is much less than that of concrete in which this precaution has not been taken.

The slabs were cast in alternate bays to allow sufficient time for setting before the adjacent slab was cast. Each bay was constructed in a continuous operation without any interruption.
In constructing the sides, it was found convenient to construct the hip blocks first, shape off the sides to the required slope, then construct the toe blocks after which the concrete slabs could be laid working from the bottom upwards. 8" x 4" strips of 4:2:1 concrete were laid under all the lower joints in the floor and the sides.

In each layer the four sides were cast in rotation and the bottom of the reservoir was constructed last.

**CONSTRUCTION OF ASPHALT JOINTS.**

\( \frac{1}{2} \)" wooden screeds were left in during the placing of the concrete so as to form joints between the slabs.

The screeds were greased and iron handles were attached so that they could be pulled out later.

The asphalt joints were constructed about one month after the concrete slabs were laid. The joints were dried and carefully cleaned out before the asphalt was poured.

Socony asphalt Grade 102 was used.

The asphalt was heated in a 60-gallon tar boiler to a temperature of 350° to 400° and placed in the joints by pouring from receptacles with V shaped spouts.

Fine sand was mixed in sufficient quantities to prevent the asphalt from flowing straight down the side and also to give substance to the mixture. Only just sufficient sand was added to form a plastic mixture.

The joints were constructed in three pourings, the jointing material, being consolidated firmly each time with an iron tool, care being taken not to damage the slabs on each side.

**INTERMEDIATE LAYER OF ASPHALT.**

After the first layer of slabs had been completed a layer of asphalt \( \frac{1}{2} \)" thick was spread over the whole of the inner surface of the reservoir to form an intermediate impervious lining between the upper and lower layers of concrete. Care was taken to see that the asphalt in the joints below was thoroughly pinned in. Delay was caused from time to time in the progress of the work due to rain. The surface of the concrete had to be
thoroughly dry as otherwise the asphalt would not have adhered to it.

This asphalt lining was laid at dry periods when rain was not likely to fall.

It was dried out without the addition of any sand.

**CONSTRUCTION OF SECOND LINING.**

The second lining of concrete slabs was now laid. The thickness of concrete being 4" and the mixture the same as that for the lower layer, *i.e.*, 4:2:1.

A feature of the construction was that the lines of asphalt joints in the upper layer should not occur immediately above those in the lower layer at any place in the reservoir.

As in the lower layer, the slabs were cast on the alternate bay system and each bay was constructed in a continuous operation.

The joints for the second lining were formed by means of asphalt joints 2\(\frac{1}{8}\)" thick finished with cement concrete joints (1:4), 1\(\frac{1}{4}\)" thick.

A concrete kerb 1'6" wide and 1'6" above ground level was constructed along the top of the reservoir.

**INLET ARRANGEMENTS.**

A Y connection was made with the existing 5" pipe line and a new 5" C.I. pipe line was laid to the inlet chamber.

Details of inlet are shown on the drawings.

A stop cock is provided at the entrance.

The inlet chamber is divided into two portions by a dressed stone baffle wall 6" thick and 1' 9" high.

The inlet chamber cover is formed of precast concrete slabs 4" thick. Dressed stone linings are provided for the floor of the baffle chamber also for the sill.

A 5" equilibrium ball valve is fixed in order to control the supply.
OUTLET ARRANGEMENTS.

The detailed arrangement is shown on the drawings. The walls of the outlet chamber were constructed of coursed stone masonry in cement mortar with the interior joints pointed.

The portion of the reservoir slab suspended over the chamber was constructed in two thicknesses—the first being a reinforced slab 12" thick and the second plain concrete 4" thick. There were no joints to the lower layer and this was constructed in a continuous operation. Joints were provided in the upper layer. For the top 2" of the upper layer, pudlo was mixed with the cement in the proportion of 5 lbs., of pudlo to 100 lbs. of ordinary cement. The delivery pipe and the washout pipe are controlled by stop cocks in the outlet chamber. There is a manhole at the top and iron steps are provided down to the interior of the Chamber.

Both the delivery and the washout pipe lines were constructed with 6" C. I. pipes. A 6" ball valve was fixed to control the supply at the entrance of the delivery pipe to the balance tank.

WASHOUT.

A 6" C. I. washout pipe was arranged so as to empty into the stream.

When it is required to clean the reservoir, the supply to the town is deflected so as to run through the original 5" pipe.

There is thus no interruption of supply to the town while the cleaning is being done.

The bottom of the reservoir is sloped towards a central drain 18" wide running down the middle.

OVERFLOW.

An overflow pipe constructed with 9" C. I. Pipes was arranged as shown on the drawings.

CONTROL OF SUPPLY.

The supply is to be controlled by means of a Guest and Chrimes automatic recording turbine meter.

From the daily observations marked on the recording drum of this meter, the supply can be carefully controlled.
COST.

The original estimate sanctioned was for Rs. 34,000.00. Due however, to certain modifications in the design, the large amount of rock met with in the course of excavation and the provision of an improved type of recording meter, application was made and sanction was obtained for the expenditure of a further amount of Rs. 3,900.00.

Considering the capacity, the cost of this reservoir is very reasonable in comparison with other types.

GENERAL.

The approach to the reservoir is very steep and all the materials with the exception of the aggregate had to be transported by hand to the top. Temporary buildings (a store and an office) were erected close to the reservoir and careful records were kept showing the progress of the work from day to day.

Delay was often caused during the construction due to the wet weather experienced.

The reservoir has now been in use for some months and, from the tests carried out it has proved very satisfactory. The design was prepared in the Head Office and is the first of its type in Ceylon.

In conclusion my thanks are due to Mr. S. Mahadeva, in charge of the P.W.D. Designs Branch for reading over this paper and making various suggestions, also to Mr. W. J. Thornhill, Director of Public Works, for his kind permission to have access to official records.
HATTON WATER SUPPLY

DETAIL OF INLET

TYPICAL DETAIL OF KERB & BLOCK

TYPICAL DETAIL OF TOE BLOCK ETC.

ELEVATION SHOWING FIRST AND SECOND LAYERS OF CONCRETE.