A brief history of the Cruz Milagre Dam compiled from the records of the Chief Engineer's office -

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G.O. No. 2967 dated 19th September 1868

In September 1868, when passing orders on a report submitted by the Consulting Engineer for Railways on the general question of the extension of the railway system in this Presidency, the Government remarked that "the recent action of "the sea near Cochin and the protective "measures which have in consequence "been rendered necessary suggest the "propriety of a deliberate professional "opinion being obtained on the capabilities "of the Cochin backwater as a harbour, "and the value and prospects of that "port, as well as of the anchorage

"at Naraikal." The Government accordingly requested the Master Attendant of Madras, the Consulting Engineer for Railways, and Mr. Anderson, Chief Engineer of the Madras Railway Co., "to investigate the present circumstances "and future prospects of the port."

2. The report of the Committee thus appointed was submitted in December of the same year, and among other matters, the "Cruz Milagre Gap" near Cochin was reported on. In 1862 the sea, which had for some years been making gradual inroads upon the coast to the north of the town of Cochin, broke through into the backwater at a point called "Cruz Milagre" (or the Miraculous Cross, from a church of that name which formerly stood there but which had been submerged) about a mile and a quarter to the north of the Cochin channel, and the gap then formed, though it had varied in size from year to year, had never been closed.

3. When examined by the Committee the width of the gap was nearly 300 yards and the depth of the water at low tide exceeded twenty one feet in some places. The Committee recorded their unanimous opinion that there could be no question "as to the danger with which the "very existence of the port of Cochin "is threatened so long as this gap "remains open." Although the depth of water in the greater portion of the

Cochin channel and inner harbour had not been affected by the gap, nor had there been any sensible diminution of water over the bar, the effect of the escape to the sea through the Cruz Milagre Gap, of a large volume of water which would otherwise have contributed its force to scour the Cochin channel, had become manifest by the gradual silting up of the southern margin of that channel. The Committee therefore urged the necessity of at once closing the Gap in the manner suggested by Mr Dalrymple, the Master Attendant of Madras, viz: by the construction of two groynes,

× old mouth of the back water.

one being run from the north and the other from the south side of the Gap.

5. In submitting the Committee's report for the orders of Government, the then Secretary to Govt, P.W. Dept, Colonel Orr, remarked that it appeared to him very doubtful whether groynes placed as recommended would effect what was expected of them to the extent of causing a sufficient accumulation of sand to close the gap. He thought that they would only make the opening tortuous and deeper - to say nothing of the cost of the groynes which would be heavy.

6. Colonel Orr considered that an attempt should be made to accomplish

the desired object in the manner practised in Tanjore and other localities for closing breaches in rivers and channel banks by means of "modussils" made of palmyra or cocoanut trees, and by brushwood, grass and earth.

7. In disposing of the Committee's report the Government accepted Colonel Orr's recommendation and directed that "before adopting the more "costly expedient of constructing stone "groynes, the simple and inexpensive "method by which breaches in river "and channel banks are closed in "Tanjore by means of modussils should "be tried."

(G.O. No. 453 dd 11th February 1869.)

8. In October of the following year an estimate amounting to Rs 31,500/- for closing the Cruz Milagre Gap in the manner above mentioned was sanctioned, and the Cochin Sirkar shortly afterwards consented to contribute towards the cost. The work was commenced, but in January 1871 the Government were informed of the arrival from England of an Engineer who had been deputed by the Secretary of State to examine and report on the harbours of India. It was therefore directed "that all further outlay on the operation "of closing the Cruz Milagre Gap "be suspended until Mr. Robertson, "the Harbour Engineer, has had an "opportunity of inspecting that gap "and of affording the Govt the benefit "of his advice."

(G.O. No. 2543 dd 25th October 1870)
(G.O. No. 2767 dd 17th Nov 1870)
(G.O. No. 147 dd 19th January 1871)
(G.O. No. 587 dd 28th July 1871)

9. In the following April Mr. Robertson communicated his opinion that the Gap might be closed without much difficulty and at little expense by throwing out a groyne from the inner northern angle of the gap so that the current might be diverted sufficiently to cause comparatively still water in the opening. This, Mr. Robertson thought, would allow the natural action of the sea and the incoming tide to do spontaneously what could only be accomplished artificially at a great expenditure of labour and money. He considered that the sand brought in from seaward would soon diminish the

April 1871.

the depths of the breach sufficiently to permit of its being finally closed by manual labour.

10. The Government thereupon directed the Supty Engineer, Malabar, to put the construction of the groyne in hand, and to take the necessary steps for protecting the opposite angle of the Gap with a revetment of stakes and stones. It was observed that the groyne need not be formed entirely of stone but could be constructed of stakes, leaves or grass and clay strengthened, if necessary, with loose stone.

11. In June 1871, the Supty Engineer submitted an estimate for the work amounting to Rs 8662-8-6, which was

sanctioned by Government although the Chief Engineer reported that he could not feel at all confident that the groyne would produce all the good effect that was expected of it.

G.O. No. 867 of 12th June 1871.

12. The work was however commenced but it was soon found impossible to face the strong current running through the Gap with a groyne constructed of the "temporary" materials enumerated by Government. The Supty Engineer therefore submitted a revised estimate of Rs. 24,824, for a substantial stone groyne which received the sanction of Govt in December 1871.

G.O. No. 3055 of 4th Decr 1871

13. In May 1872 the Supty Engineer reported that the groyne had been ~~extended~~ to a length of 115 feet seaward × and that although it was an experimental one he had every hope of its terminating successfully. He submitted a further estimate amounting to Rs 15,277 for the extension of the groyne for 80 feet and for strengthening the southern bank. The Supty Engineer remarked "It would be a pity after "incurring the heavy expenditure that "has already taken place that the work "should fail thereby from want of further "funds."

× See Mr. Grimes's Sketch

14. The Government were however of opinion that it was too late in the season to make any further attempt to close the gap as river freshes might be expected shortly, and therefore directed that the estimate lie over until fresh observations had been taken after the monsoon.

G.O. No. 1125 of 2d May 1872.

It was therefore necessary to construct an artificial base from which the second sandbag groyne could be projected and this was done by laying a return of sand bags - 55 feet in length - at right angles from the head of the groyne running seawards. The second sandbag groyne was then constructed, but precisely as the anticipated effect of the first sand bag groyne fell short of what was realised by the experimental stone groyne so the anticipated effect of the second groyne fell short of what was realized by the first sand bag groyne. 18. Notwithstanding this the District Engineer reported in his letter of the 28th April 1873 that he had great hopes that when the third sandbag groyne was completed, the work of closing the gap might not improbably settle itself without any further assistance.

19. With regard to the financial aspect of the question at this stage it should be stated that out of the Rs 15,277 sanctioned by Govt no less than Rs 7,309 had been expended in protective works to the Gap and for maintenance during the monsoon of 1872, thus leaving Rs 7968 only for effecting the actual closing of the Gap by means of echelon sandbag groynes. This sum, the District Engineer reported, had been largely exceeded already although the work had not approached completion. The first two returns & the second groyne groyne had cost respectively Rs 5860, Rs 1,330 & Rs 8,400 or in all Rs 15,590.

20. From the foregoing data it was calculated that the second return would cost Rs 3,300 and the third groyne Rs [illegible]

but there were large contingencies to
be provided for and the District Engineer
was of opinion that the work would be
completed for Rs 15,000, which added to
the Excess Expenditure already incurred
brought the total to Rs 22,550. This
was the amount required for finally
completing the work.

21. In passing orders on the District Engineer's report, the Government remarked, ~~that the project had been jeopardised by needless delay in acting on the sanctions accorded by the Govt.~~ ~~The Government believed~~ that the sand bag groynes en echelon had proved practically more Expensive and less efficient than would have been a sand bag dam directly across the Gap, and directed that on completion of the

G.O. No. 1323 of 13th May 1873.

second Sandbag return sandbags should be deposited in a direct line between its end and the nearest point of the opposite shore so as to shallow the gap as quickly and directly as possible. The Govt could not specially appropriate funds to cover the Excess Expenditure incurred, and the question of the provision of Rs 15,000 stated to be necessary for the completion of the work would be considered in the Financial Department. The required amount was allotted in the following month.

G.O. Financial No. 830 dated 13th June 1873.

22 Immediately on receipt of G.O. No. 1323 of 13th May 1873, Col: Farewell, who had meanwhile been promoted from Supdg Engineer to Supdg Engineer for Ports and Communications, took upon himself the responsibility

the Dam across the Cruz Milagre Gap.
The Dam was completed to two feet
above low tide level by the 25th June
or within a month and a week.

It was not perfectly watertight
but the leaks were ~~being~~ stopped as
discovered. 23. Col. Farewell did not
24 propose to protect the Dam by a rough
stone revetment inside the backwater
as he hoped that at least eight or
nine* feet of clay would silt on in
front of it by which means the toe
of the Dam would be well secured.
Fresh sand bags were to be added
where required to protect the contents
of the old bags when they commenced
to rot. It was hoped that with
due care the front of the Dam would
be silted straight across within

* This silting has not occurred.

two months.

25. In reporting the satisfactory completion of the work, Col: Farewell stated that the total cost of closing the Gap (876 feet in width) including maintenance and all expenditure from first to last amounted to Rs 83,827. The actual cost of the Dam alone was Rs 24,614, and of the entire work as completed Rs 59,230, while establishment, contingencies &c cost Rs 24,597. Of this sum a certain portion was defrayed by the Cochin State, the closing of the Gap being one of the "Coast defensive works" towards the cost of which the Cochin State contributed Rs 30,000/-,

No 2138 dl
27th August 1893

26 In their order marginally noted the Govt remarked that the cost of

closing the Cruz Milagre Gap had been considerable, but the experience gained at such cost would enable similar operations to be carried out in the future with certainty and comparative economy. To Col. Farewell's energy, perseverance and ready resources the Govt attributed the successful result of operations which at one time threatened to come to a stand still.—

In October 1873 and January 1874 two sums of Rs 10,000/- each were transferred to meet the expenditure incurred in closing the Gap. { G.O. No. 2649 dd 30th Octr 1873. G.O. No. 87 dd 13th January 1874.

27. In December 1873, a revised estimate for the work amounting to Rs 72,310 was submitted for sanction. The excess was owing to the Dam having sunk considerably, and Col. Farewell reported that he had authorised the District Engineer to thoroughly secure the Dam by adding sand slopes outside the sand bags. The revised estimate was as follows:—

Total additional amount required for strengthening the Dam	Rs 10,080-6-3
Amount actually expended on the work before the original estimate was submitted - but which was inadvertently omitted	" 2,999-9-9
Amount of original estimate	" 59,230-"-"
Total Rupees	72,310-"-"

28. In dealing with this estimate, the

Government observed that the omission of Rs 3,000/- from the original estimate was most unsatisfactory, and directed Colonel Farewell to adopt measures for promptly ascertaining which of the estimates was really correct, and to account for the discrepancy of rates in them. The Government were not satisfied in regard to the constant expenditure that was going on in connection with the work. It was reported to be impossible to say what further sums would be required. Such doubts must be put a stop to and the Govt therefore directed the taking of periodical sections across the Dam for the purpose of ascertaining whether

{ G.O. No. 353 of 14th Feby 1874.

any natural accretions of sand or clay were forming on either side of it. All further outlay on the work without previous sanctioned Estimate was absolutely prohibited. In conclusion, the Govt transferred from various other works sums amounting in all to Rs 25,000/- to cover outlay incurred but not provided for.

29. In March 1874, the Inspecting Engineer submitted an estimate amounting to Rs 2800 for facing with rough stone the inner slope of the Cruz Milagre Dam where such protection did not already exist. In noting on the estimate the Chief Engineer objected to the work as its necessity had not been proved. He pointed out that the work was quite inconsistent with

sections taken after the estimate had been framed. In reply the Inspecting Engineer reported that the proposed work was not absolutely necessary, and the estimate was withdrawn. 30. He submitted a bill amounting to Rs. 515:15:5 being the actual expenditure on maintenance during the last quarter of 1873-74. The bill was passed by Govt. with the remark that care should be taken that no abuses were allowed to creep in unnoticed in connection with the work which, valuable as it was, had cost a much larger sum than had been anticipated or could be spared. 31. The Govt. desired that the action both of the sea and backwater on the

{ G.O. No. 1315 d/ 16th May 1874.

Dam during the approaching monsoon should be carefully watched and precautions taken for guarding against damages from either quarter.

32. At the time the foregoing order was passed the Government had under consideration the Inspecting Engineer's reply to G.O. No. 363 dated 14th February 1874 - offering Explanations in regard to the discrepancies in the estimates for closing the breach Milagre Gap. The discrepancies were reported to be due to the actual Expenditure incurred having been taken from progress reports,

from which the amount in question (Rs 3000/-) had been omitted by a mistake in transfers, instead of from the station books.

33. In the following month a sum of Rs 1000/- was allotted for emergent repairs to the Dam pending the receipt of a regular maintenance estimate; and in July attention was again called to the necessity for carefully watching and maintaining the Dam. Shortly before this the Resident of Cochin had been asked by the Inspecting Engineer to cause the Cruz Milagre Ferry to be disused and the Dam used for foot traffic instead, the passage of cattle being prohibited. This was satisfactorily arranged and duly reported to Govt.

{ G.O. No. 1714 dy 25th June 1874.

{ G.O. No. 1792 dy 4th July 1874.

Endorsement No. 126 dy 15th Sept. 1874.

34. In March 1875 an estimate of Rs 1000/- for repairing and maintaining the Dam was submitted but on the representation of the Chief Engineer the proposed repairs were modified resulting in a reduction of the estimate by Rs 200/-. The Govt. sanctioned a sum of Rs 800/-" for carrying out so much "of the precautionary measures recommended by Mr. Harris as are "approved by the Chief Engineer."

G.O. No: 835 dy 24 March 1875.

35. In November 1875, the District Engineer, Malabar, submitted a survey, plans and sections of the Cruz Milagre lagoon bank and beach with soundings accompanied by a very

satisfactory report. The District Engineer was of opinion that the reformation of the river banks and beach on the south was due entirely to the successful closing of the Cruz Milagre Gap. Among other improvements reported may be noticed the fact that at low tide there was a foot more water over the bar at the mouth of the Cochin Harbour than there had been during the preceding year. The Government ordered the report to be recorded "with the renewed "Expression of the satisfaction of H.E. the "Governor in Council at the success "with which the operations of closing "the Cruz Milagre Gap and guarding "against erosion of the coast at Cochin "has been attended."

{ G.O. No. 3450 dd 6th Decr 1875.

36. In March of the following year × 1876

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an estimate of Rs 705 for the maintenance of the Dam during 1876-77 was submitted by the District Engineer with the remark that although the actual expenditure would probably not be so much, he strongly recommended that the full amount asked for should be sanctioned in order that he might be prepared with funds to meet any emergency.

37. The Chief Engineer, however, was unable to support Mr Harris' recommendations. In a memorandum dated 6th April 1876, he again deprecated "the constant tendency on the part of "the Malabar Public Works officers "to exaggerate the cost of maintaining "the Cruz Milagre Dam." He pointed out that he had already disproved the necessity of the work for which an

estimate of Rs 2,860 had been submitted in 1874; that he had been compelled to cut down the maintenance estimate for 1875-76 from Rs 1000/- to Rs 800/- and that he had protested against the petty estimates proposed in 1874 as excessive. He considered that if a sum of Rs 500/- was placed at the disposal of the District Engineer for the maintenance of the Dam during 1876-77 it would be sufficient. The Government agreed with the Chief Engineer and Rs 500/- were allotted accordingly. This was in April.-

{G.O. No 939 of 10th April 1876.

38. In July following a retrospective estimate for work done on emergency in repairing damages at the Dam and for measures taken for its preservation was submitted by the District Engineer with the remark that the provision of funds applied for was quite independent of the grant of Rs 500/- for maintenance. As there was no balance left with Government from the Provincial reserve, and as the repairs carried out were to prevent deterioration of the Harbour of Cochin, the P.W.

{G.O. No 1775 of 12th July 1876.

Dept requested the Financial Dept to consider whether "the cost of "maintaining the integrity of the "seabeach at the site of the Cruz "Milagre Gap should not be "defrayed from Port Funds."

39. The Financial Dept evidently did not approve the proposal for in March 1877, the estimate, which

amounted to Rs 1000/-, was sanctioned and funds were allotted under Provincial G.O. No. 916 dt 17th March 1877. G.O. No. 441 dt 7th February 1877.

40 In the following month, an estimate of Rs 485 for maintaining and repairing the Cruz Melagre Dam during 1877-78 was sanctioned with the remark that "as the maintenance of "the Dam is essential for the safety "of the Port of Cochin, the present "and all future expenditure should be "defrayed from Port Funds." G.O. No. 1216 dt 9th April 1877

41. About this time the Master Attendant of Madras visited the ports of Cochin and Calicut, and among other matters he reported on the Cruz Melagre Dam and the lagoon that had been formed by it.

He considered that the question of the ever recurring estimates for the maintenance of the Dam might be settled in perpetuity by filling up the lagoon from the sea shore. He thought that the ground thus made would be very valuable and soon pay expenses. It was necessary something should be done as the lagoon had increased in area and depth since he last visited Cochin in 1874. 42. The Govt thereupon directed the District Engineer to report on the subject, and he accordingly submitted a survey and sections of the lagoon, with an expression of his concurrence in the Master Attendants' suggestion that it would be advisable to fill up G.O. No. 624 dt 22nd August 1877

the lagoon, or a part of it so as to
strengthen the Dam. The matter was
dealt with by Government in connection
with the general question of the
conservation of the Cochin Harbour
Entrance, and the Collector of Malabar
was directed to communicate with
the Resident in Travancore (Cochin) in view
to the relinquishment to the British
Govt of such extent of the sea
beach as was needed for the
conservation of the Harbour Entrance.

G.O. No 871 W dt 21st July 1878.

43. In May 1878 an estimate of
Rs 484 for maintaining the Dam was
sanctioned, and the District Engineer
asked to report whether any portion
of the lagoon had been filled up.

G.O. No 2341 W dt 31st May 1878.

He replied that no action had
been taken in the matter, and
submitted an estimate of Rupees
3,260/- for widening the Dam to
50 feet at the top with slope
of 3 to 1 by which the principal
object - the security of the Dam -
would be effectually obtained and
the deep part of the lagoon
in its immediate vicinity be
partially filled up. The District
Engineer considered that the
filling up of the remainder of the
lagoon might be left to nature
as it would surely though perhaps

slowly completely silt up. The
Government sanctioned the — {G.O. No. 3217 W dt 12th Augt 1878.
estimate, subject to the necessary
provision being made from —
Port Funds. This was done in {G.O. No. 3682 W dt 19th Sept 78.
September 1878.

44. There is nothing further on record
in connection with the Dam until
August 1880, when an estimate of
Rs 285 for petty repairs was —
submitted. This was sanctioned {Marine G.O. of 16th Sept 1880 No. 468.
in September from Port Funds. —

In March 1881 a sum of
Rs 900 was allotted from Port Funds for
of the lagoon Dam. This was {G.O. No. 821 W dt 25th March 1881.

G.O. No. 978 W dt 12th April 1881. } subsequently reduced by Rs. 35/-.

145. On the 1st August 1881, the Govt
G.O. No. 1883 W approved the undermentioned arrange-
-ments which had been proposed by
the Supty Engineer for future
guidance in connection with the
Cruz Malaga Dam and groynes at
Cochin:—

(a) That the Dam, Groynes &c. should
be in the charge of the Port
Officer at Cochin, who should,
under the Marine Dept., carry
out all necessary repairs to them
which did not exceed Rs 1000/-,
and even repairs exceeding
that amount under special
arrangement.

(b) That the P.W.D. should, when

called on, give their advice regarding the repairs &c and should also occasionally inspect the works, and, if necessary, report on their state and recommend any action they considered necessary.

46. During the same month the Financial Dept. were asked to allot Rs 24/- from Port funds to meet the pay of a maistry employed on certain repairs to the Dam. Within a week of this, the Suply. Engineer brought to notice that the Port officer at Cochin was of opinion that the eastern side of the Dam required further protection as the shingle revetment had sunk below high tide level and consequently the earth was being gradually washed away. The Port officer recommended a permanent protection of stone pitching or shingle, and the Executive Engineer was directed to prepare an estimate for the thorough repair of the Dam. In the Marine Dept. the matter was brought to the notice of the Master Attendant and he called upon the Port officer to submit an estimate for the substantial repairs that he had proposed.-

G.O. No. 1782 W
dt. August 1887.

G.O. No. 1987 W dt. 12th Augt. 1887.

G.O. No. 422 W dt. 29th Augt. 1887.

47. The question of the incidence of the charge of maintaining the Dam in good repair having been again brought forward and it having been represented that the Cuz Malaipe Gap was closed in the

interest of the port of Cochin, Sir
for increasing the scour on the Cochin
bar, the Gut. directed that all
such charges should be debited to
Port Funds.

{ G.O. N. 2226 W d/
8th Sept. 1881.

48. In September 1881 the Master
Attendant submitted two estimates
prepared by the Port officer, Cochin,
for the repairs previously recommended.
one estimate provided for the use of
stone boulders and amounted to
Rs 1250/-; the other for shingle
at a cost of Rs 538-8-0. They
were permitted to lie over
pending the receipt of the
estimate which the Supdg Engineer

to submit. This came to hand in
March 1882, and amounted to Rs 1350.
After due consideration the Gut.
accepted this latter estimate and
funds as per margin were allotted for
the work from Port Funds.

Works .... 1350.
Establt. ... 310
Tools & Plant 34
1694

+ G.O. N. 737 W d/21.3.82.
" " 1082 W d/1.5.82.

49. The next paper on record in
connection with the Cruz Milagre
Dam is a note by the Chief Engineer,
(Major General Sankey) dated 16th
February 1883. Having been at Cochin
in the early part of the month, the Chief
Engineer took the opportunity to examine
the works at the Gap. These he
found in fair order and in the memorandum
referred to said:- "From information
"on the spot it would seem that on the
"settling in of last monsoon the gneiss

"after reducing the sand spit in front
"to some 90' in width bowled freely
"over at high tide and caused a rather
"heavy wash against the east face
"of the bund, flattening the slope on
"that side.

"It would be well to have the edge
"of the revetment of the bund on this
"side dealt with in the same way
"as the west, i.e. with larger material,
"and again that the whole of the
"top of the bund should be covered
"with "rabbit wire" to hold better
"together the sandy surface.

"A few small trees in themselves
"perhaps harmless have been allowed
"to grow on the top of the bund
"and should be cut away, and all
"kept quite clear of trees as the roots
"may displace the stones of the revetment.

"I could not well ascertain whether
"any erosion is going on the side of
"the backwater during flood, and
"think it will certainly be necessary
"to have a sufficient number of
"cross sections taken and recorded
"after every monsoon so as to help
"future reference on this point. The
"sections should extend to 60' or 80'
"on both sides of the bunds, and
"embrace the whole width from earth
"to earth. They should be regularly
"submitted yearly to the Chief
"Engineer." These remarks were
communicated for the information
and guidance of the Supty Engineer.

No. 460 C dl
21st July 1883

In June 1883, a sum of Rs 25 was allotted from Port Funds for survey operations; and in November of the same year the Supty Engineer submitted for sanction and allotment of funds, an estimate, amounting to Rs 1920, for revetting the west or lagoon side of the Dam, and covering the top with "rabbit work" in the manner directed by the Chief Engineer in his memo: above quoted. The estimate was sanctioned for early execution, and the necessary allotment made from Port Funds.

{G.O. No. 1805 W dy 26th June 1883.
{G.O. No. 1982 W dy 16th July 1883.
{G.O. No. 3477 W dy 4th Dec: 1883.
{G.O. No. 725 W dy 17th March 84.

In December 1884, the Chief Engineer reminded the Supty Engineer {No. 2096 Cdl 15th Dec: 1884.
that the cross sections of the Dam had not been taken, and asked that when submitting them the Supty Engineer would submit a brief report on the work executed at the Gap, and upon its then state.

In his reply dated 12th February 1885, Colonel Beatty reported that the cross sections had been regularly taken and recorded, but by oversight they had not been submitted to the Chief Engineer. He therefore sent copies of three for 1883/84, and stated that the works ordered by General Sankey had been fully carried out. The Ex: Engineer had reported at the end of the preceding months that the Dam might

"perfectly safe," but as the sections showed a tendency towards the deepening of the river bed on the side of the backwater the Executive Engineer recommended that rough stone be dropped in and allowed to take its own angle of repose. The Safety Engineer considered that to prevent the toe of the revetment on the backwater side of the Dam from slipping, about two cubic yards of stone per running yard should be dropped in along the toe of the revetment. It was at the same time grow out that the lagoon was ad would be being gradually

filled up by silt brought in through the escape by the river floods, and also by drift sand from the seabeach.

In regard to the cost of the work upto date, the Safety Engineer furnished the following figures:—

Original cost of Dam according to accounts of 1870 to 1874	Rs	1,07,408
Cost of widening it in 1878	"	3,219
Cost of revetting it on the lagoon side in 1883-84	"	1,871
Repairs as follows:—		
1874-75	"	999
1875-76	"	571
1876-77	"	1,466
1877-78	"	252
1880-81	"	338
1882-83	"	1,360
Total	Rs	1,17,484

furnished by Safety Engineer. to be considered

In passing orders on the Supty Engineer's letter the Govt directed that the necessary steps should be taken for the early execution of the work recommended by the Ex. Engr. In June 1885 the Master Attendant heard from the Port Officer, Cochin, that an erosion of the beach had taken place near the Dam, and that the revetment had sunk in some places. The Supty Engineer was thereupon directed to take the necessary action immediately. Before the order reached him the Supty Engineer had submitted the

G.O. No. 605 W dt 13th March 1885.

G.O. No. 1523 W dt 30th June 85.

estimate called for in G.O. No. 605 W dated 13th March 1885 for protecting with rough stone the toe of the backwater slope of the Dam. The estimate, which amounted to Rs. 2190 was sanctioned by Govt in July, and the necessary grant made for the work from Port Funds.

G.O. No. 1613 W dt 13th July 1885.

G.O. No. 2006 W dt 31st Augt 1885.

It having been reported by the Supty Engineer that the planting of cocoanut trees on the lagoon side of the sand bank that lies between the Cranganore Dam and the sea would greatly tend to strengthen the bank and protect the Dam, the Political Dept addressed the Cochin

Govt. on the subject. In reply the Cochin Govt. stated that there was no objection to the measure but it was desirable that the land should be parcelled out to different persons who would expend capital and who were either natives or permanent residents of the State. It was requested that arrangements might be made for the payment of rent for the land.

The Supty Engineer was thereupon authorised to arrange to let [illegible] para bank for cocoanut Supty — and to dispose of the

G.O. No. 2245 W dt 28th Septr 85

revenue derived therefrom in the manner suggested by the Cochin Government.

56. The latest cross sections of the Dam were taken on the 15th & 16th May 1885; they were submitted to Govt. by the Supty Engineer in August last. They show that the lagoon is silting up gradually, and that there is a slight scouring action going on at the backwater face of the Dam. If this continues it will become necessary to specially protect the Dam on the backwater side.—

G.O. No. 2614 W dt 5th Nov. 1885.

P.J.O.

SUPG: ENGINEER
NO. 1131
18 DEC. 85
P. W. D.
FOURTH CIRCLE

Enc: 1

The expenditure upto the End of 1883 as shown by the Supg Engineer amounted to Rs: 1,17,484. and since then an estimate of Rs: 2190 has been sanc. tioned which brings the total upto Rs: 1,19,674; or including contingencies for 1883/84, and 1804/85. Rs: 1,20,000. in round numbers.

HB.
9.12.85.

23. The following Notes from Memory showing the method adopted in closing the gap have been furnished by Mr. J. Grimes, now Executive Engineer, Madura:—

I I was Assistant Engineer, 2d grade in charge of the West Coast Canal Range 1872-73, consisting of Cochin Harbour Works, and Canal from Cochin to Tirur.

II. The bush and pile groyne was started under the immediate supervision of Vedamuthoo, Overseer 1st grade (since deceased). About 50 feet long was done, The cocoanut piles which had been driven into the bed of the back water bout 8 to 10 feet deep were scoured clean away by the first fresh.—

III. The stone groyne* a, answered very well. It was composed of large stones from 1 to 2 tons in weight which were brought on Jungárs (2 boats lashed together with a platform of bamboos). The stones were lifted out of the jungárs by a 5

ton

* See sketch accompanying

tow crane, and deposited on carts specially made for such heavy work. The carts were pushed along a tramway of wooden sleepers and mangoe planks, and the stones were rolled off where required.

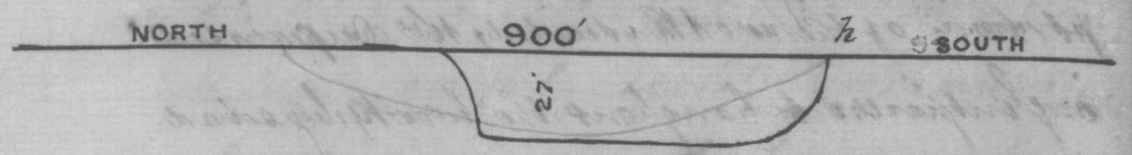
IV. As the stone groyne was advanced, it was found that the sand on the sea side formed behind it. Then a double row of sand Bags were placed as per dotted lines, the water being shallow; and the new beach, thus protected, was quickly raised by drift sand, &c.

V. The experience gained from this portion of the work, decided the Superintending Engineer to carry out the work by sand bag groynes "en echelon", and returns as shown in sketch attached, and this system was sanctioned by Government.

VI. After the completion of groyne a and its return (b), the work had to be maintained during the monsoon of 1872. The bottom of the gap was lined with one layer of sand bags to prevent its deepening and the south bank was pitched with large stones

stones.

VII. It was found that the tides ran in and out about every 5 or 6 hours at the rate of from 4 to 5 miles an hour as measured by me with a current meter; the action of the sea pushed sand in by the flow, but the ebb carried it away again except the portions shown in the sketch which were covered by the groynes; the natural waterway of the gap did not however appear to diminish, only the shape of the section changed thus; and it did not get deeper:-



References.

Red Former section.

Black The sections after the groynes were made.

A great quantity of stone was rolled in on the south side, as this point had to be held at all risks.

VIII. The large stones cost about Rs: 2

a

a ton, or Rs: 3„12„0 per Cyd: ; each large stone being measured separately as delivered, the small ones in the heap at Rs: 1½ a ton. The sand bags were the best procurable, mostly new, and cost 4 annas each and about 1 anna for filling with sand, sewing up and depositing in the work.

IX. The sand bags were loaded on the carts aforesaid and were pushed on a tramway and shot off from the tail of the carts on to sloping planks from which they slid into their proper places. The tramway was carried over the new beach on short piles to keep it above high water until it reached the groynes; Sand Banks were made under the piles to keep out the sea water.

X. All the materials were got from suppliers and the work was done by daily labour; Sometimes as many as 1000 coolies a day being employed; their minimum rate was 4 annas 10 pies a day; they used to get 5 annas: but this reduced with great difficulty.

XI. About the 15th May 1873, the groyne and return were completed; and the Superintending Engineer having arrived on 17th, the dam was commenced on 20th.

XII. Stout posts were fixed on the north and south sides of the gap and from them a hawser (thick rope) was stretched across; it was supported in the centre on two large boats (about 10 tons each) which were moored head and stern. Then Jungars, (about three dozen) were got ready on the North Backwater side, each Boat was about 2 tons. Across the two boats a bamboo platform was laid with an opening between the 2 boats.

XIII. These jungars were despatched one after the other and as soon as they came under the line of the hawser, on a signal being given by the overseer on one side and myself on the other,

the

the bags were rapidly pushed into the water, the empty jingáro after making the beach on the sea side (North) were dragged round with ropes on to the Back water side (north) and loaded again. Each jingar carried abont 20 bags, each bag abont 5 cft:

XIV. No work could be done on the sea side as there was always a surf — some times heavy. It was with great difficulty that jingáro could be recovered at times as they were nearly carried ont to sea, several men were nearly being drowned, but as the coolies were all fishermen or boatmen, they were able to swim and so escaped.

The hire of each boat was abont 2 annas a day; the bamboos, &c., were bought from suppliers at market rates; and the labor paid for daily.

XV. In this way the dam was raised a few feet a day, soundings being taken at the close of each day, so that we might know where to deposit the

(63)

On several occasions jingáro narrowly escaped being carried out to sea — they were recovered with great difficulty, and at considerable risk to the coolies. Also boatmen being fishermen

the bags next. In this way the dam was raised in layers and as it was, the velocity of the ebb and flow was sensibly diminished. It must also be remembered that the groynes deflected the current and thus facilitated the raising of the dam.

(64)

XVI. On the 25th June 1873, the dam was closed to 2 feet above low water mark. The Superintending Engineer left soon after. In this state the dam was by no means not finished, by any means, it had to be raised to abont 4 feet above high water mark and that soon, as the monsoons were on. And after the raising was completed it had to be maintained, and this was done by me until abont 22nd September.

XVII When I found that the bags were decayed, I knew that the sand would take its natural slope (angle of repose). I brought jingáro full of clay and sand and threw it down on both sides of the dam, also along the ont

side

side of the sand bag groynes and re-
-turns. And it was well I did so,
for once or twice a portion of the dam
would slip down; and once on the sea
side, it did so, with such violence that
it shot up a column of water about
10 feet high.

XVIII. We always had bags were always kept ready to
repair the top of the dam and thus
kept up the crest was thus in this way kept up to of the proper height
until all motion below had ceased.
After this the sides and top of dam
were covered with a coating of clay,
and turfed. Planks with stakes
and small stone revetments were
also placed to prevent erosion between
high and low water.

~~XX~~. After the beach outside had
closed (which took some time), the
weir I was formed to discharge the surplus
from the lagoon. This was necessary
on account of the rainfall, and also
on account of the sea water that
paced over the crest of the outer beach

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XX. On the 28th May 1874, I was re-
-lieved of charge of the Westcoastcanal
Range by Wm. Harris, Executive Engineer,
and resumed charge of the Palghat Range.

XXX

XX

The Grimes
Para.

A brief history of the Cruz Milagre Dam compiled from the records of the Chief Engineer's Office, with which is incorporated Mr. Grimes' Notes on the method of closing the Gap.

G.O. No. 2967 dated 19th September 1868.

In September 1868, when passing orders on a report submitted by the Consulting Engineer for Railways on the general question of the extension of the railway system in this Presidency, the Government remarked that "the recent action of the sea near Cochin and "the protective measures which have in "Consequence been rendered necessary suggest "the propriety of a deliberate professional "opinion being obtained on the capabilities of "the Cochin backwater as a harbour, and the "value and prospects of that port, as well as "of the anchorage at Narakal." The Government accordingly requested the Master Attendant of Madras, the Consulting Engineer for Railways, and Mr. Anderson, Chief Engineer of the Madras Railway Co., to investigate the present circumstances and future prospects of

of the port."

2. The report of the Committee thus appointed was submitted in December of the same year, and among other matters, the "Cruz Milagre Gap" near Cochin was reported on. In 1862 the Sea, which had for some years been making gradual inroads upon the Coast to the north of the town of Cochin, broke through into the backwater at a point called "Cruz Meilagre" (or the Miraculous Cross, from a church of that name which formerly stood there but which had been submerged) about a mile and a quarter to the north of the Cochin channel, and the gap then formed, though it had varied in size from year to year, had never been closed.

3. When examined by the Committee the width of the gap was nearly 300 yards and the depth of the water at low tide exceeded twenty one feet in some places.

The Committee recorded their unanimous opinion that there could be no question "as to the danger with which the very existence of the port of Cochin is threatened so long "as this gap remains open".

4. Although the depth of water in the greater portion of the Cochin Channel and river harbour had not been affected by the gap nor had there been any sensible diminution of water over the bar, the effect of the escape to the Sea, through the Cruz Milagre Gap, of a large volume of water which would otherwise have contributed its force to scour the Cochin Channel had become manifest by the gradual silting up of the Southern margin of that channel. The Committee therefore urged the necessity of at once closing the Gap in the manner suggested by Mr. Dalrymple, the Master Attendant of Madras, Viz:- by the construction of two groynes, one being run from the north and the other from the South side of the Gap.

5. In submitting the Committee's report for the orders of Government, the then Secretary to Government, P. W. Department, Colonel Orr, remarked that it appeared to him very doubtful whether groynes placed a

as recommended would effect what was expected of them to the extent of causing a sufficient accumulation of sand to close the gap. He thought that they would only make the opening tortuous and deeper — to say nothing of the cost of the groynes which would be heavy.

6. Colonel Orr considered that an attempt should be made to accomplish the desired object in the manner practised in Tanjore and other localities for closing breaches in river and channel banks; by means of "Modussils" made of palmyra or cocoanut trees, and by brushwood, grass and earth.

7. In disposing of the Committee's report the Government accepted Colonel Orr's recommendation and directed that "before adopting "the more costly expedient of constructing stone "groynes, the simple and inexpensive method "by which breaches in river and channel "banks are closed in Tanjore by means of "Modussils should be tried." — G.O. No. 1453 d/ 11th February 1869.

8. In October of the following year an estimate amounting to Rs. 31,500 for closing the Cruz Milagre Gap in the manner above mentioned — G.O. No. 2543 d/ 25th October 1870.

mentioned was sanctioned, and the Cochin Sirkar shortly afterwards consented to contribute towards the cost. The work was commenced, but in January 1871 the Government were informed of the arrival from England of an Engineer who had been deputed by the Secretary of State to examine and report on the harbours of India. It was therefore directed that "all further outlay on the operation of closing "the Cruz Milagre Gap be suspended until "Mr. Robertson, the Harbour Engineer, has "had an opportunity of inspecting that Gap "and of affording the Govt. the benefit of his advice." — G.O. No. 2767 d/ 17th November 1870; G.O. No. 147 d/ 19th January 1871; G.O. No. 587 d/ 28th February 1871.

9. In the following April Mr. Robertson communicated his opinion that the Gap might be closed, without much difficulty and at little expense, by throwing out a groyne from the inner northern angle of the Gap; so that the current might be diverted sufficiently to cause comparatively still water in the opening. This, Mr. Robertson thought, would allow the natural action of the sea and the incoming tide to do spontaneously what could only be accomplished artificially at a great

April 1871.

expenditure

expenditure of labour and money. He considered that the sand brought in from seaward would soon diminish the depth of the breach sufficiently to permit of its being finally closed by manual labour.

10. The Government thereupon directed the Superintending Engineer, 7th Division, to put the construction of the groyne in hand, and to take the necessary steps for protecting the opposite angle of the Gap with a revetment of stakes and stones. It was observed that the groyne need not be formed entirely of stone, but could be constructed of stakes, leaves, or grass and clay; strengthened, if necessary, with loose stone.

11. In June 1871, the Superintending Engineer submitted an estimate for the work amounting to Rs. 8662-8-6, which was sanctioned by Government although the Chief Engineer reported that he could not feel at all confident that the groyne would produce all the good effect that was expected of it.

G. O. No. 1567d 12th June 1871

12. The work was however commenced but it was soon found impossible to face the strong

strong current running through the Gap with a groyne constructed of the "temporary" material enumerated by Government. The Superintending Engineer therefore submitted a revised estimate of Rs. 24,824, for a substantial stone groyne which received the sanction of Government in December 1871.

G. O. No. 3055d/ 4th December 1871

13. In May 1872 the Superintending Engineer reported that the groyne had been completed to a length of 115 feet, and that although it was an experimental one he had every hope of its terminating successfully. He submitted a further estimate amounting to Rs. 15,277 for the extension of the groyne for 80 feet and for strengthening the Southern bank. The Superintending Engineer remarked "It would "be a pity after incurring the heavy expenditure "that has already taken place that the work "should fail merely from want of further funds."

G. O. No. 1125d/ 2nd May 1872

14. The Government were, however, of opinion that it was too late in the season to make any further attempt to close the gap as river freshes might be expected shortly, and therefore directed that the estimate lie

over

over until fresh observations had been taken after the monsoon.

15. In accordance with these instructions the Superintending Engineer in due course inspected the Gap, and found that in consequence of the wind having blown freshly from the Northwest for several days the Gap had been suddenly widened to a considerable extent. After carefully studying the action of the groynes the Superintending Engineer reported, in June 1872, that he was of opinion that all further lengthening of the experimental stone groyne should cease; and in lieu thereof a sandbag groyne, 100 feet in length, should be constructed parallel to the stone groyne.

16. The Superintending Engineer was of opinion that by constructing a parallel system of equidistant groynes the Gap would soon be reduced to damable proportions. He thought that four such groynes would be sufficient; and added that he had arranged to effect the final closing of the Gap when feasible by a sandbag dam. The

Government

G.O. No. 1757 d/ 24th July 1872.

Government after due consideration approved the Superintending Engineer's recommendations and sanctioned the former estimate of Rs. 15,277 in order that they may might be carried out; the Superintending Engineer having reported that the cost would be about the same. This, however, proved to be incorrect, as will appear hereafter.

17. On the completion of the first sandbag groyne it was found that the actual result was not up to expectations, as the spit of sand deposited on the sea face of the groyne did not extend beyond the head of the groyne. It was therefore necessary to construct an artificial base, from which the second sandbag groyne could be projected; and this was done by laying a return of sand bags—55 feet in length—at right angles from the head of the groyne running seawards. The second sandbag groyne was then constructed; but precisely as the anticipated effect of the first sand bag groyne fell short of what was realised by the experimental stone groyne, so the anticipated effect of the second groyne

fell

fell short of what was realized by the first sand bag groyne.

18. Notwithstanding this, the District Engineer reported, in his letter of the 28th April 1873, that he had great hopes that when the third sandbag groyne was Completed, the work of closing the gap might not improbably settle itself without any further assistance.

19. With regard to the financial aspect of the question at this stage, it should be stated that out of the Rs. 15,277 sanctioned by Government no less than Rs. 7,309 had been expended in protective works to the Gap and for maintenance during the monsoon of 1872; thus leaving Rs. 7968 only for executing the actual closing of the Gap by means of echelon sandbag groynes. This sum, the District Engineer reported, had been largely exceeded already although the work had not approached Completion. The first groyne, the return, and the second groyne had cost respectively Rs. 5860, Rs. 1330, and Rs. 8,400; or in all Rs. 15,590.

20. From the foregoing data it was calculated that the second return would cost Rs. 3,300, and the third groyne Rs. 7,000; but there were large contingencies to be provided for and the District Engineer was of opinion that the work would be completed for Rs. 15,000, which, added to the excess expenditure already incurred, brought the total to Rs. 22,550. This was the amount required for finally completing the work.

21. In passing orders on the District Engineer's report, the Government remarked that the sand bag groynes en echelon had proved practically more expensive and less efficient than would have been a sand bag dam directly across the Gap; and directed that, on completion of the second sand bag return, sand bags should be deposited in a direct line between its end and the nearest point of the opposite shore, so as to shallow the gap as quickly and directly as possible.

G.O. No. 1323 dd 13th May 1873.

The Government could not specially appropriate funds to cover the excess expenditure incurred, and the question of the provision of

of Rs 15,000 stated to be necessary for the completion of the work would be considered in the Financial Department. The required amount was allotted in the following month. G.O. Financial No 830 dated 13th June 1873.

22. Immediately on receipt of G.O. No 1323 dated 13th Meay 1873, Col: Farewell, (who had meanwhile been promoted from Superintending Engineer to Supty. Engineer for Ports and Communications,) took upon himself the responsibility of commencing the Dam across the Cruz Milagre Gap.

The Dam was completed to two feet above low tide level by the 25th June or within a month and a week. It was not perfectly watertight but the leaks were stopped as discovered.

23 24. Colonel Farewell did not propose to protect the Dam by a rough stone revetment inside the backwater as he hoped that at least eight or nine feet of clay would silt on in front of it, by which means the toe of the Dam would be well secured. Fresh sand bags were to be added, where required, to protect the contents of the old bags when they commenced to rot. It was hoped that with due care the front of the Dam would be silted straight across within two months.

24. 25. In reporting the satisfactory completion of the work, Colonel Farewell stated that the total cost of closing the Gap (876 feet in width) including maintenance and all expenditure from first to last amounted to Rs 83,827. The actual cost of the Dam alone was Rs 24,614, and of the entire work as completed Rs 59,230, while establishment, Contingencies & Cost Rs 24,597.

Of this sum a certain portion was defrayed by the Cochin State, the closing of the Gap being one of the "Coast defensive works" towards the cost of which the Cochin State contributed Rs 30,000.

In

26. 25 In their order marginally noted the Government remarked that the cost of closing the Cruz Milagre Gap had been considerable, but the experience gained at such cost would enable similar operations to be carried out in the future with certainty and comparative economy. To Colonel Farewell's energy, perseverance and ready resources the Government attributed the successful result of operations which at one time threatened to come to a stand still.—

No 2138 d/ 27th August 1873.

In October 1873 and January 1874 two sums of Rs 10,000 each were transferred to meet the expenditure incurred in closing the Gap.

G.O. No 2649 d/ 30th October 1873.

G.O. No 87 d/ 15th January 1874.

27. 26 In December 1873, a revised estimate for the work amounting to Rs 72,310 was submitted for sanction. The excess was owing to the Dam having sunk considerably and Colonel Farewell reported that he had authorised the District Engineer to thoroughly secure the Dam by adding Sand Slopes outside and Sand bags. The revised estimate was as follows:—

Total

× exclusive of establishment contingencies &c. H.H.P. 03

28

Total additional amount required for strengthening the Dam ——— Rs 10,080-6-3

Amount actually expended on the work before the original estimate was submitted, but which was inadvertently omitted ——— " 2999-9-9

Amount of original estimate ——— " 59,230-0-0

Total Rupees ——— 72,310-0-0

G.O. No 363 d/ 14th February 1874.

28. 27 In dealing with this estimate, the Government observed that the omission of Rs 3,000 from the original estimate was most unsatisfactory, and directed Colonel Farewell to adopt measures for promptly ascertaining which of the estimates was really correct, and to account for the discrepancy of rates in them.

The Government were not satisfied in regard to the constant expenditure that was going on in Connection with the work. It was reported to be impossible to say what further sums would be required. Such doubts must be put a stop to, and the Government therefore directed the taking of periodical

sections

sections across the Dam for the purpose of ascertaining whether any natural accretions of sand or clay were forming on either side of it. All further outlay on the work without previous sanctioned estimate was absolutely prohibited. In conclusion, the Government transferred from various other works sums amounting in all to Rs 25,000 to cover outlay incurred but not provided for.

29. 28 In March 1874, the Inspecting Engineer submitted an estimate amounting to Rs 2860 for facing with rough stone the river slope of the Cruz Milagre Dam where such protection did not already exist. In a note on the estimate the Chief Engineer objected to the work as its necessity had not been proved.

He pointed out that the work was quite inconsistent with sections taken after the estimate had been framed. In reply the Inspecting Engineer reported that the proposed work was not absolutely necessary, and the estimate was withdrawn.

30. 29 He submitted a bill amounting to Rs 515-15-5 being the actual expenditure on maintenance during the last quarter of 1873-74.

The

G.O. No 1315 d/ 16th May 1874.

The bill was passed by Government with the remark that care should be taken that no abuses were allowed to creep in unnoticed in connection with the work which, valuable as it was, had cost a much larger sum than had been anticipated or could be spared.

31. The Government desired that the action both of the sea and backwater on the Dam, during the approaching monsoon, should be carefully watched and precautions taken for guarding against damages from either quarter.

32. 31. At the time the foregoing order was passed the Government had under consideration the Inspecting Engineer's reply to G.O. No 363 dated 14th February 1874 offering explanations in regard to the discrepancies in the estimates for closing the Cruz Milagre Gap. The discrepancies were reported to be due to the actual expenditure incurred having been taken from progress reports, from which the amount in question (Rs 3000) had been omitted by a mistake in transfers, instead of from the station books.

In

33. 32 In the following month a sum of Rs 1,000. was allotted for emergent repairs to the Dam pending the receipt of a regular maintenance estimate; and in July attention was again called to the necessity for carefully watching and maintaining the Dam. Shortly before this the Resident of Cochin had been asked by the Inspecting Engineer to cause the Cruz Milagre Ferry to be disused and the Dam used for foot traffic instead, the passage of cattle being prohibited. This was satisfactorily arranged and duly reported to Government.

G.O. No 1714 d/ 25th June 1874.

G.O. No 1792 d/ 4th July 1874.

Endorsement No 126 d/ 15th Augt 1874.

34. 33 In March 1875 an estimate of Rs 1000 for repairing and maintaining the Dam was submitted but on the representation of the Chief Engineer the proposed repairs were modified resulting in a reduction of the estimate by Rs 200. The Government sanctioned a sum of Rs 800- "for carrying out so much of the "precautionary measures recommended by Mr "Harris as are approved by the Chief Engineer."

G.O. No 835 d/ 24th March 1875.

35. 34 In November 1875, the District Engineer, Malabar, submitted a survey, plans and sections of the Cruz Milagre lagoon bank and beach with soundings accompanied by a very satisfactory report. The District Engineer was of opinion that the reformation of the river banks and beach on the South was due entirely to the successful closing of the Cruz Milagre Gap.

Among other improvements reported may be noticed the fact that at low tide there was a foot more water over the bar at the mouth of the Cochin Harbour than there had been during the preceding year. The Government ordered the report to be recorded "with the renewed "expression of the satisfaction of H.E. the Governor "in Council at the success with which the operations "of closing the Cruz Milagre Gap and guarding "against erosion of the Coast at Cochin has been attended."

G.O. No 3450 d/ 6th December 1875.

36. 35. In March of the following year an estimate of Rs 705 for the maintenance of the Dam during 1876-77 was submitted by the District Engineer with the remark that although the actual expenditure would probably not be so much, he strongly recommended that the full amount asked for should be sanctioned inorder that he

e might be prepared with funds to meet any
mergency.

37.36 The Chief Engineer, however, was unable
to support Mr. Harris' recommendations. In
a memorandum dated 6th April 1876, he again
deprecated "the constant tendency on the part of
the Malabar Public Works Officers to exaggerate
the cost of maintaining the Cruz Milagre Dam."
He pointed out that he had already disproved
the necessity of the work for which an estimate
of Rs. 2860 had been submitted in 1874; that
he had been compelled to cut down the main-
tenance estimate for 1875-76 from Rs. 1000 to
Rs. 800; and that he had protested against
the petty estimates proposed in 1874 as excessive.
He considered that if a sum of Rs. 500 was
placed at the disposal of the District Engineer
for the maintenance of the Dam during 1876-77
it would be sufficient. The Government agreed
with the Chief Engineer and Rs. 500 were allotted
accordingly. This was in April.—

G.O. No. 939 d/
10th April 1876.

38.3 In July following a retrospective
estimate for work done on emergency in repairing
damages at the Dam and for measures taken
for its preservation was submitted by the District
Engineer with the remark that the provision of
funds applied for was quite independent of the
grant of Rs. 500 for maintenance. As there
was no balance left with Government from
the Provincial Reserve, and as the repairs carried
out were to prevent deterioration of the Harbour
of Cochin, the P. W. Department requested the
Financial Department to consider whether "the
"cost of maintaining the integrity of the sea beach
"at the site of the Cruz Milagre Gap should
"not be defrayed from Port Funds."

G.O. No. 1775 d
15th July 1876.

39.38 The Financial Department evidently
did not approve the proposal for in March
1877, the estimate, which amounted to Rs. 1000,
was sanctioned and funds were allotted under
Provincial.

G.O. No. 916 d/
17th March 1877.
G.O. No. 441 d/
7th February 1877.

40.39. In the following month, an estimate
of Rs. 485 for maintaining and repairing the
Cruz Milagre Dam during 1877-78 was sanctioned
with the remark that "as the maintenance of
"the Dam is essential for the safety of the Port of
"Cochin, the present and all future expenditure
"should be defrayed from Port Funds."

G.O. No. 1216 d/
9th April 1877.

41 About this time the Master Attendant of Madras visited the ports of Cochin and Calicut, and among other matters he reported on the Cruz Meilagre Dam and the lagoon that had been formed by it. He considered that the question of the ever recurring estimates for the maintenance of the Dam might be settled in perpetuity by filling up the lagoon from the Sea Shore. He thought that the ground thus made would be very valuable and soon pay expenses. It was necessary something should be done as the lagoon had increased in area and depth since he last visited Cochin in 1874.

42 41 The Government thereupon directed the District Engineer to report on the subject and he accordingly submitted a survey and sections of the lagoon, with an expression of his concurrence in the Master Attendants suggestion that it would be advisable to fill up the lagoon, or a part of it so as to strengthen the Dam. The matter was dealt with by Government in connection with the general question of the conservation of the Cochin Harbour Entrance, and the Collector of Malabar was directed to communicate with the Resident in Travancore and Cochin in view to the relinquishment to the British Government of such extent of the Sea beach as was needed for the conservation of the Harbour Entrance.

G.O. № 871 W d/21st Feby. 1878.

43 42 In May 1878 an estimate of Rs 484 for maintaining the Dam was sanctioned, and the District Engineer asked to report whether any portion of the lagoon had been filled in.

G.O. № 2341 W d/31st May 1878.

He replied that no action had been taken in the matter, and submitted an estimate of Rs 3260 for widening the Dam to 50 feet at the top with slope of 3 to 1 by which the principal object - the security of the Dam - would be effectually obtained and the deep part of the lagoon in its immediate vicinity be partially filled up.

The District Engineer considered that the filling up of the remainder of the lagoon might be left to Nature as it would surely though perhaps slowly completely silt up. The Government sanctioned the estimate, subject to the necessary provision being made from Port Funds. This was done in September 1878.

G.O. № 3217 W d/12th Augt 1878.

G.O. № 3682 W. d/19th Septr/78.

46. There is nothing further on record in Connection with the Dam until August 1880, when an estimate of Rs. 285 for petty repairs was submitted. This was sanctioned in September from Port Funds. In March 1881 a sum of Rs. 231 was allotted from Port Funds for repairs to the Dam. This was subsequently reduced by Rs. 35.

Marine G.O. d/ 16th September 1880 No. 468.

G.O. No. 821 W. d/ 25th March 1881.

G.O. No. 978 W. d/ 12th April 1881

46. On the 1st August 1881, the Government approved the undermentioned arrangements which had been proposed by the Superintending Engineer for future guidance in Connection with the Cruz Milagre Dam and groynes at Cochin:-

G.O. No. 1883 W.

(a) That the Dam, Groynes &c. should be in the charge of the Port Officer Cochin, who should, under the Marine Department, carry out all necessary repairs to them which did not exceed Rs. 1000; and even repairs exceeding that amount under special arrangement.

(b) That the P.W. Department should, when called on, give their advice regarding the repairs &c. and should also occasionally inspect the works, and, if necessary, report on their State and recommend any action they considered necessary.

G.O. No. 1782 W. d/ 2nd Aug. 1881.

46. 45 During the same month the Financial Department were asked to allot Rs. 24 from Port Funds to meet the pay of a maistry employed on certain repairs to the Dam. Within a week of this, the Supg. Engineer brought to notice that the Port Officer at Cochin was of opinion that the eastern side of the Dam required further protection as the shingle revetment had sunk below high tide level and consequently the earth was being gradually washed away. The Port Officer recommended a permanent protection of stone pitching or shingle, and the Executive Engineer was directed to prepare an estimate for the thorough repair of the Dam. In the Marine Department the matter was brought to the notice of the Master Attendant and he called upon the Port Officer to submit an estimate for the substantial

G.O. No. 1987 W. d/ 12th Aug. 1881.

G.O. No. 1422 W. d/ 29th Aug. 1881.

substantial repairs that he had proposed.

47.46 The question of the incidence of the charge of maintaining the Dam in good repair having been again brought forward and it having been represented that the Cruz Milagre Gap was closed in the interest of the port of Cochin, viz: for increasing the scour on the Cochin bar, the Govt directed that all such charges should be debited to Port Funds.

G.O. No. 2226 Wds 8th September 1881.

48.47 In September 1881 the Master Attendant submitted two estimates prepared by the Port Officer, Cochin, for the repairs previously recommended - one estimate provided for the use of stone boulders and amounted to Rs. 1250; the other for shingle at a cost of Rs. 538-8-0. They were permitted to lie over pending the receipt of the estimate which the Superintending Engineer had called on the Executive Engineer to submit. This came to hand in March 1882, and amounted to Rs. 1350. After due consideration the Government accepted this latter estimate and funds as per margin were allotted for the work from

Works --- 1350
Establishment 310
Tools & Plant 34
1694

× G.O. No. 737 Wds 21-3-82
" " 1082 Wds 1-5-82

from Port Funds.

49.48 The next paper on record in connection with the Cruz Milagre Dam is a note by the Chief Engineer, (Major General Sankey) dated 16th February 1883. Having been at Cochin in the early part of the month, the Chief Engineer took the opportunity to examine the work at the Gap. These he found in fair order and in the memorandum referred to said:- "From "information on the spot it would seem that on "the setting in of last monsoon the sea after "reducing the sand spit in front to some 90' in "width bowled freely over at high tide and "caused a rather heavy wash against the east "face of the bund, flattening the slope on that side.

"It would be well to have the edge of "the revetment of the bund on this side dealt "with in the same way as the west, i.e. with "larger material, and again that the whole of "the top of the bund should be covered with "rabbit wort" to hold better together the sandy surface.

"A few small trees in themselves perhaps harmless

harmless have been allowed to grow on the top of the bund but should be cut away, and all kept quite clear of trees as the roots may displace the stones of the revetment.

"I could not well ascertain whether any "erosion is going on the side of the backwater "during flood, and think it will certainly "be necessary to have a sufficient number "of cross sections taken and recorded after "every monsoon so as to help future reference "on this point. The sections should extend "to 60' or 80' on both sides of the bunds, and "embrace the whole work from South to North. "These should be regularly submitted yearly "to the Chief Engineer." These remarks were communicated for the information and guidance of the Superintending Engineer.

No. 460 C dl/ 21st Feby 1883.

50. 49 In June 1883, a sum of Rs. 25 was allotted from Port Funds for Survey operations; and in November of the same year the Superintending Engineer submitted for sanction and allotment of funds, an estimate amounting to Rs. 1,920, for revetting the east or lagoon side of the Dam, and covering the top with "rabbit work" in the manner directed by the Chief Engineer in his Memo: above quoted. The estimate was sanctioned for early execution, and the necessary allotment made from Port Funds.

G.O. No. 1804 W dl 26th June 1883.

G.O. No. 1982 W dl 16th July 1883.

G.O. No. 3477 W dl 4th Dec. 1883.

G.O. No. 728 W dl 17th March 1884.

No. 2096 C dl 18th Dec. 1884.

50. In December 1884 the Chief Engineer reminded the Supt.g. Engineer that the Cross sections of the Dam called for by General Sankey had not been received, and asked that when submitting them the Supt.g. Engineer would submit a brief report on the work executed at the Gap, and upon its then state.

52. 51. In his reply dated 12th February 1885, Colonel Beatty reported that the Cross sections had been regularly taken and recorded; but by oversight they had not been submitted to the Chief Engineer. He therefore sent copies of those for 1883/84, and stated that the works ordered by General Sankey had been fully carried out. The Executive Engineer had reported at the end of the preceding month that the Dam might be considered "perfectly safe;" but as the sections showed a tendency towards the deepening of

of the river bed on the side of the backwater the Executive Engineer recommended that rough stone be dropped in and allowed to take its own angle of repose. The Superintending Engineer considered that to prevent the toe of the revetment on the backwater side of the Dam from slipping, about two cubic yards of stone per running yard should be dropped in along the toe of the revetment. It was at the same time reported that the lagoon was apparently being gradually filled up by silt brought in through the escape by the river floods, and also by drift sand from the seabeach.

P.52 In regard to the cost of the work up to date, the Suptg. Engineer furnished the following figures:—

Original Cost of Dam according to accounts of 1870 to 1874 —— Rs. 1,07,408.
Cost of widening it 1878 —— " 3,219
Cost of revetting it on the lagoon side in 1883. 84 —— " 1,871.
Carried over Rs. 1,12,698

Brought forward Rs. 1,12,698.

Repairs as follows:—

1874. 75	"	999
1875. 76.	"	571
1876. 77	"	1,466
1877. 78.	"	252
1880. 81.	"	338
1882. 83.	"	1,360
Total Rs.		1, 17, 484.

In passing orders on the Suptg. Engineer's letter the Government directed that necessary steps should be taken for the early execution of the work recommended by the Executive Engineer.

G.O. No. 605 W dt. 13th March 1885.

P.53 In June 1885 the Master Attendant heard from the Port Officer, Cochin, that an erosion of the beach had taken place near the Dam, and that the revetment had sunk in some places. The Superintending Engineer was therefore directed to take the necessary action immediately. Before the order reached him the Superintending Engineer had submitted the estimate called for in G.O.

G.O. No. 1523 W dt. 30th June 1885.

No.

№ 605 M. dated 13th March 1885 for protecting with rough stone the toe of the backwater slope of the Dam. The estimate, which amounted to Rs 2190 was sanctioned by Government in July, and the necessary grant made for the work from Port Funds.

G.O. № 1613 M d/ 13th July 1885

G.O. № 2006 M d/ 31st Aug. 1885.

55. 54. It having been reported by the Superintending Engineer that the planting of Cocoanut trees on the lagoon side of the Sand bank that lies between the Cruz Milagre Dam and the Sea would greatly tend to strengthen the bank and protect the Dam, the Political Department addressed the Cochin Government on the subject.

In reply, the Cochin Government stated that there was no objection to the measure but it was desirable that the land should be parcelled out to different persons who would expend Capital, and who were either natives or permanent residents of the state.

It was requested that arrangements might be made for the payment of rent for the land.

The Superintending Engineer was thereupon

G.O. № 2245 M. d/ 28th Sept. 1885.

therenpon authorised to arrange to let the Sand bank for Cocoanut planting, and to dispose of the revenue derived therefrom in the manner suggested by the Cochin Government.

56. 55 The latest Cross sections of the Dam were taken on the 15th & 16th May 1885; they were submitted to Government by the Superintending Engineer in August last. They show that the lagoon is silting up gradually, and that there is a slight scouring action going on at the backwater face of the Dam. If this continues it will become necessary to specially protect the Dam on the backwater side. The ex-penditure up to the end of 1883, as shown by the Superintending Engineer, amounted to Rs 117,484; and since then an estimate of Rs 2190 has been sanctioned which brings the total up to Rs 119,674; or including Contingencies for 1883/84, and 1884/85, Rs 120,000., in round Numbers.

G.O. № 2644 M. d/ 5th Nov. 1885

L. Beatty. Col. R.E
Colonel & Supg. Engineer
23/1/86.

Chief Engineer.
P. W. Dept

Ex 2
Dr 4/1878

Brief History
of the
Cruz Milagre Dam;
with which is incorporated
Mr. Grimes' Notes on the
method adopted in closing
the Gap.

paragraph 29 may be added (to take the place of paras 27 & 30 in proof.)
It may be worded as follows.
"The entire cost of the work, up to ..... has amounted to about ₹1,20,000."

N.B. The paper should bear a date, but it does not seem necessary that any signature should be affixed. It is stated in the heading to be a brief history, compiled from certain records.

W.
23.3.86

Resubmitted for final approval.
HBed
C/Approved

30TH MARCH 1886, No. 857 W., PUBLIC WORKS.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following paper:—

From the Superintending Engineer, IV Circle, dated 2nd February 1886, No. 80 C./E.W.

ORDER—dated 30th March 1886, No. 857 W., Public Works.

Ordered that the annexed history of the Cruz Milagre Dam, which has been prepared in the Chief Engineer's office, be recorded in the proceedings of Government.

(True Extract.)

Major, R.E.,
Under Secy. to Govt., P.W.D.

To the Superintending Engineer, IV Circle.
" Chief Engineer for Irrigation.
" Marine Department.

Exd. E. Fernandez.
Spare Copies

Govt. of {1886} Madras.

PUBLIC WORKS.

Dated March, 30th.

Recd. *Encl.*

G.O., 30th Mar. 1886, No. 857 W.

MARCH.

Cruz Milagre Dam

History of the —, recorded.

Annexure to G.O., No. 857 W., dated 30th March 1886.

A BRIEF HISTORY OF THE CRUZ MILAGRE DAM, COMPILED FROM THE RECORDS OF THE CHIEF ENGINEER'S OFFICE.

In September 1868, when passing orders on a report submitted by the Consulting Engineer for Railways on the general question of the extension of the railway system in this Presidency, the Government remarked that "the recent action of the sea near Cochin and the protective measures which have in consequence been rendered necessary suggest the propriety of a deliberate professional opinion being obtained on the capabilities of the Cochin backwater as a harbour, and the value and prospects of that port, as well as of the anchorage at Narakal." The Government accordingly requested the Master Attendant of Madras, the Consulting Engineer for Railways, and Mr. Anderson, Chief Engineer of the Madras Railway Company, "to investigate the present circumstances and future prospects of the port."

G.O., No. 2967, dated 19th September 1868.

2. The report of the Committee thus appointed was submitted in December 1868, and, among other matters, the "Cruz Milagre Gap," near Cochin, was reported on. In 1862 the sea, which had for some years been making gradual inroads upon the coast to the north of the town of Cochin, broke through into the backwater at a point called "Cruz Milagre" (or the Miraculous Cross, from a church of that name which formerly stood there, but which had been submerged) about a mile and-a-quarter to the north of the Cochin channel,* and the gap then formed, though it had varied in size from year to year, had never been closed. When examined by the Committee the width of the gap was nearly 300 yards and the depth of the water at low-tide exceeded twenty-one feet in some places. The Committee recorded their unanimous opinion that there could be no question "as to the danger with which the very existence of the port of Cochin is threatened so long as this gap remains open."

* Old mouth of the backwater.

3. Although the depth of water in the greater portion of the Cochin channel † and river harbour had not been affected by the gap, nor had there been any sensible diminution of water over the bar, the effect of the escape to the sea, through the Cruz Milagre Gap, of a large volume of water, which would otherwise have contributed its force to scour the Cochin channel, had become manifest by the gradual silting up of the southern margin of that channel. The Committee therefore urged the necessity of at once closing the gap in the manner suggested by Mr. Dalrymple, the Master Attendant of Madras, namely, by the construction of two groynes, one being run from the north and the other from the south side of the gap.

† Old mouth of the backwater.

4. In submitting the Committee's report for the orders of Government, the then Secretary to Government, Public Works Department, Colonel Orr, remarked that it appeared to him doubtful whether groynes placed as recommended would effect what was expected of them to the extent of causing a sufficient accumulation of sand to close the gap. He thought that they would only make the opening tortuous and deeper—to say nothing of the cost of the groynes, which would be heavy. Colonel Orr considered that an attempt should be made to accomplish the desired object, in the manner practised in Tanjore and other localities for closing breaches in river and channel banks, by means of "*modussils*" made of palmyra or cocoanut trees, and by brushwood, grass and earth.

5. In disposing of the Committee's report, the Government accepted Colonel Orr's recommendation and directed that "before adopting the more costly expedient of constructing stone groynes, the simp

G.O., No. 453, dated 11th February 1869.

and inexpensive method by which breaches in river and channel banks are closed in Tanjore by means of '*modussils*' should be tried."

6. In October 1870 an estimate, amounting to Rs. 31,500, for closing the Cruz Milagre Gap in the manner above mentioned was sanctioned; and the Cochin Sirkar shortly afterwards consented to contribute towards the cost. The work was commenced, but in January 1871 the Government were informed of the arrival from England of an Engineer who had been deputed by the Secretary of State to examine and report on the harbours of India. It was therefore directed "that all further outlay on the operation of closing the Cruz Milagre Gap be suspended until Mr. Robertson, the Harbour Engineer, has had an opportunity of inspecting that gap and of affording the Government the benefit of his advice."

G.O., No. 2543, dated 25th Oct. 1870.
„ 2767 „ 17th Nov. „
„ 147 „ 19th Jan. 1871.

G.O., No. 587, dated 28th February 1871.

7. In April 1871 Mr. Robertson communicated his opinion that the gap might be closed, without much difficulty and at little expense, by throwing out a groyne from the inner northern angle of the gap, so that the current might be diverted sufficiently to cause comparatively still water in the opening. This, Mr. Robertson thought, would allow the natural action of the sea and the incoming tide to do spontaneously what could only be accomplished artificially at a great expenditure of labor and money. He considered that the sand brought in from seaward would soon diminish the depth of the breach sufficiently to permit of its being finally closed by manual labor.

8. The Government thereupon directed the Superintending Engineer to put the construction of the groyne in hand, and to take the necessary steps for protecting the opposite angle of the gap with a revetment of stakes and stones. It was observed that the groyne need not be formed entirely of stone, but could be constructed of stakes, leaves, or grass and clay, strengthened, if necessary, with loose stone. An estimate, amounting to Rs. 8,662-8-6, was sanctioned for the work in June 1871.

G.O., No. 1567, dated 12th June 1871.

9. It was soon found impossible to face the strong current running through the gap with a groyne constructed of the specified materials, and a revised estimate of Rs. 24,824 for a substantial stone groyne was therefore sanctioned by the Government in December 1871.

G.O., No. 3055, dated 4th December 1871.

10. In May 1872, the Superintending Engineer reported that the groyne had been completed to a length of 115 feet, and that, although it was an experimental one, he had every hope of its terminating successfully. He submitted a further estimate, amounting to Rs. 15,277, for the extension of the groyne for 80 feet and for strengthening the southern bank. The Government were, however, of opinion that it was too late in the season to make any further attempt to close the gap as river freshes might be expected shortly, and therefore directed that the estimate lie over until fresh observations had been taken after the monsoon.

G.O., No. 1125, dated 2nd May 1872.

11. In accordance with these instructions the Superintending Engineer, in due course, inspected the gap, and found that, in consequence of the wind having blown freshly from the northwest for several days, the gap had been suddenly widened to a considerable extent. After carefully studying the action of the groynes, the Superintending Engineer recommended, in June 1872, that all further lengthening of the experimental stone groyne should cease; and, in lieu thereof, a sand-bag groyne, 100 feet in length, should be constructed parallel to the stone groyne. He thought that four parallel equidistant groynes would reduce the gap to damable proportions. The Government approved the Superintending Engineer's recommendations and sanctioned an estimate of Rs. 15,277 in order that they might be carried out.

G.O., No. 1757, dated 24th July 1872.

12. On the completion of the first sand-bag groyne it was found that the actual result was not up to expectations, as the spit of sand deposited on the sea-face of the groyne did not extend beyond the head of the groyne. It was therefore necessary to construct an artificial base, from which the second sand-bag groyne could be projected; and this was done by laying a return of sand-bags—55 feet in length—at right angles from the head of the groyne running seawards. The second sand-bag groyne was then constructed; but precisely as the anticipated effect of the first sand-bag groyne fell short of what was realised by the experimental stone groyne, so the anticipated effect of the second groyne fell short of what was realised by the first sand-bag groyne.

13. With regard to the financial aspect of the question at this stage, it should be stated that out of the Rs. 15,277 sanctioned by the Government, no less than Rs. 7,309 had been expended in protective works to the gap and for maintenance during the monsoon of 1872; thus leaving Rs. 7,968 only for executing the actual closing of the gap by means of *echelon* sand-bag groynes. This sum, the District Engineer reported, had been largely exceeded already although the work had not approached completion. The first groyne, the return, and the second groyne had cost, respectively, Rs. 5,860, Rs. 1,330, and Rs. 8,400; or in all Rs. 15,590. From the foregoing data it was calculated that the second return would cost Rs. 3,300, and the third groyne Rs. 7,000; but there were large contingencies to be provided for, and the District Engineer was of opinion that the work would be completed for Rs. 15,000, which, added to the excess expenditure already incurred, brought the total to Rs. 22,550. This was the amount required for finally completing the work.

14. In passing orders on the report, the Government remarked that the sand-bag groynes *en echelon* had proved practically more expensive and less efficient than a sand-bag Dam directly across the gap would have been; and directed that, on completion of the second sand-bag return, sand-bags should be deposited in a direct line between its end and the nearest point of the opposite shore, so as to shallow the gap as quickly and directly as possible. The Government could not specially appropriate funds to cover the excess expenditure incurred, but the question of the provision of Rs. 15,000 stated to be necessary for the completion of the work would be considered in the Financial Department. The required amount was allotted in the following month.

G.O., No. 1323, dated 13th May 1873.

G.O., Financial, No. 830, dated 13th June 1873.

15. Immediately on receipt of G.O., No. 1323, dated 13th May 1873, Colonel Farewell commenced the Dam across the Cruz Milagre Gap. It was completed to 2 feet above low-tide level by the 25th June, or within a month and a week. It was not perfectly water-tight, but the leaks were stopped as discovered. Colonel Farewell did not propose to protect the Dam by a roughstone revetment inside the backwater as he hoped that at least 8 or 9 feet of clay would silt on in front of it, by which means the toe of the Dam would be well secured. Fresh sand-bags were to be added, where required, to protect the contents of the old bags when they commenced to rot. It was hoped that with due care the front of the Dam would be silted straight across within two months.

16. In reporting the satisfactory completion of the work, Colonel Farewell stated that the total cost of closing the gap (876 feet in width) including maintenance and all expenditure from first to last amounted to Rs. 83,827. The actual cost of the Dam alone was Rs. 24,614, and of the entire work as completed Rs. 59,230, while establishment, contingencies, &c., cost Rs. 24,597. Of this sum a certain portion was defrayed by the Cochin State, the closing of the gap being one of the "coast defensive works" towards the cost of which the Cochin State contributed Rs. 30,000.

17. In December 1873, a revised estimate for the work, amounting to Rs. 72,320,* was submitted for sanction. The excess was owing to the Dam having sunk considerably, and Colonel Farewell reported

* Exclusive of establishment, contingencies, &c.

that he had authorised the District Engineer to thoroughly secure the Dam by adding sand slopes outside and sand-bags. The revised estimate was as follows :—

	Rs.	A.	P.
Total additional amount required for strengthening the Dam.	10,080	6	3
Amount actually expended on the work before the original estimate was submitted, but which was inadvertently omitted	2,999	9	9
Amount of original estimate	59,240	0	0
Total ...	72,320	0	0

18. During the next two years various estimates for minor works and repairs were sanctioned, and sundry bills on account of actual expenditure on the maintenance of the Dam were passed.

19. In November 1875, the District Engineer, Malabar, submitted a report on the beneficial results of the closing of the gap. Among other improvements reported may be noticed the fact that at low-tide there was a foot more water over the bar at the mouth of the Cochin harbour than there had been during the preceding year. The Government ordered the report to be recorded "with the renewed expression of the satisfaction of His Excellency the Governor in Council at the success with which the operations of closing the Cruz Milagre Gap and guarding against erosion of the coast at Cochin has been attended."

G.O., No. 3450, dated 6th December 1875.

20. From this time until the middle of 1878 no important alterations or repairs to the Dam were carried out; but several estimates for minor works and bills for maintenance were sanctioned. An estimate of Rs. 3,260 for widening the Dam to 50 feet at the top was sanctioned in September 1878.

G.O., No. 3682 W., dated 19th September 1878.

21. There is nothing else important on record in connection with the Dam until August 1881, when the Government approved the undermentioned arrangements for future guidance in connection with the Cruz Milagre Dam and groynes at Cochin—

G.O., No. 1883 W., dated 1st August 1881.

(*a*) That the Dam, groynes, &c., should be in the charge of the Port Officer, Cochin, who should, under the Marine Department, carry out all necessary repairs to them which did not exceed Rs. 1,000; and even repairs exceeding that amount under special arrangement.

(*b*) That the Public Works Department should, when called on, give their advice regarding the repairs, &c., and should also occasionally inspect the works; and, if necessary, report on their state and recommend any action they considered necessary.

22. During the same month the Superintending Engineer brought to notice that the Port Officer at Cochin was of opinion that the eastern side of the Dam required further protection as the shingle revetment had sunk below high-tide level and consequently the earth was being gradually washed away. The Port Officer recommended a permanent protection of stone pitching or shingle, and the Executive Engineer was directed to prepare an estimate for the thorough repair of the Dam. It amounted to Rs. 1,350 and was sanctioned in May 1882.

G.O., No. 1987 W., dated 12th August 1881.

G.O., No. 1802 W., dated 1st May 1882.

23. The question of the incidence of the charge of maintaining the Dam in good repair having been again brought forward, and it having been represented that the Cruz Milagre Gap was closed in the interest of the port of Cochin, viz., for increasing the scour on the Cochin bar, the Government directed that all such charges should be debited to Port Funds.

G.O., No. 2226 W., dated 8th September 1881.

24. The next paper on record in connection with the Cruz Milagre Dam is a note by the Chief Engineer, dated 16th February 1883. Having been at Cochin in the early part of the month, he took the opportunity to examine the works at the gap. These he found in fair order, and in the memorandum referred to said : "From information on the spot it would seem that on the setting in of last monsoon the sea after reducing the sand spit in front to some 90′ in width bowled freely over at high-tide and caused a rather heavy wash against the east face of the bund, flattening the slope on that side. It would be well to have the edge of the revetment of the bund on this side dealt with in the same way as the west, *i.e.*, with larger material; and, again, that the whole of the top of the bund should be covered with rabbit wort to hold better together the sandy surface. A few small trees, in themselves perhaps harmless, have been allowed to grow on the top of the bund but should be cut away, and all kept quite clear of trees as the roots may displace the stones of the revetment. I could not well ascertain whether any erosion is going on the side of the backwater during flood, and think it will certainly be necessary to have a sufficient number of cross sections taken and recorded after every monsoon so as to help future reference on this point. The sections should extend to 60′ or 80′ on both sides of the bunds, and embrace the whole work from south to north. These should be regularly submitted yearly to the Chief Engineer." These remarks were communicated for the information and guidance of the Superintending Engineer.

No. 460 C., dated 21st February 1883.

25. In November 1883 the Superintending Engineer submitted an estimate, amounting to Rs. 1,920, for revetting the east or lagoon side of the Dam, and covering the top with "rabbit wort" in the manner directed by the Chief Engineer in his memorandum above quoted. The estimate was sanctioned for early execution, and the necessary allotment made from Port Funds.

G.O., No. 3477 W., dated 4th December 1882.
„ 728 W., „ 17th March 1884.

26. In February 1885, Colonel Beatty reported that the works ordered by the Chief Engineer had been fully carried out; but as the sections showed a tendency towards the deepening of the river bed on the side of the backwater, he recommended that to prevent the toe of the revetment on the backwater side of the Dam from slipping, about two cubic yards of stone per running yard should be dropped in along the toe of the revetment. It was at the same time reported that the lagoon was apparently being gradually filled up by silt brought in through the escape by the river floods, and also by drift sand from the sea-beach. The Government directed that the work recommended by the Executive Engineer should be carried out; and the estimate, which amounted to Rs. 2,190, was sanctioned in July.

G.O., No. 605 W., dated 13th March 1885.
„ 1613 W., „ 13th July „

27. It having been reported by the Superintending Engineer that the planting of cocoanut trees on the lagoon side of the sand-bank that lies between the Cruz Milagre Dam and the sea would greatly tend to strengthen the bank and protect the Dam, the Cochin Government was addressed on the subject. In reply, the Cochin Government stated that there was no objection to the measure, but it was desirable that the land should be parcelled out to different persons who would expend capital and who were either natives or permanent residents of the State. It was requested that arrangements might be made for the payment of rent for the land. The Superintending Engineer was instructed accordingly.

G.O., No. 2245 W., dated 28th Sept. 1885.

28. The latest cross sections of the Dam were taken in May 1885; they show that the lagoon is silting up gradually, and that there is a slight scouring action going on at the backwater face of the Dam. If this continues it will become necessary to specially protect the Dam on the backwater side.

G.O., No. 2614 W., dated 5th November 1885.

29. The entire cost of the work, up to the end of 1885, has amounted to about Rs. 1,20,000.

CHEPÂK.
1st April 1886.

№ 800
P.W.

Supg. Engineer's Office, IV Circle.
Camp Calicut 2nd Feby/86.

From

The Superintending Engineer,
Fourth Circle.

To

The Chief Engineer,
P. W. Department.

Sir

Enclosures 4.
1 Revised copy of the history
1 Original Do
1 Survey
1 sketch by Mr. Grimes

As directed in your Memorandum № 2183 C of 17th Decr/85, I have the honor to submit herewith a revised copy of the History of the Cruz Milagre Dam.

2. In preparing this, I have carefully examined the original rough draft sent from your office, and made some petty corrections where these seemed necessary; I have also divided it into paragraphs as seemed to me desirable.

3. As there were no Engineering details of the actual construction of the Dam on record in my office, it occurred to me that Mr. Grimes, now at Madura, who as Assistant Engineer

Engineer constructed the Dam under the immediate instructions of the Supg. Engineer, Col: Farewell, would be the best person to furnish them; and this he has done from memory in the notes which I have proposed should form para 23 of the History.

4. I send with the History a sketch of the Gap as it was at the time of closing 1873, and a survey of the site of the Dam taken about two years ago, which shows approximately the condition of things as they are at present. I also return the draft which accompanied your Memo: under reference.

I have the honor to be,
Sir,
Your most obedt. Servt.,

R. Beatty - Col: R.E.
Superintending Engineer IV Circle

G.O. 1792 dy 4-7-74
" 1714 dy 25-6-74
1377 dy 22-5-74
1315 dy 16-5-74
363 dy 14-2-74
87 dy 13-1-74
2649 dy 30-10-73
2138 dy 27-8-73
1323 dy 13-5-73
3002 dy 18-12-72
1757 dy 24-7-72
1449 dy 12-6-72
1125 dy 2-5-72
634 dy 8-3-72
3055 dy 4-12-71
1567 dy 12-6-71
1105 dy 20-4-71
587 dy 28-2-71
147 dy 19-1-71
2767 dy 17-11-70
2543 dy 25-10-70
453 dy 11-2-69
2967 dy 19-9-68

Arch 918

From

The Supg. Engineer,
Fourth circle.

F. FEB 86

Dated 27
Despr. 31 } February 186.
Rec 5

No 80c
Gw.

Enc: 4 (2 Sketches)

Cruz Mileapre Dam:-

Returns the Brief History of the — with additions and corrections as requested in Chief Engineer's Memo. No: 2183C of 9th december 185.

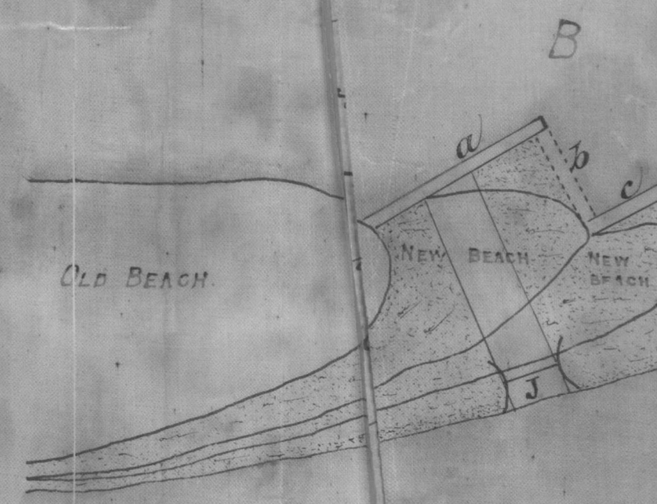
4321 W a/ 11-11-78
4125 W a/ 24-10-78
No 1282 Cd/ 25.7.85
" 2183 Cd/ 17.12.85
2614 W a/ 5-11-85
2245 W a/ 28-9-85
1613 W a/ 13-7-85
605 W a/ 13-3-85
3477 W a/ 4-12-83
2006 W a/ 31-8-85
1755 W a/ 29-7-85
1699 W a/ 21-7-85
1523 W a/ 30-6-85
644 W a/ 16-3-85
2096 Cd a/ 18-12-84
903 W a/ 2-4-84
702 W a/ 14-3-84
725 W a/ 17-3-84
1982 W a/ 16-7-83
1804 W a/ 26-6-83
460 Cd a/ 21-2-83
1082 W a/ 1-5-82
737 W a/ 21-3-82
2844 W a/ 15-11-81
C.E. No 2601 a/ 7-11-81
2226 W a/ 8-9-81
422 a/ 29-8-81
1984 W a/ 12-8-81
1782 a/ 2-8-81

3682 W a/ 19-9-78
3217 W a/ 12-6-78
2863 W a/ 12-7-78
2341 W a/ 31-5-78
2037 W a/ 3-5-78
811 W a/ 21-2-78
1624 W a/ 22-8-77
1216 a/ 9-4-77
916 a/ 17-3-77

408 a/ 7-9-80
433 W a/ 14-11-78
6-10-80
C.E. 46 a/ 26-2-81
2316 W a/
778 W a/ 12-4-81
821 W a/ 25-3-81
1883 W a/ 1-8-81
1147 W a/ 4-5-81

6-12-75 4027 a/ 7-1-75
8-0 3450 a/ 6-12-75
835 a/ 24-3-75 2437 a/ 28-8-74
397 a/ 12-2-75
12-7-76 8-0 1775 a/ 12-7-76
10-4-76 1939 a/ 10-4-76
20-1-76 139 a/ 20-1-76

Enc. 29. 3. 86. R 30. 3. 86.



— REFERENCE. —

a.....STONE GROYNE
b.....ITS RETURN.
c.....SAND BAG GROYNE No 1
d.....ITS RETURN.
e.....SAND BAG GROYNE No 2.
f.....ITS RETURN.
g.....THE DAM
h.....SOUTH BANK REVETMENT.
J.....WEIR 100 FEET LONG.

W.

I think the last
letter by Mr Grunsky
might be revised
the important points
only being forwarded
June 23

Lin

6 918

Note

The history of the
Cruz Milagro Dam,
as revised by the
S.E. V Circle, might
now be put into
type for convenience
of perusal. Any
corrections considered
necessary can be
carried out in the
proof —

Approved.
The paper will be finally
brought on Proceedings
as in the form of
a small monograph.

Cr
8-2-26

DW/W

57 The foregoing paragraphs ~~supersede~~ contain ~~copy~~ a synopsis of the events in connection with the closing of the dam, and information in regard to the cost of the various works carried out. It now remains to record the following Engineering details of the work which have been furnished by Mr J. Grunsky, Executive Engr, who at the time ~~Supervised~~ the works was Asst Engr in charge of the West Coast Canal Range, and under whose immediate superintendence the works in connection with the closing of the C. M. Gap were carried out.

1883 Act 1-3-0 Act 1826

B & R
Civil works

PUBLIC WORKS DEPARTMENT.

No. 857 W

A
Circ

PROCEEDINGS OF THE MADRAS GOVERNMENT.

UNDER date the 30th March 1886

READ the following

From the S. E. IV. C. 80.C. / Env. 3 2nd 2nd. 86.

Ordered that the annexed History of the Cruz Milagre Dam, which has been prepared in the Chief Engineer's office, be recorded in the proceedings of Govt.

Dead, 5-4-86

Lee
29/3/86

S. E. IV. Circle ✓
C. E. for Irrig.ⁿ ✓
Marine dept.

Ws
29.3.86

1883 Nov. 1 to Dec. 31 B-8-1 to 8-8

15-12-11 B II

23-4-14

7.9.08

Govt. of 1886 Madras.

PUBLIC WORKS.

31/3/1887

Dated

Rcvd. Encl.

G.O., 30th March 1886, No. 857 W.

Cruz Billagre Dam.

History of the Excavation.

95/5

Dr.

Proof of the History of the Cuddam as prepared in this office is submitted for approval.

The para added by S.E. IV. (Mr Grime's notes) has been omitted as directed by you.

WB

20.2.86.

approved

L

26/2/86

I think this paper may be boiled down still further. E.g. paras 49-52, & similar portions, might be omitted without loss of interest. VH

Please go through it carefully. SAW

For approval

Lucas
23/5/86

DW
W

it still appears to me that a good deal of this 'History' may be omitted.

What is required is a history of the work - not of the officers employed on it - or of the various small estimates which from time to time have been sanctioned.

Keeping this in view, it seems to me that much which has been put into the draft may be omitted, especially after para 17. I should like it to be carefully revised on these lines.

WS
5-3-86

SAW

W.

Revised History of the Cruz Milagro Dam submitted for approval.

FB.
4.3.86.

I think this will do now.
It cannot well be cut down more

Lucas
25/5/86