CHAPTER 68

EXECUTION OF TRAINING DIKES AT THE OUTLET OF A DIVERSION CHANNEL ON THE COAST OF JAPAN SEA

by

Toru Shigemi : Director, Construction Division, Hokuriku Agricultural Administration Bureau, Kanazawa, Japan
Kagetoshi Amano : Chief, Reclamation Construction Section, Hokuriku Agricultural Administration Bureau, Kanazawa, Japan
Kazuaki Mizuno : Director of Kaga-Sanko Reclamation Office, Komatsu, Japan
Tokuhiro Takada : Reclamation Engineer, Reclamation Construction Section, Agricultural Land Bureau, Ministry of Agriculture and Forestry, Tokyo, Japan

ABSTRACT

The record of the construction work of training dikes at an outlet of a diversion channel is presented here. The discharge in this channel is very small throughout the irrigation season and this fact makes difficult to maintain open outlet against the drift sand. Therefore the training dikes must be extended to fairly large depth. The special difficulty of execution is the limitation of construction time in summer that is a sole season of quiet sea.

INTRODUCTION

This paper presents a report on a part of the reclamation project of Kaga-Sanko (Kaga three lagoons). This project is to reclaim the lakes derived from lagoons separated from the Japan Sea by sand dunes.

Such kind of reclamation works requires either widening the existing rivers or opening a new channel in order to divert flood water from the related basins into the sea. The success of entire reclamation project depends solely on the capacity of this diversion channel, the drainage of which, if sufficiently great, keeps the neighboring fields from being submerged.

Our project was a Japanese precursor of this kind of reclamation. In addition to technical difficulties, the execution presented other problems. Unlike the construction of other public work of harbors, as that the agricultural reclamation in Japan has to be partly financed by the farmers who are to be allotted the reclaimed land, although the fund can be borrowed from the government. Thus the facts that an unlimited invest-

ment for the project was not permissible and that the construction of this kind of diversion channel had never been executed in Japan, required considerations other than merely technical.

DIVERSION CHANNEL

Shibayama-gata, Imae-gata, (called collectively the Kaga-Sanko) are located in central Japan on the coast of the Japan Sea (Fig. 1). The low land around these lagoons used to suffer from frequent floods due to counter-currents from the river Kakehashi, which was the only outlet for the water from these three lagoons. Nevertheless its drainage capacity is rather poor and the most of the farm land here was frequently flooded.

Thus, this project was planned with the multiposes; (1) to provide a means of fully utilization of the surrounding farm area, to modernize agricultural techniques and thereby to increase the productivity from the land; (2) advancing general development including other industries well adapted to the locality; (3) properly distributing employed labor; (4) preserving the land by building reclamation dikes, and so forth. The construction works of this project to obtain 502ha of farm land by the reclamation of the Kaga-Sanko and to improve the drainage of 2,311ha of surrounding low land were started in 1952 under the direct supervision of the Ministry of Agriculture and Forestry.

In planning the diversion channel the conditions of the river flowing into the lagoons, the inflow at the time of floods, the direction of wind, the topography, the gradient of channel etc. were taken into consideration. It was confirmed that it would be better both technically and economically to open a new channel at the place where Shibayama-gata is closest to the sea. This was decided in order to discharge the outflow from Shibayama-gata directly into the sea thereby dividing the body of water into two systems: that of Lake Shibayama and that of Lake Kiba and Lake Imae, rather than maintaining the then existing drainage system as it was and merely to widen the river Kakehashi and to empty the entire outflow through it into the sea.

In 1914, the farmers in this district tried to dredge a channel in order to keep the farm land from being inandated by the flood, and completed it in four years at nearly the same place as our plan. However the outlet was completely closed by drifting sand immediately after the opening. If the dikes were projected into the sea for enough outside the zone where the bottom sand and silt is moved by the wave, there would be no fear of clogging the outlet. In that case, however, the exorbitant investment required would be too much of a burden to the farmers concerned and this agricultural reclamation would be an impossible thing. Therefore, considerations outside mere techniques had to be taken into account at present. Accordingly, the decision was made to extend a pair of training

dikes, which are mainly composed of caissons and the length should at least be sufficiently large to avoid clogging at the outlet. Thus the dikes end at a depth of 8m, the left one 117.2m long and the right 89.7m. After the execution, the movement of drifting sand, the change of the shore line, gradient of the bottom, etc. were investigated but no tendency of clogging was found. The structure, execution and after checks of the dikes will be outlined in the following.

DESIGN OF THE TRAINING DIKES

Wind waves : The wind direction at the location is W to NW in winter, E to NE in summer, but sand drifting is conspicuous in winter when the average wind velocity is V=13.0m/s and fetch is L=750km. From these the following items are calculated: Offshore wave height is Ho=4.50m; Period is T=11.0s; Offshore wave length is Lo=188.76m.

Coastal observation : According to the report submitted by Professor Aramaki, the coast in this part has been suffering from erosion as great as 2,000m in past 1,800 years and it is still in process of receding. Besides, the shore line fluctuates greatly, and thus there is as much as 15 to 30m difference in the position of the shore line between the summer depositing period and the winter erosive period. In winter season the shore line can move 10m in a few days. Notably, in January, 1963, the shore line receded drastically by more than 100m in a particular spot.

As to coastal deposits, the gravel coast in summer becomes sandy in winter. The coast is 1.5m to 2.0m lower in the winter. These phenomena are quite extraordinary in Japan.

The shoreline constantly fluctuates since sand and gravel are carried offshore at the time of high waves and then they are brought back and deposited just off the shore line as the wave subsides. On the other hand, the movement on the sea bottom, judging from the gradient, is very active between the shoreline and the bottom of approximate depth of 6m, about 200m offshore. The limits of active littoral drift must be 8~9m deep, 250~300m offshore. The gradient is 1/10, which is greater than that at the mouth of the river Kakehashi. Judging from the layout of the bottom layers and the amount of sand measured by direction, sand drifting in a SW direction is particularly abundant and the movement is very quick. Thus, on the coast having such an active movement of sand and gravel, artificial structures would greatly influence clogging of outlets, coastal erosion, etc.

Direction of the training dikes : To avoid the most frequent direction of waves so as to minimize the wave energy entering the channel; to keep the channel clear of the disturbance of waves reflecting from the dikes or advancing along the

dikes and to make use of the results of observations at the training dikes of the river Kakehashi, the direction adopted was nearly straight north. The distance between the two dikes was gradualy decreased towards the head in order to make use of the tractive force of the outflowing water.

Length of the dikes : The dikes have to be extended farther than the 5.45m depth where the design wave of 4.50m breaks. They were actually extended 8.0m depth which judging from the study of the contour of the bottom is supposed to be the maximum depth for the wave-instigated movement of the bottom silt and sand. The final decision is;
The lengh of right dike is 89.7m (original plan; 93.0m), and that of left dike is 117.2m (original plan; 133.0m)

Structure of dikes : Due to an unexpectedly great strength of wind waves the original project to build compound dikes of block mounds and caissons was altered into that of building upright training dikes mainly composed of caissons with some cellular blocks but no block mounds (Fig. 2, Fig. 3).

From the shoreline to the depth of 3.0m, wave is not so powerful and four 5M caissons were used, which are 5.0m high, 6.0m long and 9.0m wide (Fig. 4). Farther than this point the caissons of three different heights and four kinds of cellular blocks were used in combination. Although, as for the structure, 5m to 8m high caissons would be appropriate for this part of the dikes, the water at the slipway has to be 8m deep for the launching and 6.5m deep for the tugging. No harbor maintaining such a depth is to be found nearby and the expense of building such a construction would be too great to sustain. Hence caissons and cellular blocks mentioned above were used in combination. The dikes inside the shoreline are of well type.

For the protection of the dikes, 4 ton tetrapods along the well dikes and 2 to 6 layers of 8 ton tetrapods along the caissons are installed to decrease the wave energy.

Concerning the stability of the dikes, the safety factor was intended to be over 1.5 for overturn and over 1.2 for sliding. Caisson itself would be safe enough against overturning but would be somewhat unstable to prevent sliding under the design condition. Therefore 8 steel pipe piles (500mm in diameter and 9mm in thick) were driven into the foundation every 9m in order to secure enough stability.

EXECUTION OF THE PROJECT

In order to surmount the difficulties of the stormy sea where works could be done only during the period from the middle of May to the middle of August (even during this period wind waves were so strong as to make it impossible to work once every

week or ten days, and for the succeeding few days were needed for reopening the mouth closed by the waves) a caisson slipway and two platforms for constructing caissons were built in the channel about 150m inland from the shore line (Fig. 4). The slipway was 15m wide and about 8m long; the platforms were 13.0 m wide and 10.0m long. Caissons were constructed upon the platforms and those with a bottom were launched as soon as they were completed and cellular blocks were launched with the aid of floats. Both were tentatively placed inside the channel and then tugged to the construction site and sunk when the sea was fairly calm. After caissons were sunk, the pile space was filled with gravel and then concrete was poured in with pressure. The central space was filled with sand by a suction dredger and then immediately topped with concrete lest the sand should be washed away by waves.

Installing work of caissons was started in 1960, but the channel was frequently clogged or dislocated caissons had to be readjusted so progress was delayed. However, by utilizing meteological and seashore observation, appropriate measures were taken and the installation work was completed in August, 1965.

REPORT ON OBSERVATIONS

As has been stated above the construction of the dikes was executed from 1960 to 1965. During this period the sea bottom was sounded once or twice every year (Fig. 5). As a result, it was known that sand deposit raised the bottom level 3 to 4m at a place 50m apart from the head and 2 to 3m, 100m away from the head, but no great change was found over 150m away from the outlet.

During the most changeable period of winter from October, 1964 to March, 1965, which was the last period of the main construction of the dikes, the sea bottom and the shore line were reinvestigated. The results showed that the contour of the bottom had not undergone any remarkable change and that the shore line on the right side alone advanced or receded aproximately 30m for certain days. There was, however, no particular change on other days. So it was decided that there may be no necessity to lengthen the established plan further more.

If we observe the contour line map of sea bottom for the latest coastal change, it is noticed there was distinct elevation of the bottom along the center line of the dikes and the contour lines there advanced by 50 to 80m but the change was not large at the depth exceeding 9~10m.

On the right side of the dikes, the contour lines advanced 40 to 70m and so did the shore line by 20 to 40m but there was not recognigeable influence any farther east than the spot 400

to 500m away from the dikes. On the left side, the contour lines receded 30 to 50m within the zone of about 200m west of the dikes and the shore line likewise receded approximately 30m. Therefore the dikes are protected by tetrapods, both dikes have shoals deposited 70 to 100m along the shore from the channel and they are thus securely imbedded.

The period of observation has not been long enough for us to draw a definite conslusion, but further observation will be made. Nevertheless, at least up to the present time no tendency to close the outlet of channel has been noticed.

CONCLUSION

The present project had economical qualification due to the farmers sharing the expense and the dikes were shortened to the least necessity. Considering as indices the position of wave breaking and the range of movement of silt and sand, the project was successfully executed and seems to have achieved its purpose. Its success has contributed a great deal to similar projects at Hachiro-gata and Kahoku-gata on the Japan Sea coast.

Our profoundest gratitude is due to Prof. Homma, Dr. Tsuruoka and other members of the Kako-shingi-kai (River-Outlet Council) for their guidance and encouragement.

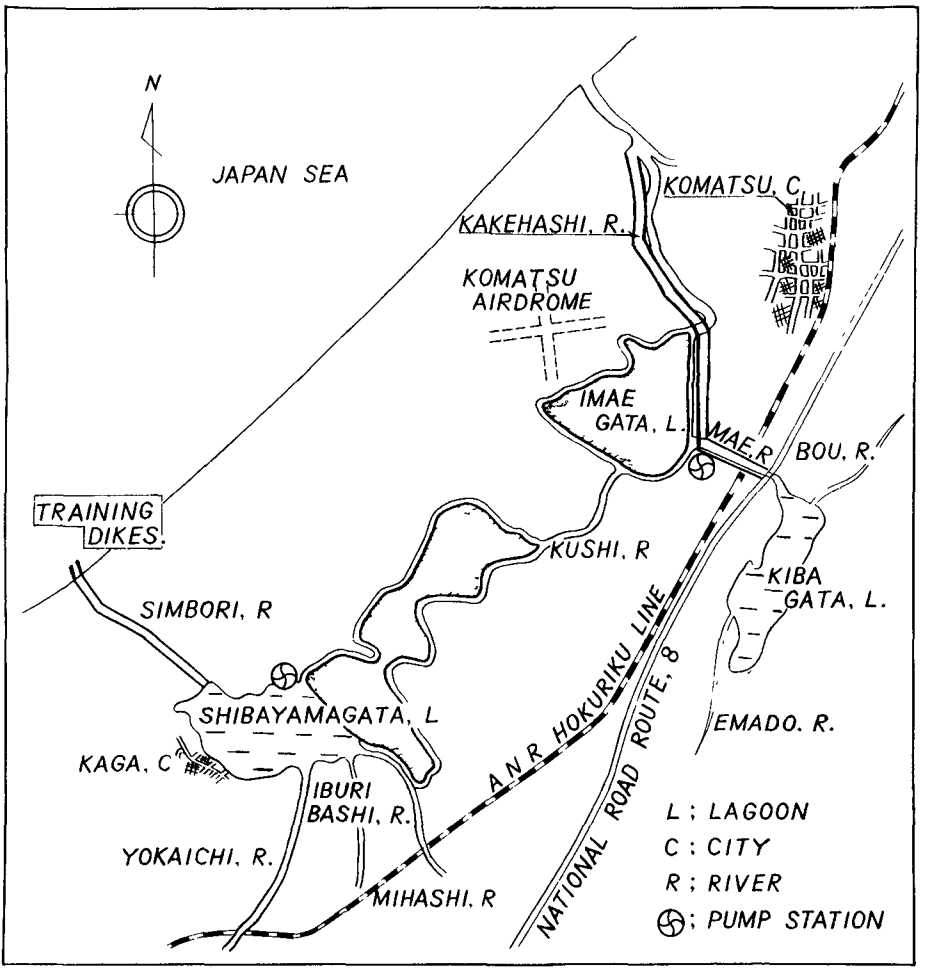

Fig. 1. General plan of Kaga-Sanko reclamation project.

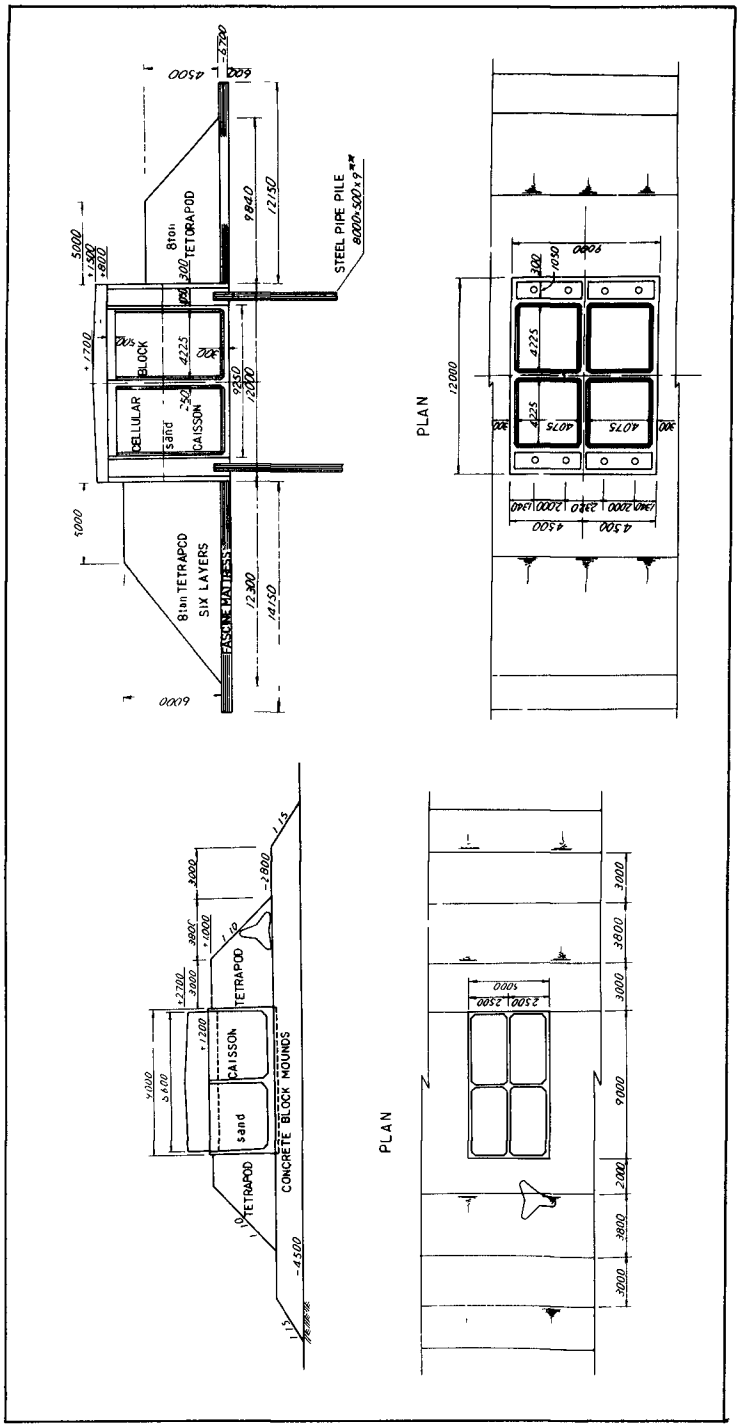

Fig. 2. Standard-cross section of training dikes (original plan).

Fig. 3. Standard-cross section of training dikes.

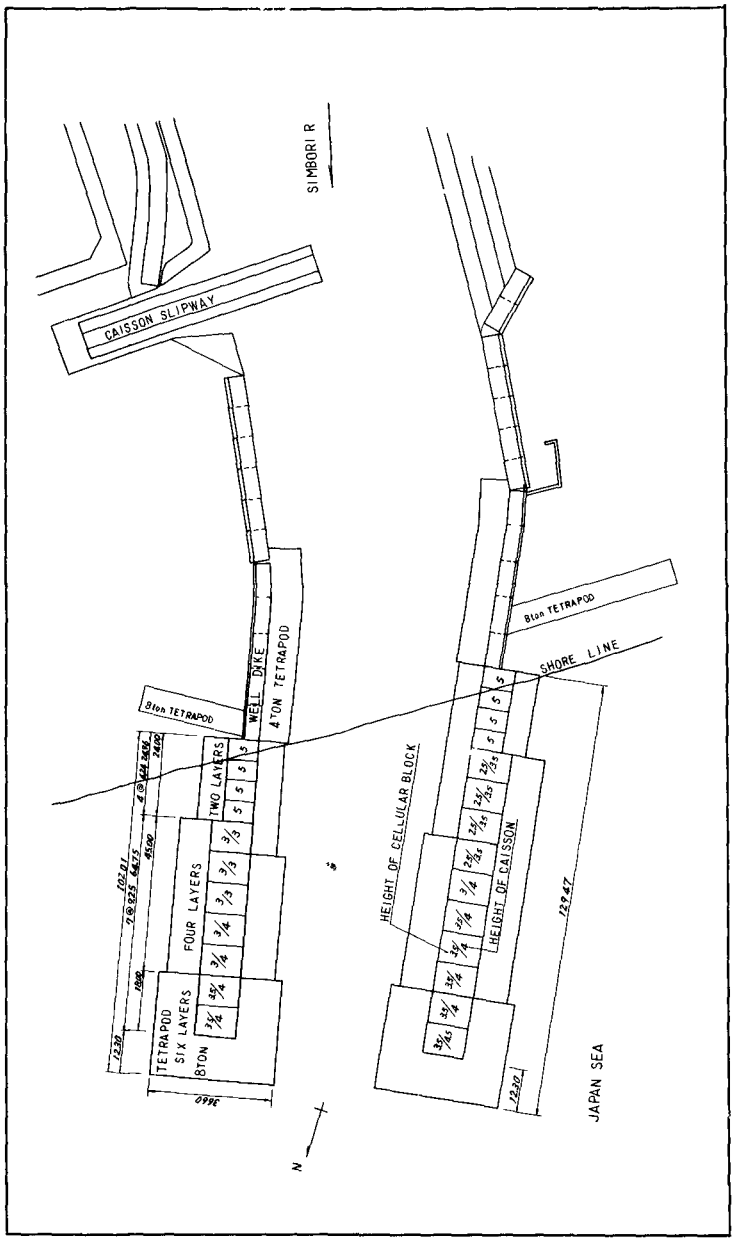

Fig. 4. Plan of training dikes.

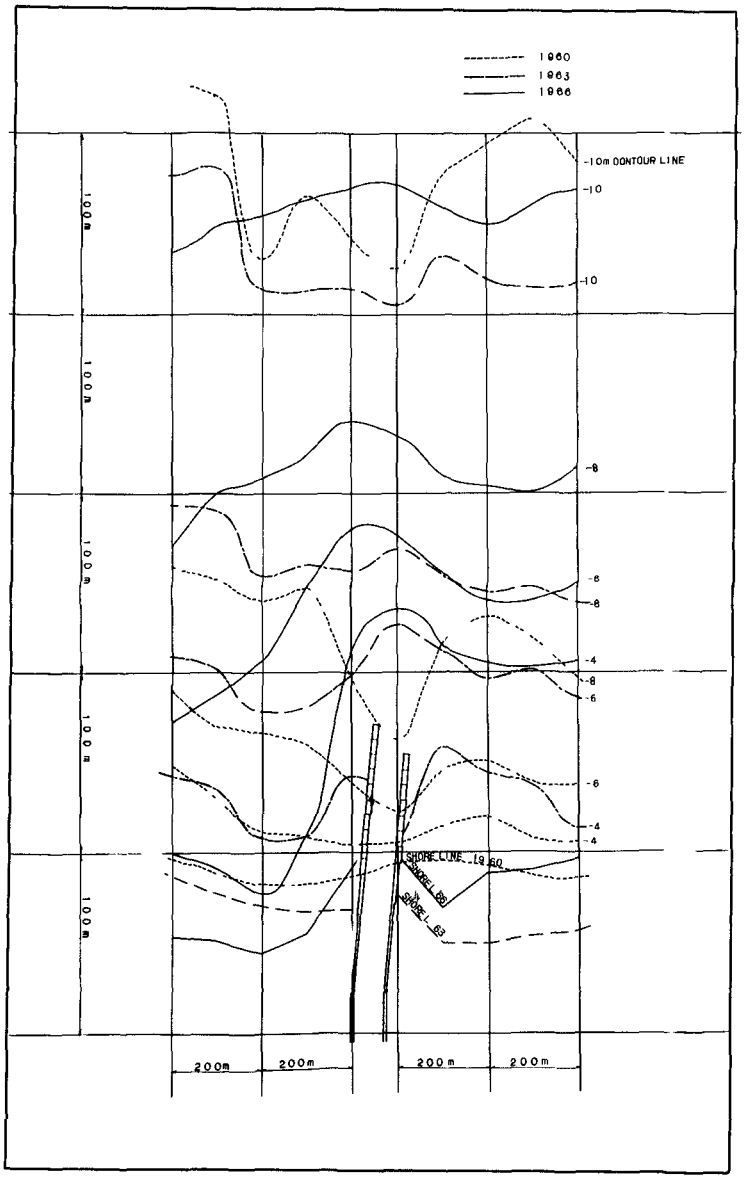

Fig. 5. Map of shore line and bottom contour lines.

Fig. 6. Tugging a caisson with the aid of floats.

Fig. 7. Training dikes.

Fig. 8. Mouth of Simbori River diversion channel.