Public Works (1898) Department

No. 5

G.O., No. 184-1859

DATED 9-3-1898.

[Despatch Abstract.]

Bezwada head sluice. — Directing that the Note by the Chief Engineer for Irrigation suggesting, with remarks, that the regulator in rear of the — is not necessary, be forwarded to the Govt. of India

— .. —

Bezwada head sluices. Forwarding with remarks note by the Chief Engineer for Irrigation suggesting that the regulator in rear of the — is not necessary

BACK PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

FURTHER PAPERS.

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S.W. 1724

~~Marine~~ (1898) Department.

Official

G.O., No. 184-5 I

DATED 9th March 1898

[Despatch Abstract.] ~~with remarks~~

Bezwada Head Sluice: Directing that the note by the Chief Engineer for Irrigation, suggesting, with remarks, that the regulator in rear of the —— is not necessary, be forwarded to the Govt. of India.

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B. 9.3.98

[M. 5. 500—18-8-97.]

Reg'd 23/3

BACK PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.
550	I	14.6.97					
231	I	6.3.97					
	722	10.3.91					

FURTHER PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

IRRIGATION.

Government {1898} of Madras.

PUBLIC WORKS.

Recd. } 1898. *Enclosures*
Regd. } *Spare copies*

G.O., Nos. 184, 185 I., 9th March 1898.

MARCH.

Bezwada Head Sluice

Forwarding, with remarks, note by the Chief Engineer for Irrigation suggesting that the regulator in rear of the — is not necessary.

4. The question of faults in the design has been carefully gone into and I agree with Captain Ellis, R.E., that, if the structure could be made monolithic, its stability would be increased very considerably; but I am not at present in favour of building in the vacant spaces between the old and new work, with masonry. I think it would be better to try the effect of struts and shores, and I have directed the Executive Engineer to prepare the necessary plans and estimates.

5. In considering the loss of stability caused by holding up of water in rear of the sluice, it must not be forgotten that the risk of the floor blowing up is very much diminished by reducing the head, and it would, in my opinion, be a most dangerous experiment to close the vents of the sluice entirely during a heavy flood unless there was a subsidiary work in rear to hold up, say, 15 feet of water.

6. If the work that I propose to carry out this season to bring the back part of the sluice into use during floods, proves successful in reducing vibration, I am not at all sure that a subsidiary sluice in rear to hold up 15 feet of water would not be advisable; for though it would rarely come into operation, it would prevent any risk of the sluice blowing up, although it would, to some extent, diminish the stability.

7. The difficulties in the way of building a sluice in rear of the old one, of such dimensions as to take the whole head of the river, are very great, but the subject is receiving attention and before long some practicable scheme may be thought out.

(Signed) W. L. C. BADDELEY, Major, R.E.,
19th March 1897. Supg. Engineer, II Circle.

To the Superintending Engineer, II Circle, dated 10th April 1897, No. II/67 K.S.
[His No. 3661 K.N., dated 19th March 1897.]

It is satisfactory to find that the Bezwada head sluice shows no serious signs of injury and that its stability, as shown by the calculations, is greater than was anticipated.

2. The great difference in weight of the masonry shown in the cases when the canal is empty and with 12 to 15 feet water indicates some error (on the safe side, however) in the calculations of the upward pressure of the water. If the piers have been included with the submerged masonry and the calculation made as if there were an open joint between them and the floor, most, if not all, of the error would be accounted for. The error is not of importance, except that it might lead one to undervalue the support and relief given to the sluice by the admission of a large body of water into the canal. The opening of the vents tends, in several ways, to obviate danger. It reduces the pressure in front, increases that in rear, reduces the pressure tending to cause dangerous leakage under the work and probably saves the shutters which are only 3″ or 4″ thick from being blown in. The necessity of admitting a considerable depth into the canal in floods must be accepted as long as the present sluice is the only regulating work and it remains to do whatever is feasible to strengthen the work.

3. The second line of shutters fitted in 1869 or 1870 was apparently intended to facilitate the working of the needle shutters in the front of the vents. They were plank shutters running on rollers. The inefficiency of the arrangements for working them was commented on by the Chief Engineer for Irrigation in his Inspection notes of March 1871 and September 1874, and it is presumed the defects were remedied as ordered and that the shutters continued to be used until the screw shutters were fitted to the sluice in 1881. It has been considered whether it would be advisable to put in again a rear line of shutters so as to make the sluice double and so reduce the velocity through the vents, but the practical difficulties of working such shutters to advantage, fitted as they would be with some vents as the front shutters, are insuperable and the idea of the Superintending and Executive Engineers to improve the connection of the addition built in 1868–69 is accepted as the best feasible. The Superintending Engineer must decide how this can best be done. Probably, it would be well to fill the whole space between the two parts of the sluice with cement concrete made with not too much water.

4. The Superintending Engineer refers to some slight cracks. If these are in the piers, which undoubtedly are greatly over-weighted in a 26½ feet flood, they may indicate some serious danger. The Superintending Engineer will oblige by reporting where they are and by noting their position so that any future enlargement may be detected.

5. With regard to the vibration of the sluice in the flood of last year, only those who were present have the means of judging whether any suggested causes may be correct. The filling between the old and new parts of the sluice should at least reduce the vibration, but there seems likely to be always some when water is admitted to such a level as to impinge with a high velocity against the inner face of the rear arches.

6. The Superintending Engineer's attention is drawn to the Irrigation Chief Engineer's instructions in his notes of March 1881 regarding the permissible difference of water level in the canal and river. If there is nothing to show that the danger which then existed has since ceased, those instructions must be adhered to.

(Signed) W. HUGHES,
Chief Engineer for Irrigation.

From Major W. L. C. BADDELY, R.E., Superintending Engineer, II Circle, to the Chief Engineer for Irrigation, dated 3rd June 1897, No. 727 K.N.

In reference to paragraph 3 of your memo., No. 2/67 K.S., dated 10th April 1897, I have the honour to inform you that the space between the old and new portions of the Bezwada sluice has been filled with sand, with a layer of concrete on top.

The filling in has only been carried out up to the level of the platform of the rear part of the sluice.

The additional weight added amounts to rather less than 6 tons over each vent, or under 90 tons on the whole sluice.

I hope that this may have the effect of reducing the vibration in the sluice during floods.

From Captain W. M. ELLIS, R.E., Executive Engineer, Kistna Northern division, to the Superintending Engineer, II Circle, dated 10th December 1897, No. 588 S.E.

[Your No. 975 K.N., date 1st July 1897.]

I have the honour to submit, herewith, a design and a rough estimate amounting to Rs. 75,000 for a regulator in rear of Bezwada head sluice.

Along with the estimate I submit a further note showing the statical effect on the stability of the head sluice which will be effected by the construction of the regulator under various conditions.

2. The result shows that, considered purely statically, the effect of the regulator holding up 15 feet of water will not be such as to bring the resultant pressure in a maximum flood within the central third of the base of the original sluice. The regulator, however, has the effect of reducing the greatest intensity of pressure on the sluice, supposing the canal to be empty, from 1,654 lb. per square foot to 718 lb. per square foot. In practice, however, the canal has always been filled up to 12 feet in a big flood, and the intensity of pressure on the head sluice in such a case is only 905 lb. per square foot.

3. The regulator will therefore—

(*a*) Enable us to keep the water in the canal at any convenient depth during floods, instead of being forced as at present to keep the canal abnormally high at a time when this is practically inconvenient, causing breaches and damage to crops.

(*b*) It will reduce the maximum intensity of pressure on the head sluice from 905 to 718 lb. per square foot.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Irrigation.

Read—the following papers :—

From Captain W. M. ELLIS, R.E., Executive Engineer, Kistna Northern division, to the Superintending Engineer, II Circle, dated 11th March 1897, No. 837 S.E.

In accordance with verbal instructions, I have the honour to forward a tracing of stability diagrams taken out for Bezwada head sluice. I also enclose a note on the stability of the sluice with references to the diagrams.

Enclosure.

Note on Bezwada Head Sluice.

The Bezwada head sluice is subjected to very great vibration and shakes all over during moderate floods. Such vibration is not noticeable in the case of the Seetanagram sluice on the other side of the river.

On examining the design of the sluice it will be noticed that, in the original design, the width of the sluice from face wall to original rear wall (front of second row of grooves) is 16′ 2″.

The width of the Seetanagram sluice is 24′ 6″.

The latter sluice is a good deal cracked both arches, wings and piers, and has been, for some years, regarded as unreliable ; nevertheless, there is an absence of the vibration which is noticed in Bezwada sluice. In 1867–68 an addition was made to the Bezwada sluice by adding the second vents in rear and prolonging the piers backwards a distance of 7′ 1″, making a total length of pier of 23′ 3″ and a corresponding distance between front and rear face walls. This is about the same as the Seetanagram sluice, but the nature of the buildings differ as below :—

(*a*) In the fact that the former was all built at the same time, whereas the latter was not.

(*b*) The only parts in Bezwada sluice, where the addition backs up the old work, is in the prolongation of the piers ; between these there are openings left for working the needles in the second vents.

The Bezwada sluice, so far as we know, is a perfectly sound work and has not cracked seriously, and the only explanation of the excessive vibration, having in view the fact that this does not happen at Seetanagram, is that the old work does not back up and support the new in the way it would have done, had all been built at the same time or without the openings for the rear shutters.

With a view of studying the conditions of pressure in the Bezwada sluices, diagrams have been drawn showing the lines of resultant pressure.

I. Supposing the sluice to be as in the great floods of last August without the new parapet wall, and further supposing the addition in rear to have no effect in supporting it. These diagrams are in red lines.

II. Supposing the addition in rear to have the full effect it might be supposed to have, had it been built at the same time as the rest of sluice.

The base of the pier in case I is of length 16′ 2″, and in case II, 23′ 3″.

These diagrams are in black lines.

In case I, supposing a head of 26½ feet in front of the sluice, the resultant pressure falls without the middle third of the base under the following conditions of water level in rear as shown :—

	Resultant outside middle third of base. FT.	INS.
Canal empty	1	11
„ 12 feet deep	2	0
„ 15 „ „	1	10

R R R

(*vide* red lines on diagram marked—0 12 15)

The reason why the stability results are actually more disadvantageous with 12 feet than with the canal empty is, that a deduction of 62·5 lb per cubic foot is made on each cubic foot of masonry submerged, and this more than counterbalances the reduction by the 12 feet head of water in the canal.

The results are undoubtedly striking as showing that, from a point of view of actual stability, no advantage is to be gained by holding up water to a moderate height behind a sluice. There is, however, a gain in diminution of pressure on the piers and also less tendency to blow up of the floor.

Case II.—The black lines show resultant pressures for case II and show that the resultant pressure falls well within the middle third.

Two different conditions are taken—

(1) With the sluice as it now stands.

(2) With the open space "A" filled in solid with masonry.

In both cases the canal is supposed to be empty, the wall 4′ 6″ high built on the sluice platform since the floods, is taken into consideration.

The diagrams, therefore, show—

Case I.—Considerable deficiency in stability.

Case II.—Ample stability.

The truth, probably, lies between the two ; but considering the great vibration, it is probable that case I more nearly represents the truth than case II.

There are two reasons for case II not approximating to the truth for the sluice either :

(*a*) The additional length added on the section of the piers is not sufficiently bonded and backed into the original structure to act as an integral part of it.

(*b*) The great voids left for the working of the needle shutters has affected the stability of the work.

A diagram of stability has been taken out for a section across the centre of an arch, and this shows that the original work is perfectly stable down to this level, and I am inclined to favour (*a*) as being the explanation ; but for all that, I would try blocking in the spaces "A" (*vide* section) with solid masonry (the weight of which would be 34,000 per span), or, if preferred, shoring and strutting between the face walls of the opening with beams. I prefer the former method. Should such method fail to reduce vibration, and I fear it will fail, I see nothing for it but to build a new head sluice and either destroy the present sluice or keep it with the new one in reserve as is done at Seetanagram.

In the former case, I would place the new sluice just in rear of the present one. In the latter, just behind the bridge over the main canal and alter the lock into a double one, the lower gates being nearly in line with the new sluice.

The danger of the latter arrangement would be failure of the wall between the lock and the river in high flood. This would be much more liable to fail than the sluice and would require very deep foundation protection to prevent the water forcing itself under the foundations of the wall and up into the lock through the floor.

I would prefer the former arrangement.

(Signed) W. M. ELLIS, Capt., R.E.,
Ex. Engr., Kistna Northern Dn.

No. 3661 K.N.

Forwarded to the Chief Engineer for Irrigation with the following remarks.

2. The head sluice at Bezwada has been carefully examined and, though there are several small cracks in the work, none of them appear to be new or at all serious.

3. The inside of the vents show signs of severe water action, but there is nothing in the condition of the sluice to excite alarm, and there will be no difficulty in putting the whole work into good order.

(c) It will affect the statical stability of the head sluice to the extent of shifting the resultant pressure some 4 to 6 inches nearer the centre of the base of the work.

(d) By enabling us to close or almost close the head sluice allows us to escape the vibration and shocks caused by the water entering and rushing through the vents in large masses and with great velocity. It appears to be a doubtful point whether this dynamic action counterbalances the greater statical pressure brought on the sluice by closing the vents. Personally, I think it far more than counterbalances it.

(e) By enabling us to almost or quite close the head sluice during floods allow us to keep out a lot of silt which now enters the canals at such times.

(f) Increase the capacity of the lock for navigation in ordinary times and enable the lock to be used for navigation at times when it is now closed and also add greatly to the safety of the existing lock during floods by means of the double lock, the formation of which forms a part of the scheme.

3. The alternatives to a regulator, such as is now proposed, are two—

(a) To build a new head sluice either just in rear or on the site of the present one making it amply strong to withstand all floods. This would cost about 1¼ lakhs.

(b) To build as at Sitanagaram a work at such a distance in rear of the present sluice as to act as a regulator without necessitating the destruction of the present head sluice. This work to be of such a design as to be capable of replacing the head sluice should that work fail at any time. Were the site suitable this would, in my opinion, be the course to adopt, but it is not suitable. The lock chamber wall would have to be rebuilt and prolonged up to the new work and would have to withstand the whole head to which the present sluice is subjected were that work to fail. Unless a most expensive work were built the wall would be a standing source of danger and anxiety. In other respects, also, the site is not well adapted for this alternative. The cost would be at least 1½ lakhs.

4. The present head sluice was carefully examined last dry season. There are many cracks but no serious ones and none seem to have increased lately even under the stress of the great floods of 1896. The alterations made since then have had the effect of reducing vibration in a marked degree. The vibration during the highest floods of this year was not greater than that of the old Sitanagaram sluice at the same time. Under these circumstances, I think it would be questionable policy to build a new sluice and destroy the old one (case "A"). This was the course of action I originally advocated, but the improvement in the old sluice, as regards vibration, has caused me to alter my views—this especially as the cost of the regulator is less than I anticipated it would work out to.

5. I therefore submit the estimates with a strong recommendation that this or a work of a similar nature may be sanctioned.

6. If sanctioned by the end of February, I could arrange to put in the foundations of the prolonged piers of the bridge and put in the foundations and build the dividing wall between the lock and the basin up to a height of 15 feet during next working season. This would leave all plain sailing for completing the work the year after. Such a work would not commit one to any special type of shutter but only to the general arrangements of the design. It is, however, highly desirable that the type of shutter should be decided on early. Colonel Smart's shutters are, it is believed, more economical and would probably answer the purpose.

No. 53 K. N.

Forwarded to the Chief Engineer for Irrigation for orders. The necessity for a regulator in rear of Bezwada head sluice is dealt with in Mr. Higham's notes, paragraph 16 (e), published with G.O., No. 550 I., dated 14th June 1897.

2. If the general arrangements proposed are approved there appears no reason why foundations should not be put in this year as these would not be affected by alterations in the type or details of shutters or other gear. Early orders would be necessary if any action in this direction is to be taken.

3. Owing to the necessity for early orders no copies have been made of the designs, and it is requested that the plans may be returned with any orders concerning the work. Copies could then be made and sent for reference.

(Signed) W. M. ELLIS, Capt., R.E.,
Offg. Supg. Engineer, II Circle.

7th January 1898.

Enclosures.

Note on statical stability of Bezwada Head Sluice.

The previous notes on this subject to be referred to are—

Kistna Northern, dated 7th March 1897, and forwarded to Superintending Engineer with this office, No. 837 S.E., dated 11th March 1897.

Chief Engineer for Irrigation, memo. No. II/67 K.S., dated 10th April 1897.

The Chief Engineer points out that, supposing the joints of the piers to be watertight, it is incorrect to deduct the specific gravity of water from that of the stone composing the submerged part of the piers in taking out the stability of the sluice. This is true supposing the joints of the stone to be watertight; but this is not so in this case to at least a partial extent. The effect of the water rushing through the vents is to rake out the joints of the masonry to a great depth. When examining the structure during last closure, I found many joints into which I could insert a footrule as much as 9 inches. The stone also is of a porus nature. I therefore very much doubt if the assumption that the submerged piers may be counted at their full weight in air is a correct one. I must admit, however, that this point was overlooked in making the first note on the subject.

2. The difference made by taking the submerged masonry of the piers at its full weight has now been calculated, and the results are noted as follows :—

Case I.—The part of the sluice originally built only being constructed. (The part of the work referred to by the red lines in the diagram originally submitted is referred to . Height of water in front of the sluice 26½ feet. The resultant pressure falls outside the middle third of the base by the distance noted below under the several conditions shown :—

Table I.

—	Deductions made for submergence of piers.	Deductions not made for submergence of piers.	Deductions not made for submergence of piers. No pressure assumed on area of open vents. Vents epen 4·1 foot.
	FT. INS.	FT. INS.	FT. INS.
Canal empty	1 11	1 11	..
,, 12 feet deep	2 0	1 8	1 1½
,, 15 ,, ...	1 10	1 2	..

Case II.—Waterlevel in front of sluice as before taking the whole structure as it now stands and considering the additions made as forming an integral part of the sluice (see blank lines in original diagram) and further the hollow at A filled in solid with masonry. Then in every case the resultant pressure falls within the middle third.

Making no reduction for the submergence of piers and considering the sluice as if the shutters were closed. The statical stability works out as under—

Table II.

Canal empty.	Canal 12 feet deep.	Canal 15 feet deep.	—
FT. INS. 0 10	FT. INS. 1 1	FT. INS. 1 5	Distance resultant pressure falls within the central third.

3. The effect on the statical stability of the sluice considering that there is no water pressure acting on the area of the vents open is shown in the third column of table I for the case when there is 12 feet of water in canal and the vents of sluice open 4·1 foot. This was the amount open in the great floods of 1896. This shows that the sluice considering only the part originally built is unstable under a record of flood under every condition and that the opening of vents has little effect on the statical stability, the diminution of pressure being nearly counterbalanced by the consequent raising of the levels of the centre of pressure.

4. The sluice, including the additions to the rear part being taken as one mass is statically stable under all conditions. As stated in my first note on the subject, it is probable that the truth lies between the two.

With regard to the effect on the stability of the sluice of opening the vents, I take the view that the shocks to which the sluice is subjected by the mass of rushing water passing through it has the effect of reducing stability by causing vibration, and that such reduction of stability is probably greater than any gain by reduction of statical pressure caused by opening the vents. I believe that, with a regulator in rear holding up 15 feet of water behind it, the sluice would be safer altogether shut than partially open. This, however, I cannot prove, and it is only a matter of conjecture.

5. There can be no doubt that, as regards vibration, the alterations made since the floods have caused a material improvement to the condition of this sluice.

These alterations are —

(*a*) Building the new parapet wall in front and falling in the span (6′ 6″ × 3′ 3″ sectional area) below it with solid concrete.

(*b*) Filling in the hollows (A) over the vents of the added part with sand surfaced with concrete.

In the highest floods of this year the vibration of the sluice was not more than that of the Sitanagaram old sluice on the other side and not at all abnormal. I took special and personal note of this. I will remember the excessive vibration of this sluice in the moderate floods of 1895. In the similar floods of this year no such vibration was noticeable.

9th December 1897.

(Signed) W. M. ELLIS, Capt., R.E.,
Ex. Engineer, Kistna Northern Divn.

From the Superintending Engineer, II Circle, to the Executive Engineer, Kistna Northern Division, dated 1st July 1897, No. 975 K.N.

The undersigned has the honour to invite the attention of the Executive Engineer to paragraph 16 of Mr. Higham's notes printed with G.O., No. 550 I., dated 14th June 1897.

2. It will be observed that these notes were first issued (so far as the Kistna is concerned) with G.O., No. 231 I., dated 6th March 1897, and it is necessary to consider what steps have been taken to comply with the orders received.

3. As regards the height and section to which the left training bank up stream of the Kistna bridge should be maintained, the Chief Engineer for Irrigation has been informed that the top of the bank should be 6 feet above the H.F.L. of August 1896, and that the present section of bank is considered sufficient if the extra height required is given by a small bank on the river-side of the roadway along the top of the present bank.

4. Turning to the works mentioned in paragraph 6 —

(*a*) Is being attended to.

(*b*) Has not been attended to, but the alternative proposed in the last clause of paragraph 10 of the notes has been adopted, or, in other words, the present practice will be continued.

(*c*) Will be attended to by the Railway department.

(*d*) Is being attended to.

(*e*) This subject must now be taken up. In the opinion of the undersigned, the arrangements should be as follows:—

Construct a regulator (with 3 spans of 40 to 50 feet each with shutters to hold up 15 feet of water) at such distance in rear of the present Bezwada head sluice, as will avoid excessive disturbance of the water in the chamber; the site that suggests itself is immediately below the ghâts or steps on each side of the main canal.

Abandon all idea of using the lock during very high floods. The only vessels that could be taken out on the river during very high floods are the new steamers, and these can always be moored in the slack water near the boat lunka.

A design by Mr. Stoney for three 50-feet span vents with shutters and a description of the proposals are forwarded for information and with a request that a rough design may be made for the masonry required to fit up these shutters.

5. In the opinion of the undersigned it is of the greatest importance, in the interests of navigation, that the spans should be as large as possible, for with a full canal and a strong wind it is even now no easy matter to bring a boat from the lock channel into the main canal, and therefore it is essential that the waterway should be blocked as little as possible.

These proposals are, of course, open to much criticism, for they are based on the assumption that the existing head sluice will, with the assistance and relief afforded by the proposed regulator, last practically for ever.

6. It is not now necessary to discuss the various arrangements that might be made, but when sending in the plan and estimate for the new regulator, the facts brought out by the recent examination of the statical conditions of the head sluice during high floods, will be again laid before Government, together with any suggestions that Captain Ellis may wish to make, such as making the rear regulator sufficiently strong to take the place of the existing sluice.

No. 36 I.

Note by the Chief Engineer for Irrigation.

In his report on the flood of August 1896, the Superintending Engineer, II Circle, described the vibration in the Bezwada head sluice and the apparent danger of its failure when the flood was near its maximum height. The opinion was formed that the work was insecure and that a regulator was required in rear to hold up water to such a level as would reduce to a safe limit the pressure on the sluice and at the same time enable water in the canal to be kept down to any desired level.

2. The work was subsequently inspected by the undersigned in company with the Inspector-General of Irrigation. The following is an extract from the undersigned's notes of inspection :—

"3. *Eastern head sluice.*—A very neat parapet has been built from the anicut, over the head sluice, to the upper gates of the lock. The head sluice is said to be in good order, but is not to be relied on to withstand a very heavy flood unless the pressure can be adequately reduced. The Superintending Engineer proposes to effect this by a regulator capable of holding up 15 feet of water between it and the head sluice. The regulator would have to be of 3–40 feet spans. If fitted with shutters of Lieutenant-Colonel Smart's design, it would cost probably three-fourth lakh. I am not altogether satisfied with the proposal, as nothing can compensate for the absence of a head sluice capable of standing any possible pressure from the river side with just enough water in the canal to permit of navigation. It is frequently desirable to reduce the intake when the water is very silty and especially so in heavy floods. A regulator would enable this to be done, but assuming the intake one-fourth of what it was on the 6th August, the head sluice would be liable to not less strain than on that occasion when the vents were opened 4 feet : thus reducing the pressure in front to 180 tons less than it would have been with one foot of vents open. This was about the amount of relief afforded by raising the water in rear from ordinary full supply level to 13 feet. The area of vents open is therefore a factor not to be neglected in calculations. Before making designs for a regulator, the Superintending Engineer should calculate the strains in the head sluice assuming depths front and rear 27 and 15 feet above floor, and the sluice raised and strengthened as far as practicable. The work should be closely inspected during the closure in order to see whether it has sustained any damage and whether it can be trusted to stand a maximum flood. If there is cause to doubt its security, it will have to be considered whether a new head sluice cannot be built. Unfortunately there is no good site for one."

3. The Inspector-General's views are given in his notes—paragraphs 14 to 16—printed with G.O., No. 550 I., dated 14th June 1897, as follows :—

"14. It remains to consider what other works are required to ensure the safety of the head works during an extraordinary flood, and which must be undertaken whether the bridge is lengthened or not. The weak points are the head sluices or regulators on each bank. As regards those on the Sitanagaram side or Western delta canal, it appears that, owing to apprehensions felt as to their safety, a second regulator was commenced in 1895, a chain or two below the existing work so as to take its place in the event of failure. The chamber referred to in paragraph 4 of the Superintending Engineer's No. 1244 K., dated 13th August 1896, is the length of canal lying between the two regulators, and the construction of the retaining walls proposed was in progress during my visit. This lower regulator was only partially completed when the flood occurred, but it was of considerable service, as by the insertion of planks, water was held up 2·65 feet in the chamber. The head on the upper regulator was 13·85 feet, which is almost as much as it can stand with safety, and if it had not been for the lower regulator, it would have been necessary either to increase this head or to have increased the canal supply from 11·20 to 13·85 feet, which would have increased the number of breaches, and also have brought into the canal a very large quantity of silt. If the lower regulator had been completed, the canal might have been closed altogether or the supply reduced to the minimum required. The work is, however, in active progress and should be completed before next flood season. The other works in the Western delta head sluice, referred to in paragraph 7 of the Superintending Engineer's letter, No. 1244 K., dated 13th August 1896, were also in hand."

15. "On the Bezwada or Eastern delta side there is no second or ancillary regulator, and in order to avoid subjecting the existing regulator to an excessive head, the depth of water admit- ted into the canal as measured on the rear gauge was 12·9 feet, and this has resulted in a very heavy silt deposit in the upper reach of the canal. A second regulator is very necessary on this side, but to construct it on the ordinary pattern with small vents would lead to a great loss of head, which cannot be spared in view of the extensions of irrigation which are contemplated in the Eastern delta. The Superintending Engineer, therefore, proposes to build two piers in the line of the piers of the existing bridge below the head sluices, with suitable flank walls, and to have three large sluice gates of 40 feet span, constructed in accordance with Stoney's patent. This will be more costly than sluices of the ordinary type, but under the conditions that obtain at the site, will be the most suitable form of regulator. Unless something of the kind is made, there will always be a danger of the head regulator failing in such a flood as occurred in August last, so that apart from the advantage of being able to control the amount of flood water passed into the canal, the matter may be regarded as one of great urgency, and the necessary plans and estimates should be prepared at once. If preferred, the sluices might be constructed on the principle proposed by Colonel Smart, referred to in paragraph *infra*, which is said to be less expensive than Stoney's system, and in the situation proposed could certainly be worked without any risk of failure, but this is a detail to be considered when the plans are under preparation."

16. "The works required at Bezwada are therefore—

(*a*) Substitution of falling shutters for the upper 2 feet of anicut.
(*b*) Extension of the apron downstream of the anicut and under-sluices.
(*c*) Raising and strengthening the left training embankment between anicut and bridge.
(*d*) Completion of the lower regulator and connected works in the Sitanagaram side.
(*e*) Construction of a lower regulator on the Bezwada side, consisting of three 40-feet sluices.

"Of these (*a*), (*d*) and (*e*) may fairly be charged to the Capital Account of the canal, and (*b*) might also be so charged unless the Local Government prefers to charge it to Revenue; (*c*) should apparently be carried out at the cost of the railway as part of the bridge works."

"I understand that no estimate has yet been sanctioned by the Government of India for the work now in progress in the Sitanagaram side, and that the outlay already incurred is held under objection. It appears to have been thought that, under the orders conveyed in Government of India letter, No. 95, dated 8th May 1896, estimates for new works for which no provision was available from the current sanction for the Kistna canals could not be considered or sanctioned until the construction estimate had been formally closed on 31st March 1898. This is, however, a misapprehension. In the letter referred to, the Government of India declined to sanction an addition of Rs. 8,00,000 in a lump sum to the existing sanction for the Kistna canals to provide generally for unforeseen contingencies, but there is nothing in those orders to prevent the submission of specific estimates even before the closing of the construction estimate for works that may be urgently required. Such estimates will be considered on their merits, and if the safety of the canal works is involved, no time should be lost in submitting them for the orders of the Government of India."

4. At this time no calculations had been made of the strength of the sluice and the opinions expressed must be taken as provisional. Since then there has been some correspondence on the subject, and it is desirable that the papers be referred to the Inspector-General through the Government of India for a further expression of his opinion. The section of the sluice shows the additions made at different times. The calculations show that it would add comparatively little to the stability of the sluice to hold up water to 15 feet depth in rear instead of the 10 feet which we are now obliged to admit owing to weakness of the river bank below the sluice when the river is in very high flood. They also show that, if the portion added in rear of the sluice in 1869 can be taken as an integral portion of the work, the maximum pressure in the piers is only 6 tons per square foot. Without this addition, the sluice would be demonstrably unsafe, as the pressure would be 8 to 9¼ tons, and the masonry would be in tension for 5½ to 6½ feet from its face. The new part of the sluice must undoubtedly add greatly to the strength though perhaps not so much as if it had been a part of the original work. It is probable that the pressure in the piers is something between the extremes mentioned above possibly 7 tons per square foot with 10 feet of water in canal. This does not seem too much as long as the piers are kept

in good order. The piers are at least faced with dressed stone and the erosion of mortar in the points referred to by Captain Ellis does not appear serious, as this cannot occur to any large extent in a single year and the points can always be made safe for the future by filling them with cement. Since the construction of the parapet and the better connection of the rear part with the original work of the sluice which has recently been carried out, the vibration is said to have decreased. The lowering of the anicut by 2 feet further tends to the security of the sluice. With regard to the question whether there may not be a risk of material being blown out from under the sluice, if not more than 10 feet of water is admitted into the canal, I do not think there is any real danger. The foundations must have been subjected to more severe trials before the rear part was added than are ever likely to occur in future. Under all the circumstances I am of opinion that a regulator in rear is not required and do not propose to submit an estimate for it unless the Inspector-General with full information before him adheres to the opinion that it is necessary.

(Signed) W. HUGHES,
Chief Engineer for Irrigation.

26th January 1898.

ORDER—No. 184 I., dated 9th March 1898.

The note by the Chief Engineer for Irrigation will be forwarded to the Government of India with a request that the papers may be sent to the Inspector-General of Irrigation for a further expression of his opinion.×

× Opin
lees
Picks
26/

[Here enter No. 185 I., dated 9th March 1898.]

(True Extract.)

(Signed) W. HUGHES,
Joint Secy. to Government,
Irrigation Branch.

To the Chief Engineer for Irrigation.
„ the Superintending Engineer, II Circle.
„ G. T. Walch, Esq.

ENDORSEMENT—No 185 I., dated 9th March 1898.

Forwarded accordingly.

(Signed) W. HUGHES,
Joint Secy. to Government,
Irrigation Branch.

Exd. Md. Pahlivan.

Public Works (1898) Department.

CURRENT No. 1724

Print with C. E.'s letter

From

The Chief Engineer for

Order

No. 36 I.

Dated 26 January 1898

Received
Registered } 24. 2. 98

Enclosures ~~14~~ (~~3~~ plans)

Spare copies

1 plan not

24

SUBJECT:

Regulator in rear of Berwada Head Sluice. Note suggesting with reasons that the — is unnecessary

CK PAPERS.

No.	Date.

FURTHER PAPERS.

No.	Date.

Public Works Department,
Irrigation Branch.

H.E. ~~Very urgent~~ Very Urgent

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Note suggesting with remarks that the regulator in rear of Bezwada Head sluice is unnecessary-

UNDER date the

READ the following

Print with note

From Supg:Engineer, Second circle (H.E.NO:3661.KN.dated 19th March/97

Print

To ---------- DO -------------(H.E.NO:67.KSdated 10th April 1897)

From -------- DO -------------(H.E.NO:727.KW.dated 3rd June/97)

From -------- DO -------------(H.E.NO:53.KN.dated 9th Jany/98)

Print with E E letter No 588 d/ 10-12-97 note on statical stability and letter to E E No 975 KN dated 1st July 1897.

Print

Note by the Chief Engr:for Irrign (H.E.NO: 36 .I.dated 26-1-1898)

No 184 I 9.3.98

The Note by the Chief Engineer for Irrigation will be forwarded to the Government of India with a request that the papers may be sent to the Inspector General of Irrigation for a further expression of his opinion.

A.S.H. 7.2.98

Print & Issue Emergently

Endorsement- No: 185 I 9.3.98

Forwarded accordingly.

24/2

W. Hughes.

3.2

7/2/98

To

The Chief Engr:for Irrigtn.

" Supg:Engineer, Second Circle.

G.T.Walch Esquire.

D 17/3/98

Note for W Office

The following plans to Govt India

1. Bezwada Head sluice - Section through centre of arch of the sluice
Diagram of forces.

2. Do

3. Plan of Existing & Proposed Bezwada H[illegible] works

4. Site plan of Head works

5. Design for regulator in rear of Bezwada Head Sluice in 4 Sheets.

6. Copy of [illegible]

E. I. Form No 1—1,000—27-11-95.

Public Works (1898) Department.

B/

CURRENT No. 11 KS

1000

From The Superintending Eng
4 Circ

Order

No. 53 K.N

Dated 9 January 1898
Received 11 — Do —
Registered
Enclosures 10*(*5 plans)
Spare copies

SUBJECT.

Regulator in rear of
Bezwada Head slui
Forwarding with rem
a rough estimate for
constructing a

D.E.I.

15/1/98

McC
17/1/98

BACK PAPERS.

No.	Date.
R 357 I dy	29-6-97
R 195 Ko	3-6-97

FURTHER PAPERS.

No.	Date.

Report to accompany design for ancillary Regulator Eastern Delta Main Canal, Bezwada.

The design is submitted with reference to the inspection notes by Mr J. Higham, C.I.E Inspector General Irrigation published with G.O 550 I of 14 June 97 para 16 (c) and in general accordance with the instructions Containe in letter No 975 K.N ×of 1.7.97 from the Superintending Engineer, II Circle.

Copy attached ×

2/ It has been proposed to place the regulator just below the bathing ghauts which are on both sides of the Main Canal below the bridge. This site is not Considered a suitable one and the designs have been made placing the regulator on the prolongation of the piers of the present bridge 3 spans of 40 feet and closing the lock entrance with a pair of lock gates designed to hold up 15 ft of water.

I believe the question of using the bridge 3/ as a support for the shutters has previously been considered and abandoned owing to the restricted area within the basin between the Head sluice and the bridge and the fear of causing such an increase in the turmoil and disturbance which takes place as to endanger the safety of the works. An increase in the disturbance would no doubt be caused by placing the shutters on the front side of the bridge; but it is believed that this will not be the case if the shutters are placed in rear of the bridge on the prolongation of its piers The piers of the bridge will then tend to form a true bed for the water up to the Regulator and thereby tend to diminish irregular action and turmoil.

4/ If the works were placed below the bathing ghauts the ~~[illegible]~~ space between the bridge and regulator will form a second chamber in which disturbance

somewhat

somewhat similar to that in the existing one would be set up and the area being restricted there are possibilit of this disturbance being so violent a to be dangerous. This view may be erroneous but it has been arrived at aft carefully watching the action of the water in the chamber and run off through the bridge.

5/ I submit therefore that the best and safest place for the regulator is on the prolongation of the piers of the bridge and further that the position just below the bathing ghauts would be liable to cause excessive and unnecessary action.

I have verbally represented these matters to Major Baddeley, R.E., and obtained his permission to make the design for the works in the positions shewn in modification of original orders

6/ Excluding the question of disturbance and turmoil the site on the prolongation

of

f the bridge piers has very striking dvantages as compared with one lower down.

These are

(a) There will be no interference with navigation

(b) The economical construction of a second lock chamber is facilitated and forms part of the proposal.

(c) Considerable economy in construction will result.

If the regulator be built below the bathing ghauts any span under which navigation is to pass must be raised to such a height that the top will be some 40 ft above canal bed.

The navigable facilities at the wharf would be much restricted and the bathing ghauts would be rendered useless as bathing would be dangerous within the chamber. The inconveniences resulting from such a site would be considerable and the cost of works much enhanced.

The design provides for the prolongation of the piers of the bridge and for mounting on the prolongations 3 shutters 40 feet span 15 ft high to be moved on free rollers (Stoney's patent) and lifted by gear worked by hand and consisting of wynches actuating a worm shaft and wheel.

By means of spur gear this motion is conveyed to lifting drums round which are coiled the wire ropes carrying the shutters. The gear etc is a modification to suit the special conditions of site of the design submitted by Messrs Ransom and Rapier. Instead of being worked by a single wynch in the centre of the span each shutter is raised by 2 wynches – one at each end

Only necessary as platform is omitted -

As there is no platform over the shutters some such modification is necessary. There is only one wynch on each piers but by arranging that the pinion shaft can be moved horizontally parallel to its axis so as to gear on to the spur wheel actuating the gear of the shutter on either side of the pier as may be desired, one wynch is made to do work on two shutters =

A simple friction brake should be provided for each wynch to check the shutters when lowering - This is not shewn in the design. All the shutters could be lowered but they could not be raised simultaneously.

The dimensions and details of gear has not been worked out, as should these shutters be adopted the details of design would doubtless be arranged by the patent holder.

Messrs Ransom and Rapier's design provides for an overbridge and 50 ft span shutters but not for teak planking on the fall of the shutters.

The saving in omitting an overbridge and reduction of span of shutter to

to 40 feet may be taken as a set off against the cost of the teak planking and the price per square foot quoted by messrs Ransom and Rapier viz $\overset{s}{31}/6^{d}$ per square foot or say $\overset{Rs}{26}$ per sq. ft is the rate assumed in the rough estimate submitted. The shutters are designed to lift clear of a full Canal (12 feet)

8/ The treatment of the lock entrance and navigation is provided for by lock gates converting the lock into a double one the maximum depth for which the lower lock chamber is designed is 15 ft and lock chamber should be kept with the same depth of water as is held up on the Basin between the Head sluice and the regulator when not passing traffic. To facilitate this a sluice in the dividing wall between the two is provided.

This dividing wall must be rebuilt to withstand a head of 7 feet.

This head is arrived at by supposing that 8 ft will be the least water in the canal when navigation is in progress and the regulator is holding up 15 ft of water.

To get sufficient stability it is necessary to carry the dividing wall up to roadway level and the lock gates have been carried up also to this level for convenience of working and economy in gear although such a height is not otherwise necessary.

It is only proposed to plank the gates up to a height 15½ feet.

It is proposed to make the prolonged 9
piers of surki concrete faced up to 11½ feet with 1¼ feet Sattenapalli granite (granitoid gneiss) and above that level with Bezwada stone (dressed faces) to be in keeping with the rest of the bridge.

The granite is required to withstand the

the wear caused by the rush of water.

The flooring under the shutters to be rough granite similar to that in the chamber between the sluices at Seetanagaram. The wall between the lock and chamber to be Bezwada rough rubble in surki mortar with dressed faces. This being a heavier material than concrete is desirable to secure stability.

If the nature of the bottom permits of driving I strongly recommend a row of sheet piles below the foundations of the wall between the chamber and lock. This would cost an extra Rs 3000/ This is not provided for as it will probably prove impossible to drive piles.

A rough estimate on these lines is enclosed with the designs.

10 A further note on the effect of the proposed work on the statical stability of the Head sluice in continuation of previous correspondence on the subject ending with Superintending

Engineer's endorsement $\frac{234 K.N}{22-4-97}$ on Chief Engineer for Irrigation's memo: $\frac{II}{67K.S}$ dated 10.4.97 is Enclosed?

Wm. Ellis
Captain, R.E.,
Executive Engineer,
Kistna Northern Divn.
8.12.97

7/12/97

P.W.D. ENGINEER'S OFFICE
No. 2830 R
3
97

CHIEF ENGINEER FOR IRRIGATION.
11 JAN 1898
No. 11 KS
2

Regulator in rear Bezwada Head sluice

E. 120.
50,000—12-2-97.

ESTIMATE FORM.—Detail Measurements.

Detail of Work.	Number.	Measurements in Feet. Length.	Measurements in Feet. Breadth.	Measurements in Feet. Depth.	Area or Contents.	Total Quantity of each description of Work.
1	2	3	4	5	6	7
Concrete in surki mortar						
Foundations under prolonged piers	4	36.5	9.0	6.0	7,884	
under the wall between the lock chamber and basin	1	170.0	9.0	8.0	12,240	
Superstructure						
Prolonged piers	4	16.5	7.0	26.0	12,012	
Do	4	6.0	7.0	18.5	3,108	
Do	4	6.0	7.0	11.5	1,932	
Cut waters	4	area 23.0		11.5	1,058	
semi circular portion of pier	4	19.25		14.0	1,078	
Caps over piers	4	Contents 30			120	
Total					39432	
Deductions						
Settanapalli facing stone to piers up to + 52.00	8	40.5	11.5	1.25	4,658	
Bezwada facing stone from + 52.00 to 59.00	8	28.5	7.0	1.25	1,995	
do from + 59.00 to 63.50	8	22.5	4.5	1.25	1,012	
do semicircular portions of piers	4	11.0	11.5	1.25	633	
Grooves	6	3.0	3.0	26.0	1,404	
					9702	
Net concrete in surki mortar					29730	or 298 units
Rough stone in surki mortar						
Wall between lock chamber and basin	1	170.0	7.0	27.0	32130	
Deduct for dressed facing	1	170.0	56.25	1.25	11953	
					20177	or 202.0 units
Cut stone Work						
Corbelling over piers	4×3	35.0	1.5	1.0	630	
Pedestal for railing over piers	4	25.0	1.0	0.5	50	
Carried over					680	

[illegible] under Head Sluice.
Regulator in [illegible]

ESTIMATE FORM.—Detail Measurements.

Detail of Work.	Number.	Measurements in Feet. Length.	Breadth.	Depth.	Area or Contents.	Total Quantity of each description of Work.
1	2	3	4	5	6	7
	Brought forward				680	
Cut stone work (Continued)						
Corbelling over the wall between the lock chamber & basin	1x3	170·0	1·5	1·0	765	
Total					1445	or 14·5 units
Settanapalli facing stone						
as per deductions in surki Concrete					4658	or 47·0 units
Bezwada facing stone						
as per deductions in surk Concrete and rough stone in surki mortar					15593	or 156·0 units
Pointing with surk mortar						
as per dressed facing					6638	
Corbelling over piers	4	35·0	4·25	"	595	
Tops of piers	4	20·0	9·0	"	720	
Caps	4	Contents 70·0		"	280	
Wall between lock chamber and basin both sides & top	1	170·0	63·0	"	10710	
					18943	or 190·0 sqrs
Flooring						
Between piers	3	40·0	36·5		4380	
In lock channel	1	36·5	20·0		730	
					5110	or 51·0 sqrs
Roughstone packing						
In rear of flooring	1	166·0	12·0	2·0	3984	or 40·0 units

ESTIMATE FORM.—Abstract.

Quantity	Description of Work	Rate.	Per	Amount	Total.
1	2	3	4	5	6
		RS.		RS.	RS.
298·0	units Concrete in surki Mortar	12·0·0	100 cft	3576	
202·0	do Roughstone —do—	12·8·0	do	2525	
14·5	units cutstone work	50·0·0	do	725	
47·0	do Facing with Settanapalli granite stone dressed fine on faces average thickness 1'-3"	55·0·0	100 cft	2585	
156·0	units Facing with Bezwada stone dressed fine on faces average thickness 1'-3"	37·0·0	100 cft	5772	
190·0 sqrs	Pointing with surki mortar	1·12·0	100 sft	333	
51·0 sqrs	Flooring with Settanapalli rough stone granite 6" thick set in surki mortar over bed of 1' Concrete	30·0·0	do	1530	
40·0	units Rough stone packing	4·8·0	do	180	
				17226	
	Petty supervision			414	
	Contengencies			860	
				18500	
	Lock gates including gearing etc Complete			5300	
No 3	Stoney's shutters for regulator including gearing etc Complete	15600	each	46800	
	Shutter & gearing etc Complete for sluice between lock & basin			500	
	Erecting shutters & Contengencies etc			1900	
	Excavating & Pumping			2000	75000

Grand Total of Estimate .. 75,000

Station Bezwada
Date 10 December 1897.

Supdg Engr 2nd Circle 8/1/98

8.12.97
Captain R.E.
Executive Engineer.
Kistna Northern Division

Ad 6/12/97

No. 2830 Kst
4

CHIEF ENGINEER
FOR IRRIGATION.
11 JAN. 1898
No. 11/98

(E. No. 132.)

50,000—12-2-97.

CIRCLE—

DIVISION—

DISTRICT—

TALUK (OR ESTATE IN CASE OF ESTATE WORKS.)

ESTIMATE FORM.—Abstract.

Financial Head—

Budget Head—

Departmental Head—

Main Head—

Sub-Head—

Project of which the work forms part—

Section—

Name of Work— Rough estimate for constructing Regulator in rear Bezwada Head sluice.

Amount of Estimate, Rs.— 75,000

To be carried out by—

REFERENCES.

6556
1724/98

~~C.O. 17~~ S.O. 17

Print

Note on statical stability of Bezwada Head sluice

The previous notes on this subject to be referred to are:-

Kistna Northern dated 7-3-97 & forwarded to Superintending Engr. with this office No. 837 S.E., d/ 11-3-97.

Chief Engineer for Irrigation memo No. II/67 K.S., dated 10-4-97.

Print

The Chief Engineer points out that supposing the joints of the piers to be watertight it is incorrect to deduct the specific gravity of water from that of the stone composing the submerged part of the piers in taking out the stability of the sluice. This is true supposing the joints of the stone to be watertight; but this is not so in this case to at least a partial extent. The effect of the water rushing through the vents is to rake out the joints of the masonry to a great depth. When examining the structure during last closure I found many joints into which I could insert a foot rule as much as 9 inches. The stone also is of a porus nature. I therefore very much doubt if the assumption that the submerged piers may be counted at their full weight in air is a correct one. I must admit, however, that this point was overlooked in making the first note on the subject.

2. The difference made by taking the submerged masonry of the piers at its full weight has now been calculated and the results are noted as follows:-

Case I

The part of the sluice originally built only being constructed. Considered

(The part of the work referred to by the red lines in the diagram originally submitted is referred to) Height of water in front of the sluice 26½ feet. The resultant pressure falls outside the middle third of the base by the distances noted below under the several conditions shewn

Table I

	Deductions made for submergence of piers	Deductions not made for submergence of piers	Deductions not made for submergence of piers No pressure assumed on area of open vents. Vents open 4'·1 ft
Canal empty	1' 11"	1' 11"	—
" 12 ft. deep	2' 0"	1' 8"	1' 1½"
" 15 ft. deep	1' 10"	1' 2"	—

Case II. Water level in front of sluice as before taking the whole structure as it now stands and considering the additions made as forming an integral part of the sluice (the black lines in original diagram) and further the hollow at A filled in solid with masonry. Then in every case the resultant pressure falls within the middle third.

Making no reduction for the submergence of piers and considering the sluice as if the shutters were closed the statical stability works out as under

Table II

Canal empty	Canal 12 ft. deep	Canal 15 ft. deep	
0' 10"	1' 1"	1' 5"	Distance resultant pressure falls within the central third.

3. The effect on the statical stability of the sluice considering that there is no water pressure acting on the area of the vents open is shown in the 3rd Column of table I for the case when there is 12 ft. of water in Canal and the vents of sluice open 4.1 ft. This was the amount open in the great floods of 1896.

This shows that the sluice considering only the part originally built is unstable under

not unstable
It is only that
there is tension
in the front part
M

under a period of floods under every condition and that the opening of vents has little effect on the statical stability, the diminution of pressure being nearly counterbalanced by the consequent raising of the level of the centre of pressure

?

4. The sluice including the additions to the rear part being taken as one mass is statically stable under all conditions. As my stated in my first note on the subject it is probable that the truth lies between the two.

With regard to the effect on the stability of the sluice of opening the vents I take the view that the shocks to which the sluice is subjected by the mass of rushing water passing through it has the effect of reducing stability by causing vibration and that such reduction of stability is probably greater than any gain by reduction of statical pressure caused by opening the vents. I believe that with a regulator in rear holding up 15 ft of water behind it, the sluice would be safer altogether shut than partially open. This, however, I cannot prove and it is only a matter of conjecture.

5. There can be no doubt that as regards vibration the alterations made since the floods, have caused a material improvement to the condition of this sluice. These alterations are:-

(a) Building the new parapet wall in front and filling in the span (6'6" x 3'3" sectional area) below it with solid concrete.

(b) Filling in the hollows (A) over the vents of the added part with sand surfaced with concrete.

In the highest floods of this year the vibration of the sluice was not more than that of the Seethanagaram old sluice on the other side and not at all abnormal. I took special and personal note of this. I well remember the excessive vibration of this sluice in the moderate floods of 1895. In the similar floods of this year no such vibration was noticeable.

(Sd) W. M. Ellis Capt R.E.
9.12.97
Executive Engineer
Kistna Northern D.

(True Copy)

[illegible] Manager.
Superintending Engr 1st Circle

8/98

R 11 KS/97
6

Ocs. 11
1224/53

1 W ~~24~~ 21

Print

Letter from the Super-intending Engineer, II Circle, to the Executive Engineer, Kistna Northern Division, No. 975 K N, dated 1st July 97.

The undersigned has the honor to invite the attention of the Executive Engineer to para 16 of Mr. Higham's notes printed with G.O. No. 550 I, 14-6-97

2. It will be observed that these notes were first issued (so far as the Kistna is concerned) with G.O. No. 231 I, 6-3-97 & it is necessary to consider what steps have been taken to comply with the orders received.

3. As regards the height & section to which the left training bank up stream of the Kistna bridge should be maintained, the Chief Engineer for Irrigation has been informed that the top of the bank

should be 6' above the H.F.L. of August '96 and that the present section of bank is considered sufficient if the extra height required is given by a small bank on the river side of the road way along the top of the present bank.

4 Turning to the works mentioned in para 16

(a) Is being attended to

(b) Has not been attended to, but the alternative proposed in the last clause of para 10 of the notes has been adopted, or in other words the present practice will be continued.

(c) Will be attended to by the Railway department.

(d) Is being attended to.

(e) This subject must now be taken up. In the opinion of the undersigned, the arrangements

should be as follows:-

Construct a regulator (with 3 spans of 40 to 50 feet each with shutters to hold up 15 ft of water) at such distance in rear of the present Bezwada Head sluice, as will avoid excessive disturbance of the water in the chamber; the site that suggests itself is immediately below the ghats or steps on each side of the main canal

Abandon all idea of using the lock during very high floods The only vessels that could be taken out on the river during very high floods are the new steamers & these can always be moored in the slack water near the boat lunka.

A design by Mr Storey for three 50' span vents with shutters are a description of the proposals are forwarded for information & with a request that a rough design may be made for the masonry required to fit up these shutters.

6. In the opinion of the undersigned it is of the greatest importance in the interests of navigation, that the spans should be as large as possible, for with a full canal and a strong wind, it is even now, no easy matter to bring a boat from the lock channel into the main canal, and therefore it is essential that the waterway should be blocked as little as possible.

These proposals are of course open to much criticism

for

for they are based on the assumption that the existing head sluice will, with the assistance and relief afforded by the proposed regulator, last practically for ever.

7. It is not now necessary to discuss the various arrangements that might be made, but when sending in the plan and Estimate for the new regulator, the facts brought out by the recent Examination of the statical conditions of the head sluice during high floods, will be again laid before Government, together with any suggestions that Capt. Ellis may wish to make, such as making

the rear regulator sufficiently strong to take the place of the Existing sluice.

CHIEF ENGINEER
FOR IRRIGATION.
11 JAN. 1898
No. ~~11 KS~~
5

(True copy)

Mr. Dysshon
Manager,
Superintending Engr's office
II Circle.

D.
8/98.

Occ: 10
1726/38

No 36-I of 26-1-98

Note by the Chief Engineer for Irrigation.

Encls of plans
1 Copy of report
1 Copy of Note
10

In his report on the flood of August 1896 the Superintending Engineer, Second circle, described the vibration in the Bezwada Head Sluice and the apparent danger of its failure when the flood was near its maximum height. The opinion was formed that the work was insecure and that a regulator was required in rear to hold up water to such a level as would reduce to a safe limit the pressure on the sluice and at the same time enable water in the canal to be kept down to any desired level.

2 The work was subsequently inspected by the undersigned in company with the Inspector General of Irrigation. The following is an extract from the undersigned's Notes of Inspection:—

"3 **Eastern head sluice**- A very neat parapet has been built "from the anicut, over the head sluice, to the upper gates of "the lock. The head sluice is said to be in good order, but is "not to be relied on to withstand a very heavy flood unless "the pressure can be adequately reduced. The Supg: Engineer pro"-poses to effect this by a regulator capable of holding up 15 "feet of water between it and the head sluice. The regulator "would have to be of 3-40 feet spans. If fitted with shutters "of Lieutenant Colonel Smart's design it would cost probably "3/4 lakh. I am not altogether satisfied with the proposal, as "nothing can compensate for the absence of a head sluice capa"ble of standing any possible pressure from the river side "with just enough water in the canal to permit of navigation.

"It is frequently desirable to reduce the intake when the water is very silty and especially so in heavy floods. A regulator would enable this to be done, but assuming the intake one-fourth of what it was on the 6th August, the head sluice would be liable to not less strain than on that occasion when the vents were opened 4 feet: thus reducing the pressure in front to 180 tons less than it would have been with one foot of vents open. This was about the amount of relief afforded by raising the water in rear from ordinary full supply level to 13 feet. The area of vents open is therefore a factor not to be neglected in calculations. Before making designs for a regulator the Supg: Engineer should calculate the strains in the head sluice assuming depths front and rear 27 & 15 feet above floor and the sluice raised and strengthened as far as practicable. The work should be closely inspected during the closure in order to see whether it has sustained any damage and whether it can be trusted to stand a maximum flood. If there is cause to doubt its security it will have to be considered whether a new head sluice cannot be built. Unfortunately there is no good site for one."

3 The Inspector General's views are given in his notes paras 14 to 16 printed with G.O.NO:550.I.dated 14th June 1897 as follows:-

"14. It remains to consider what other works are required to ensure the safety of the head works during an

extraordinary

"extraordinary flood, and which must be undertaken whether the bridge is lengthened or not. The weak points are the head sluices or regulators on each bank. As regards those on the Sitanagaram side or Western delta canal, it appears that owing to apprehensions felt as to their safety, a second regulator was commenced in 1895 a chain or two below the existing work so as to take its place in the event of failure. The chamber referred to in paragraph 4 of the Supg: Engineer's NO:1244.K. dated 13th August 1896, is the length of canal lying between the two regulators, and the construction of the retaining walls proposed was in progress during my visit. This lower regulator was only partially completed when the flood occurred, but it was of considerable service, as by the insertion of planks, water was held up 2.65 feet in the chamber. The head on the upper regulator was 13.85 feet, which is almost as much as it can stand with safety, and if it had not been for the lower regulator, it would have been necessary either to increase this head or to have increased the canal supply from 11.20 to 13.85 feet, which would have increased the number of breaches, and also have brought into the canal a very large quantity of silt. If the lower regulator had been completed, the canal might have been closed altogether or the supply reduced to the minimum required. The work is, however, in active progress and should be completed before next flood season. The other works in the Western delta head sluice referred to in paragraph 7 of the Supg: Engineer's letter, NO:1244.K, dated 13th August/96 "were also in hand".

"15. "On the Bezwada or Eastern delta side there is no "second or ancillary regulator, and in order to avoid subjecting the existing regulator to an excessive head the "depth of water admitted into the canal as measured on the "rear gauge was 12.9 feet, and this has resulted in a very "heavy silt deposit in the upper reach of the canal. A second regulator is very necessary on this side, but to construct it on the ordinary pattern with small vents would "lead to a great loss of head, which cannot be spared in "view of the extensions of irrigation which are contemplated "in the Eastern delta. The Supg: Engineer, therefore, proposes "to build two piers in the line of the piers of the existing bridge below the head "sluices, with suitable flank walls, and to have three ~~large~~ "large sluice gates of 40 feet span, constructed in accordance with Stoney's patent. This will be more costly than "sluices of the ordinary type, but under the conditions that "obtain at the site will be the most suitable form of regulator. Unless something of the kind is made, there will always be a danger of the head regulator failing in such a "flood as occurred in August last, so that apart from the "advantage of being able to control the amount of flood "water passed into the canal the matter may be regarded as "one of great urgency, and the necessary plans and estimates "should be prepared at once. If preferred, the sluices might "be constructed on the principle proposed by Colonel Smart "referred to in paragraph infra, which is said to be less "expensive than Stoney's system, and in the situation proposed "could certainly be worked without any risk of failure, but this "is a detail to be considered when the plans are under preparation."

16. "The works required at Bezwada are therefore-

"(a) Substitution of falling shutters for the upper two feet of anicut.

"(b) Extension of the apron downstream of the anicut and undersluices.

"(c) Raising and strengthening the left training embankment between anicut and bridge.

"(d) Completion of the lower regulator and connected works in the Sitanagaram side.

"(e) Construction of a lower regulator on the Bezwada side, consisting of three 40-feet sluices.

"Of these (a), (d) and (e) may fairly be charged to the Capital account of the canal, and (b) might also be so charged, "unless the Local Govt: prefers to charge it to Revenue; (c) "should apparently be carried out at the cost of the railway, "as part of the bridge works".

" I understand that no estimate has yet been sanctioned by "the Govt: of India for the work now in progress in the Sitanagaram side, and that the outlay already incurred is held under objection. It appears to have been thought that under the "orders conveyed in Govt: of India letter NO:.95.I.dated 8th "May 1896, estimates for new works for which no provision "was available from the current sanction for the Kistna canals "could not be considered or sanctioned until the construction "estimate had been formally closed on 31st March 1898. This is, "however, a misapprehension. In the letter referred to, the Govt "of India declined to sanction an addition of Rs 8,00,000 in a "lump sum to the existing sanction for the Kistna canals to "provide generally for unforeseen contingencies, but there "is nothing in those orders to prevent the submission of "specific estimates even before the closing of the construction estimate for works that may be urgently required. "Such estimates will be considered on their merits, and if "the safety of the canal works is involved, no time should "be lost in submitting them for the orders of the Govt: "of India."

4. At this time no calculations had been made of the strength of the sluice and the opinions expressed must be taken as provisional. Since then there has been some correspondence on the subject and it is desirable that the papers be referred to the Inspector General through the Govt of India, for a further expression of his opinion. The section of the sluice shows the additions made at different times. The calculations show that it would add comparatively little to the stability of the sluice to hold up water to 15 feet depth in rear instead of the 10 ft which we are now obliged to admit owing to weakness of the river bank below the sluice, when the river is in very high flood. They also show that if the portion added in rear of the sluice in 1869 can be taken as an integral portion of the work the maximum pressure in the piers is only 6 tons per sq:foot. Without this addition the sluice would be demonstribly unsafe as the pressure would be 8 to 9¼ tons and the masonry would be in tension for 5½ to 6½ feet from its face. The new part of the sluice must undoubtedly add greatly to the strength though

perhaps

perhaps not so much as if it had been a part of the original work. It is probable that the pressure in the piers is something between the extremes mentioned above possibly 7 tons per sq:ft with 10 ft of water in canal. This does not seem too much as long as the piers are kept in good order. The piers are at least faced with dressed stone and the erosion of mortar in the points referred to by Captain Ellis does not appear serious as this cannot occur to any large extent in a single year and the points can always be made safe for the future by filling them with cement. Since the construction of the parapet and the better connection of the rear part with the original work of the sluice which has recently been carried out the vibration is said to have decreased. The lowering of the anicut by two feet further tends to the security of the sluice. With regard to the question whether there may not be a risk of material being blown out from under the sluice if not more than 10 ft of water is admitted into the canal I do not think there is any real danger. The foundations must have been subjected to more severe trials before the rear part was added than are ever likely to occur in future. Under all the circumstances I am of opinion that a regulator in rear is not required and do not propose to submit an estimate for it unless the Inspector General with full information before him adheres to the opinion that it is necessary.

W. Hughes.

Chief Engineer for Irrigation.

To

The Joint Secretary to Government,

P.W.D. Irrigation Branch.

Print

Copy of Letter from Captain W. M. Ellis R.E. Executive Engineer, Kistna Northern Division, to the Superintending Engineer, 4 Circle No. 588 E.E. 10-12-97

Your No. 975 R.N., dated 1-7-97.

I have the honour to submit herewith a design and a rough estimate amounting to Rs 75,000/ for a regulator in rear of Bezwada Head Sluice.

Along with the estimate I submit a further note showing the statical effect on the stability of the Head Sluice which will be affected by the construction of the regulator under various conditions.

2 The result shows that, considered purely statically, the effect of the regulator holding up 15 ft of water will not be such as to bring the resultant pressure in a maximum flood within

the central third of the base of the original sluice. The regulator, however, has the effect of reducing the greatest intensity of pressure on the sluice supposing the canal to be empty from 1654 lbs per sq ft to 718 lbs per sq ft. In practice, however, the canal has always been filled up to 12 ft in a big flood and the intensity of pressure on the Head sluice in such a case is only 905 lbs per sq. ft.

Check – this seems very little

2 The regulator will therefore

(a) Enable us to keep the water in the canal at any convenient depth during floods instead of being forced as at present to keep the canal abnormally high at a time when this is practically inconvenient, causing breaches and damage to crops.

(b) It will reduce the maximum intensity of pressure on the Head Sluice from 905 to 718 lbs per sq ft.

(c) It will affect the statical stability of the Head sluice to the extent of shifting the resultant pressure some 4 to 6 inches nearer the centre of the base of the work.

(d) By enabling us to close or almost close the Head sluice allows us to escape the vibration and shocks caused by the water entering and rushing through the vents in large masses and with great velocity. It appears to be a doubtful point, whether this dynamic action counterbalances the greater statical pressure brought on the sluice by closing

5

the vents - Personally I think it far more than counterbalances it.

(e) By enabling us to almost or quite close the Head sluice during floods allow us to keep out a lot of silt which now enters the canals at such times.

(f) Increase the capacity of the lock for navigation in ordinary times and enable the lock to be used for navigation at times when it is now closed and also add greatly to the safety of the existing lock during floods by means of the double lock the formation of which forms a part of the scheme.

3. The alternatives to a regulator such as is now proposed are two:-

(a To build a new Head sluice

either

either just in rear or on the site of the present one making it amply strong to withstand all floods.

This would cost about 1¼ lacs.

(b) To build as at Sithanagaram a work at such a distance in rear of the present sluice as to act as a regulator without necessitating the destruction of the present Head sluice. This work ~~is~~ to be of such a design as to be capable of replacing the Head sluice should that work fail at any time. Were the site suitable this would in my opinion be the course to adopt; but it is not suitable. the lock chamber wall would have to be rebuilt and prolonged up to the new work and would have to withstand the whole head to which the present sluice is subjected were that work to fail— Unless a most expensive work were built the wall would be a standing source of danger and anxiety. In other respects also the site is not well adapted for this alternative. The cost would be at least ~~would be~~ one half lacs.

4. The present Head sluice was carefully examined last dry season. There are many cracks but no serious ones and none seem to have increased lately even under the stress of the great floods of 1896. The alterations made since then have had the effect of reducing vibration in a marked degree. The vibration during the highest floods of this year was not greater than that of the old Seethanagaram sluice at the same time. Under these circumstances I think it would be questionable policy to build a new sluice and destroy the old one (case II). This was the course of action I originally advocated but the improvement in the old sluice as regards vibration has caused me to alter my views— this especially as the cost of the regulator is less than I anticipated it would work out on to.

5. I therefore submit the estimates with a strong recommendation that this or a work of a similar nature may be sanctioned.

6. If sanctioned by the end of February I could arrange to put in the foundations of the prolonged piers of the bridge and put in the foundations and build the dividing wall between the lock and the basin up to a height

of 15 ft. during next working season this would leave all plain sailing for completing the work the year after. Such a work would not commit one to any special type of shutter but only to the general arrangements of the design. It is however highly desirable that the type of shutter should be decided on early. Col. Smart's shutters are, it is believed, more economical & would probably answer the purpose.

Enclosures. 10.
1 D & A Estt.
1 Report
1 Tracing
1 Letter from Mr G. M. Stoney Esq
1 Copy of letter from S.E. to E.E. K.N.D.
1 Note
4 Plans (sent separately)

No. 53 K.N / 9.1.98

Forwarded to the Chief Engineer for Irrigation for orders. En 10.

The necessity for a regulator in rear of Bezwada Head sluice is dealt with in Mr. Higham's notes para 16 (e) published with G.O. No. 550 I. / 14.6.97

2. If the general arrangements proposed

proposed (are) approved there appears no reason why foundations should not be put in this year as these would not be affected by ~~the~~ alteration in the type ~~&~~ details of shutters or other gear. Early orders would be necessary if any action in this direction is to be taken.

3. Owing to the necessity for early orders no copies have been made of the designs and it is requested that the plans may be returned with any orders concerning the work. Copies could then be made and sent for reference.

Supg. Engrs office.
II Circle, Bezwada
7th Jany 1898

Wm. H. Ellis Capt R.E.
Offg. Superintending Engr.
II Circle

JM.

8/1/98

8/1/98

CHIEF ENGINEER
FOR IRRIGATION.
11 JAN. 1898
No. 11 KS

6205/12
1224/38

Public Works (1897) Department.

CURRENT No. 195 KS

From

Major W. L. C. Baddeley R.E.
Supg Engr 2nd Circle

No. 727 K W

Order

Recd.
11/6/97
WH

Dated 3rd June 1897

Received 8 6 97

Registered

Enclosures

Spare copies

SUBJECT.

The Bezwada
Head Sluice —
Reports on the Stability
of the —.

To D.E.I.

Indexed

LCG
9/6/97

14-6-97

BACK PAPERS.

No.	Date.
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FURTHER PAPERS.

No.	Date.
R 11 Ko	9-1-98

Decn 11

SUPERINTENDIND ENGINEER'S OFFICE,
SECOND CIRCLE,

No. 727 K.N.

DATED 3rd June 1897

Print

FROM,

Major W. L. C. Baddeley R.E.
SUPERINTENDING ENGINEER,
II CIRCLE.

TO,

The Chief Engineer,
For Irrigation,
Madras.

Enclos:

SIR,

In reference to para 3 of your Memo no. II/67 K.S. d/ 10th April 1897 I have the honour to inform you that the space between the old and new portions of the Bezwada Sluice has been filled with sand, with a layer of concrete on top.

The filling in has only been carried out up to the level of the platform of the rear part of the Sluice.

The additional weight added amounts to rather less than 6 tons over each vent, or under 90 tons on the whole Sluice.

I

I hope that this may have the effect of reducing the vibration in the sluice during floods.

CHIEF ENGINEER
FOR IRRIGATION.
8 - JUN 1897
No. 195 K.S.

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

Wm Barclay
Major R.E.
Supg Engr. II Circle

55

Public Works (1897) Department.

IRRIGATION BRANCH.

II

ISSUE No. 67 K.S.

To

The Supg Engineer
2nd Circle

(Reply to letter No. 3661 K.R. dated 19/3/97).

Dated 10-4-97
Despatched 14 do
Enclosures *

* Particulars of Enclosures.

SUBJECT.

Bezwada Head Sluice
Remarks on the proposals regarding the stability of —

Indexed

Form No. 13—2,000—23-2-97.

BACK PAPERS.

No.	Date.
R83KS	19. 3. 97

Sent to Government with No. I.,
dated 1897.
Printed with G.O., No. I.,
dated 189 .

REMINDERS ISSUED.

No. 1, dated 189 .
" 2 "
" 3 "
" 4 "
" 5 "

KEEP-WITHS.

FURTHER PAPERS.

No.	Date.
R141KS	24-4-97
R195KS	3-6-97
R11KS	9-1-98

IX
No. 67 KS of 10-4-97

SE II

His No 3661 KN d/ 19.3.97

It is satisfactory to find that the Berenda Head Sluice shows no serious signs of injury and the that its stability as shewn by the calculations is greater than was anticipated.

2. The great difference in weight of the masonry shown in the cases when the canal is empty and with 12 to 15 ft water indicates some error (on the safe side however) in the calculations of the upward pressure of the water. If the piers have been included with the submerged masonry and the calculations made as if there were an open joint between them and the floor most if not all of the error would be accounted for. The error is not of importance except that it might lead one to under-value the support and relief given to the sluice by the admission of a large body of water into the canal

The opening of the ~~Sluice~~ vents tends in several ways to obviate danger. It reduces the pressure in front, increases that in rear, reduces the pressure tending to cause leakage under the work and probably saves the Shutters which are only 3" or 4" thick from being blown in. The necessity of admitting a considerable depth into the Canal in floods must be accepted as long as the present Sluice is the only regulating work and it remains to do whatever is feasible to strengthen the ~~Sluice~~ work.

dangerous

3 The second line of Shutters fitted in 1869 or 1870 was apparently intended to facilitate the working of the needle Shutters in the front of the vents. They were plank Shutters running on rollers. The inefficiency of the arrangements for working them was commented on by the Chief Engr for Irrigation in his Inspection notes of Mch 1871 and Sept 1874 ~~but~~ and it is presumed the defects were remedied as ordered and that the Shutters continued to be used until the Screw Shutters were fitted to the Sluice ~~which~~

in 1881. It has been considered whether it would be advisable to put in again a rear line of ~~Screw~~ Shutters so as to make the Sluice double and so reduce the velocity through the vents but the practical difficulties of working such Shutters to advantage, fitted as they would be in the same vents as the front shutters, are indisputable and the idea of the Supd. and Exe. Engineers to improve the connection of the addition built in 1868-9 is accepted as the best feasible. The Supd Engr. must decide how this can best be done. Probably it would be well to fill the whole space between the two parts of the Sluice with cement concrete made with not too much water.

4 The Supd Engr. refers to some slight cracks. If these are in the piers which undoubtedly are greatly overweighted in ~~[illegible]~~ a 26½ ft flood they may indicate some serious danger. The SE will ~~[illegible]~~ oblige by reporting where they are and by noting their position so that any future enlargement may be detected —

5 With regard to the vibration of the Sluice in the flood of last

year only those who were present have the means of judging whether any suggested causes may be correct – The filling between the old and new parts of the Sluice should at least reduce the vibration but there seems likely to be always some when water is admitted to such a level as to impinge with a high velocity against the ~~rear~~ inner face of the rear arches –

6. The Supd. Engineer's attention is drawn to the Irrigation Chief Engineer's instructions in his letter of March 1881 regarding the permissible ~~limit of~~ difference of water level ~~between~~ in the Canal and River. If there is nothing to show that the danger which then existed has since ceased those instructions must be adhered to.

W.A.

10/4/97

Public Works (1897) Department.

CURRENT No. 83 K.S.

Order

From

Major W. L. C. Baddeley R.E.
Supdg. Engr., II Circle

No. 3661 K.N.

Dated 19 March 1897

Received 22 – 3 – 97

Registered

Enclosures 2

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SUBJECT.

The Bezwada Head Sluice – Reports on the stability of with proposals &c —.

To D.E.I.

W.C.B.
22/3/97

22-3-9

BACK PAPERS.

No.	Date.

FURTHER PAPERS.

No.	Date.
I67Ks	10-4-97
R141Ks	21-4-97
R195Ks	3-6-97
R11Ks	9-1-98

SW4

Note on Bezwada Head Sluice

Print

The Bezwada Head Sluice is subjected to very great vibration and shakes all over during moderate floods. Such vibration is not noticeable in the Case of the Seetanagaram Sluice on the other side of the river —

On examining the design of the sluice it will be noticed that in the original design the width of the sluice from face wall to original rear wall (front of 2nd row of grooves) is 16′-2″

The width of the Seetanagaram sluice is 24′-6″.

The latter sluice is a good deal cracked both arches wings and piers and has been

$p = 62.5 \times \frac{(26.5)^2}{2} \times 9$

$= 62.5 \times 702.25 \times 9$

```
   702.25
     62.5
   351125
  140450
 421350
 43890.625
         9
2|395016
  197508   lb
```

$+ 16\frac{1}{6} \times 27 \times 9 = 27 \times 145$ [illegible]

$- 16\frac{1}{6} \times 12 \times 6$ [illegible]

[illegible] 329560

[illegible] 368 [illegible]

been for some years regarded as unreliable nevertheless there is an absence of the vibration which is noticed in Bezwada Sluice. In 1867-68 an addition was made to the Bezwada Sluice by adding the 2nd vents in rear and prolonging the piers backwards a distance of 7'-1" making a total length of pier of 23'-3" and a corresponding distance between front and rear face walls. This is about the same as the Seetanagaram Sluice but the nature of the buildings differ as below:-

(a) In the fact that the former was all built at the same time whereas the latter was not,

(b) The only parts in Bezwada Sluice where the addition backs up the old work is in the prolongation of the piers, between these there are openings left for working the needles in the second vents.

The Bezwada Sluice so far as we know is a perfectly sound work and has not cracked seriously, and the only explanation of the excessive vibration, — having in view the fact that this does not happen at Seetanagaram, is that the old work does not back up and support the new in the way it would have done had all been built at the same time or without the openings for the rear shutters.

With a view of studying the conditions of pressure in the Bezwada Sluices diagrams have been drawn showing the lines of resultant pressure.

I. Supposing the Sluice to be as in the great floods of last August without the new parapet wall, and further supposing the addition in rear to have no effect in supporting it. These diagrams are in red lines.

II. Supposing the addition in rear to have the full effect it might be supposed to have, had it been built at the same time as the rest of Sluice.

The base of the pier in Case I is of length 16'-2" and in Case II, 23'-3".

These diagrams are in black lines.

In Case I,

Supposing a head of 26½ ft. in front of the Sluice

The resultant pressure falls without the middle third of the base under the following conditions of water level in rear as shown

	Resultant outside middle third of base.
Canal Empty.	1'-11"
" 12 ft deep.	2'-0"
" 15 ft. deep.	1'-10"

Vide. Red lines on Diagram marked R_0. R_{12} R_{15}.

The reason why the stability results are actually more disadvantageous with 12 ft.: than with the Canal empty is, that a deduction of 62.5 lbs per C. ft. is made on each C. ft of masonry submerged and this more than counterbalances the reduction by the 12 ft head of water in the Canal.

The results are undoubtedly striking

as showing that from a point of view of actual stability no advantage is to be gained by holding up water to a moderate height behind a sluice. There is, however, a gain in diminution of pressure on the piers and also, less tendency to blow up of the floor.

Case II.

The black lines show resultant pressures for Case II and shows that the resultant pressure falls well within the middle third.

Two different conditions are taken

(1) with the sluice as it now stands.

(2) with the open space "A" filled in solid with masonry.

In both cases the canal is supposed to be empty, the wall

4'-6" high built on the sluice platform since the floods, is taken into consideration.

The diagrams, therefore, show

Case I = Considerable deficiency in stability.

Case II = Ample stability.

The truth probably lies between the two but considering the great vibration it is probable that Case I more nearly represents the truth than Case II.

There are 2 reasons for Case II not approximating to the truth for the sluice either

(a) The additional length added on the section of the piers is not sufficiently bonded and backed into the original structure to act as an integral part of it.

(b)

(b) The great voids left for the working of the needle shutters has affected the stability of the work.

A diagram of stability has been taken out for a section across the centre of an arch and this shows that the original work is perfectly stable down to this level and I am inclined to favour (a) as being the explanation but for all that I would try blocking in the spaces "A" (Vide Section) with solid masonry (the weight of which would be 34,000 per span) or if preferred shoring and strutting between the face walls of the opening with beams. I prefer the former method. Should such method fail to

APG

to reduce vibration and I fear it will fail I see nothing for it but to build a new head sluice and either destroy the present sluice or keep it with the new one in reserve as is done at Seetanagaram.

In the former case I would place the new sluice just in rear of the present one. In the latter just behind the bridge over the main Canal and alter the lock into a double one; the lower gates being nearly in line with the new sluice.

The danger of the latter arrangement would be failure of the wall between the lock and the river in high flood. This would be much more liable to fail than the Sluice and would require very deep foundation protection to prevent the water forcing itself under the foundations of the wall and up into the lock through the floor.

I would prefer the former arrangement.

/Sd/ W. M. Ellis, Capt: RE
Exe Engineer, K N Dn

/ True Copy /

[illegible] Manager
Supg Engrs Offic, II Circle,

CHIEF ENGINEER
FOR IRRIGATION.
No. 83. RS

Letter from Captain W. M. Ellis R.E. Executive Engineer, Kistna Northern Dn to the Supg Engineer, 2nd Circle, dy 11.3.97. No 837 S.E.

Print

In accordance with verbal instructions, I have the honour to forward a tracing of Stability Diagrams taken out for Bezwada Head Sluice. I also enclose a note on the Stability of the Sluice with references to the diagrams.

No 3661 K.N
19.3.97

Encl
1 Note
1 Tracing
2

Forwarded to the Chief Engineer for Irrigation with the following remarks.

2. The head sluice at Bezwada has been carefully examined and though there are several small cracks in the work, none of them appear to be new or at all serious.

3. The inside of the vents show signs of severe water action, but there is nothing in the condition of the Sluice to excite alarm and there will be no difficulty in putting the whole work into good

order.

4. The question of faults in the design has been carefully gone into and I agree with Captain Ellis R.E. that if the Structure could be made monolithic, its stability would be increased very considerably; but I am not at present in favour of building in the vacant spaces between the old and new work with masonry. I think it would be better to try the effects of struts and shores and I have directed the Exe: Engineer to prepare the necessary plans and estimates.

5. In considering the loss of stability caused by holding up of water in rear of the Sluice it must not be forgotten that the risk of the floor blowing up is very much diminished by reducing the head, and it would in my opinion be a most dangerous experiment to close the vents of the Sluice entirely during a heavy flood, unless there was a subsidiary work in rear to hold up, say, 15 feet of water.

6. If the work that I propose to carry out this season to bring the back part of the Sluice into use during floods, proves successful in reducing vibration, I am not at all sure that a subsidiary sluice in rear to hold up 15 ft: of water would not be advisable, for though it would rarely come into operation it would prevent any risk of the sluice blowing up although it would to some extent diminish the stability.

7. The difficulties in the way of building a sluice in rear of the old one of such dimensions ~~and~~ as to take the whole head of the river, are very great but the subject is receiving attention and before long some practicable scheme may be thought out.

W. Baddeley

Major R.E.

Supg Engineer, II Circle

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