CHAPTER 4 Mode design

Model sign is made for deciding the reduced scale or the range of the model, for the conversion of the model value on cross-sectional shape or position of the cross-sectional stake previously before manufacturing the model, for setting of discharge, and for various facilities such as those of drain processing towards the seeping ring water channel and sand disposal at the end of model.

Major procedures of model design and its contents can be outlined as follows: Detailed notices upon designing the model will be mentioned in the next section 4.1.

(1) Model range is reviewed.

Model range should be decided so that for the flowing direction not only in the planning section of channel works but also at the measuring position, fully similarity of flow should be induced, and also, the model range should be decided by paying attention to the plane shape in the planning draft for the channel works or moving range of sediment for the lateral direction.

(2) Reduced scale of model should be decided by considering the similarity as mentioned in CHAPTER 3, technics of measurement and model manufacture, and the scale of testing facilities.

(3) For channel design, there are the operations as follows:

1) Preliminary operation for designing the channel

2) Base line design

3) Preparation of instruction for section

4) Conversion of model value of river channel structures

5) Design for model-attached structures

° Design of gauging tank, rectifying basin
° Design of water channel
° Design for sand settling basin
° Design for draining facilities
° Design for sand-supplying facilities

4.1 How to decide the reduced scale of model and model range

In model design, firstly model range and model-reduced scale will be decided. Generally considered major designing conditions are as follows:

(1) For achieving the test purpose, the necessary accuracy and capacity for measurement of hydraulic amount should be confirmed.

(2) Model range should be decided to cause the fully similar flow at the observing and measuring position. For this purpose, the end of upstream and downstream of the model should by the positions where a groundsel or an erosion-control dam is consrructed and the deformation of river bed is rather small, and also, upstream part of the erosion-control dam at the end of upstream in the model should take the model range (generally 5 times as wide as channel width) in considering the sand-supply conditions or meandering phenomena of flowing water. When there is no groundsel at upstream and downstream, the section where the deformation of river bed is small should be selected from the secular variation drawing of the river bed. Such section is a narrow part of river channel, and rock would be exposed on river bed in many cases.

In case that the river regime is obviously different from that of upstream with remarkable longitudinal change of particles by longer design interval of channel works, and that it is judged to be unfavorable to test in the use of same particle material of river bed on the whole of design section of channel work, test is done by dividing the model or by changing the material of river bed with that of upstream.

In performing the experiment on prresent state, estimation whould be made on the moving range of the sediment to the cross-sectional direction, and it should be taken into the model. For estimation of the moving range of sediment, it is recommended to use the method by the field investigation and reading of aerial photos or changing diagram of the channel of river. Model-taking range is not necessarily the whole planned section of channel-works, and also, experimental purpose should be clarified for the obtaining objects by model test and the problems in the design of channel work on the desk, thereby, it is important to decide the model range in view of the cost saving.

(3) After deciding the model-taking range, check should be done for the reduced scale to put on the testing facilities, and the reduced scales are 1/50 - 1/80 in the past model-tests. Reduced scale cannot be decided by one time alone, and desirable reduced scale is decided by repeating the review on the following contents.

In accordance with the low of similarity, calculation or actual measurement is made for the values of discharge, sand-supplying amount, water depth, flow rate, grain size and grain distribution, thus review is made if the flow does not exceed the capacity of testing facilities, if the supply of sediment is possible, if the water depth and flow rate are in the measurable range, and if the geometric similarity of grain-size distribution can be established. Moreover, review should be made on the similarity if the river-bed form is similar to that of the actual river, if water-depth can be obtained on model to be within the range of turbulent flow or if it is possible to obtain the force to move river-bed material on model.

4.2 Technics of measurement and manufacturing the movel

Accuracy of measurement and measurring range of flow rate will be limited by the using instruments, and the following Table 2 shows the generally used measuring instruments for model test and its accuracy as well as the measuring range of flow rate.

Table 2 Measurable range of flow rate, accuracy and measuring instruments

Water level and river-bed height		*Flow rate*	
Type	Accuracy	Type	Range
Piezo meter	±1.0 mm	Pilot tube	20 cm/s ~
Level	±1.0 ~ 2.0 mm	Flow rate meter of electric field type	50 cm/s ~ 1.5 m/s
Drainage texture (visual inspection)	±1.0 ~ 2.0 mm	Transister type	50 cm/s ~ 1.5 m/s
Point gage	±0.1 mm	Super-micro-flow rate meter of propeller type	3 cm/s ~ 1.0 m/s
Sand-surface meter	±0.5 mm	Flow meter of propeller type	3 cm ~ 2.0 m/s

The above values are the standards, and these are somewhat different by the conditions of skilfulness of tester and ripple on the surface of flowing water, besides the accuracy of river-bed conformity is about ±2mm while it is affected by the size of particle of using material for the test.

For the measurement of river-bed height and water level at the moval bed test with higher moving speed of sediment and with activity of sediment, standard height is set, and its matched drainage texture is regarded as standard point, thereby, visual reading is done by the scale of 1mm for river-bed height in many cases and measuring time is short. For the measurement of local phenomena a level is used, and sand-surface meter is conveniently used for the measurement of change in time course of the river-bed height and water level of fixed point.

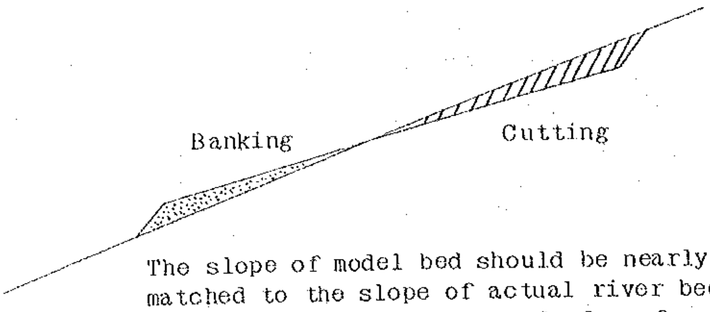
4.3 Design of river channel

(1) Preliminary operation for designing the river channel

After deciding the reduced scale or taking range of model, it is necessary to review if the model can be put into the testing site.

1) The designed model by considering the width of passage for the operation and the size of appurtenant structures such as sand settling basin and gaging tank as well as adjacent model should be reviewed by overlapping the skeleton-plane of the taking range of the model with the same reduced scale as that of the plane of testing site if the model can be put into the testing site.

2) Model-setting standard surface and basic line setting position will be set for balancing the cutting and the banking in the model bed by the river-bed longitudinal section and ground plan (described with model range). Here, the basic line means the standard measuring line in offset measurement for the display of the relative position of the distance mark (measuring stake of the left and right sides of river in performing the cross-sectional survey) showing the starting and beginning point of the field surveying section.



The slope of model bed should be nearly matched to the slope of actual river bed. In such a case, set the standard surface of the model bed for balancing the cutting and banking

(2) Design of basic line

Design of basic line is made for the distance (slave distance) Δx from the standard point on the basic line up to the crossing point of the slave-distance line and basic line, and these distances are read, then, instruction manual is prepared by converting these distances into model-values. An example of design of basic line is shown in Figure 6, and an example of instruction manual is shown in Table 3.

1) The distance (ℓ) between distance marks of the ground plane and cross-profile shoule be compared, and if there is any difference between both distance, the cause should be investigated and adjustment should be done.

2) Basic line should be set so as to match the line connecting center-points of the interval of each distance-mark. Bending of the basic line will cause the error in setting the basic line or in measuring the angle on the plane, and so, bending should be avoided. In accordance with necessity accuracy should be elevated by providing the auxiliary basic line.

3) For reducing the flexible effect of the ground plane due to the changing humidity, it is important to measure the distance within a short time.

Table 3 Example of instruction manual for setting the basic line

Section (face)		Prototype (m) X	Prototype (m) Y	Model (m) X	Model (m) Y	Distance between stakes (m)	Remarks
15	L	752.5	−32.8	10.750	−0.469	195.6 (2.794)	
	R	741.5	162.5	10.593	2.321		
17	L	833.0	−29.4	11.900	−0.420	170.1 (2.431)	
	R	824.0	140.5	11.771	2.007		
19	L	902.0	−26.5	12.886	−0.379	143.2 (2.046)	
	R	916.5	116.0	13.093	1.657		
21	L	978.0	−37.1	13.971	−0.530	160.8 (2.298)	
	R	1001.5	122.0	14.307	1.743		
23	L	1053.0	−47.5	15.043	−0.679	180.3 (2.576)	
	R	1090.0	129.0	15.571	1.843		
25	L	1135.5	−59.0	16.221	−0.843	1086.9 ( )	
	R	63.5	120.2	0.907	1.717		

4) Check-line length is necessary for testing the accuracy in setting the basic line, thus, check-line length should be measured on the diagram.

5) The accuracy of measurement shall be lmm at the model value.

(3) Preparation of instruction manual for section

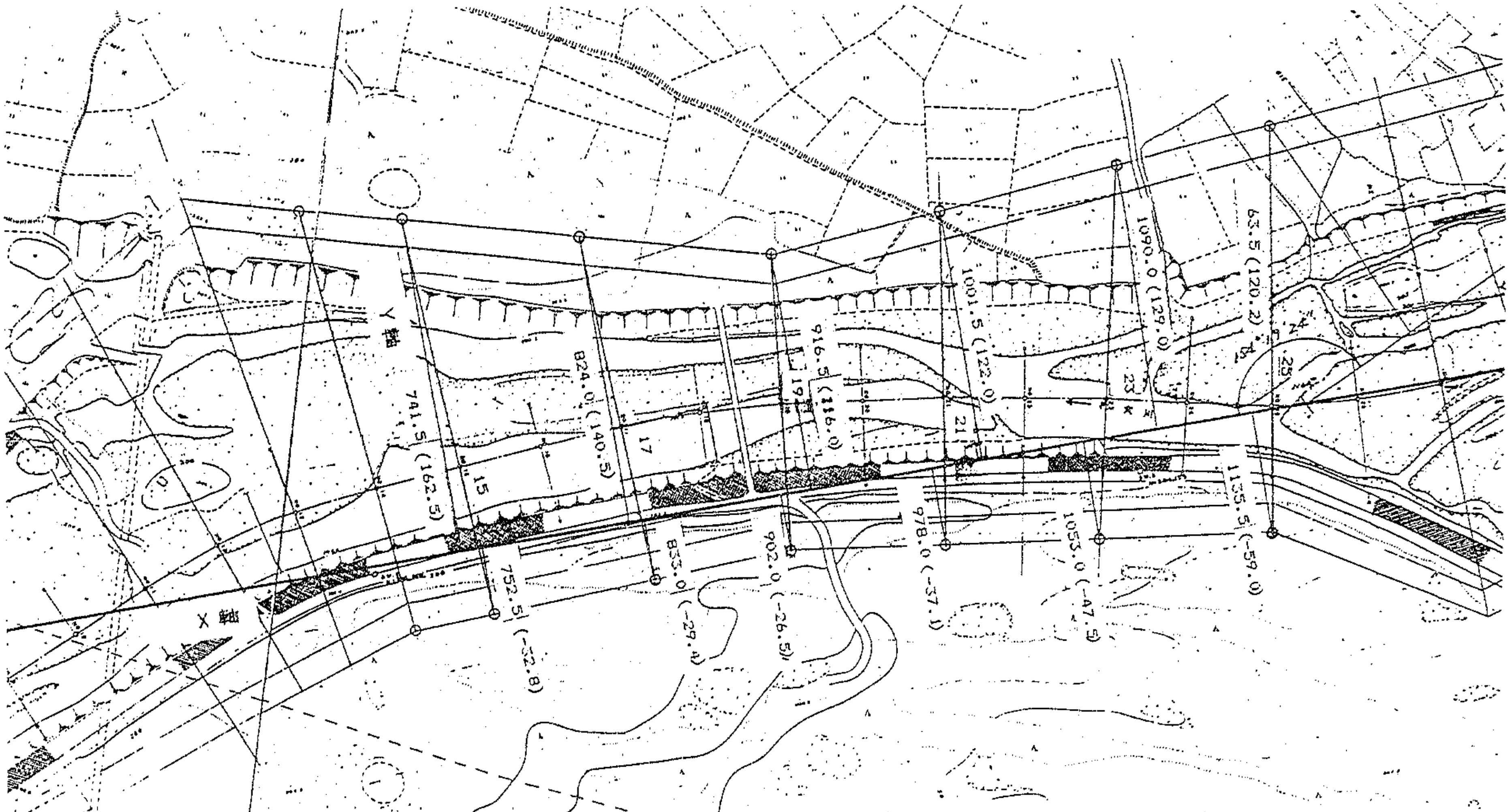
Corrdinates-values are read at each sectional changing point from cross-section or result-table of cross-sectional survey at the actual river channel, thereby, converted values into those of model should be arranged on a table (list).

For manufacturing the model of the present river channel, cross-sectional form is necessary at each measuring section simulated geometrically. Height is decided by cross-sectional survey at each section of cross-sectional survey, in which, simulated river bed is formed by connecting mortar in the use of aerial photos or ground plane.

Generally, field sectional shape with model-value is plotted on lawan plywood in accordance with the instruction manual of cross-section, and finishing is made by cutting, it is called crossing board.

1) For preparing the instruction manual by reading the values from the lateral profile or surveyed results, it is necessary to grasp the crossing changed point excatly, and its degree is different by the reduced scale, but it is unnecessary to read the value of coordinates of minute changing point giving no influence on the flow. On example of reading value from the lateral profile and the one of preparing the instruction manual are shown in Figure 7 and Table 4.

2) In the moval bed test performed so far, generally, sand thickness is decided by considering that groundsel is not exposed by the scour of river bed and that the river-bed material is full wetty at the starting time of test except the severely scoured local site at the apron as in groundsel or erosion-control dam, while testing sand is spread uniformly in its thickness of 10cm on the surface of fixed bed, thus the instruction manual is prepared with lower altitude by 10cm on the model value than the level of river bed of actual river previously for matching the conformed surface of model river bed to the one of the actual river.



Note: ° For the standard of X-axis, left bank is regarded as (-) and right bank is regarded as (+).
° X-axis ( ) none Y-axis ( ) inside

Fig. 6 Example of basic line desing

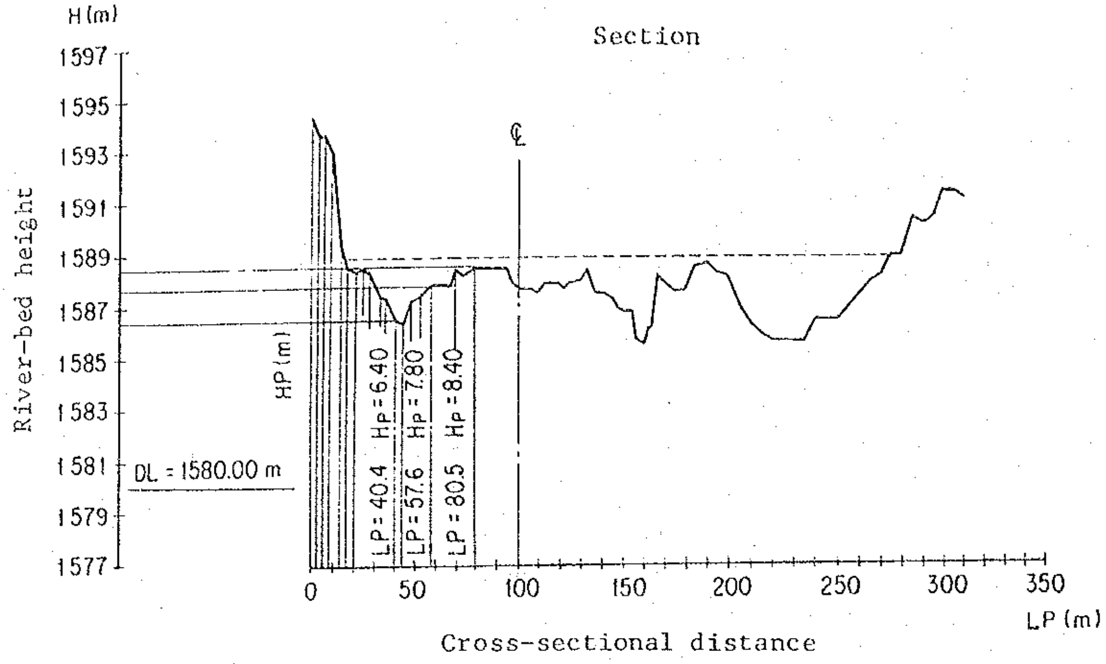


Fig. 7 Reading of change of river bed from the laterial profile

(4) Conversion of model value of river-channel structure

Conversion of value is done for model-value with the reduced scale given for the shape of channel-structures such as the lower structure of bridge pier, erosion-control dam, groundsel, bed girdle, groyne. Model-intake of the upper structure which is not immersed in water is not necessary, but if the exposure of its basic part is estimated, it is necessary to take it in the model is necessary for that the exposure of basic part is estimated without need of model intake of the upper structure which is not immersed in water.

4.4 Design of attached structures.

Figure 8 shows the outline of model facilities. Flow-head part of model is equipped with gaging tank, rectifying basin, and supplying sand placing site. Also, water-supplying equipment is given to supply the water to gaging tank.

Table 4 Instruction manual for cross-section

	Section				Remark
	Prototype		Model		
	DL=1580.00m		DL=15.800m		
	LP (m)	HP (m)	LM (m)	HM (m)	
1	0.0	14.30	0.000	0.143	
2	4.2	13.60	0.042	0.136	
3	6.6	13.60	0.066	0.136	) Road
4	9.7	13.00	0.097	0.130	
5	13.0	9.60	0.130	0.096	
6	16.1	8.50	0.161	0.085	
7	20.1	8.30	0.201	0.083	
8	24.3	8.40	0.243	0.084	
9	27.3	8.30	0.273	0.083	
10	32.6	7.30	0.326	0.073	
11	35.2	7.30	0.352	0.073	
12	35.4	7.20	0.354	0.072	
13	40.4	6.40	0.404	0.064	
14	43.9	6.30	0.439	0.063	
15	47.9	7.20	0.479	0.072	
16	52.4	7.40	0.524	0.074	
17	57.6	7.80	0.576	0.078	
18	62.0	7.80	0.620	0.078	
19	66.3	7.70	0.663	0.077	
20	67.8	8.50	0.679	0.085	
21	71.9	8.10	0.719	0.081	
22	76.0	8.40	0.760	0.084	
23	80.5	8.40	0.805	0.084	
24	88.3	8.40	0.883	0.084	
25	92.8	8.40	0.928	0.084	
26	95.4	7.80	0.954	0.078	
27	100.2	7.60	1.002	0.076	C.L
28	103.7	7.60	1.037	0.076	
29	107.8	7.50	1.078	0.075	
30	111.6	7.80	1.116	0.078	
31	115.9	7.80	1.159	0.078	
32	119.3	7.60	1.193	0.076	
33	122.8	7.80	1.228	0.078	
34	128.3	7.90	1.283	0.079	
35	131.7	8.40	1.317	0.084	
36	134.5	7.40	1.345	0.074	
37	138.7	7.40	1.387	0.074	
38	142.2	7.20	1.422	0.072	
39	145.9	6.80	1.459	0.068	
40	148.6	6.70	1.486	0.067	
41	152.4	6.70	1.524	0.067	
42	153.4	6.10	1.534	0.061	
43	154.2	5.60	1.542	0.056	
44	158.0	5.40	1.580	0.054	
45	160.2	6.10	1.602	0.061	

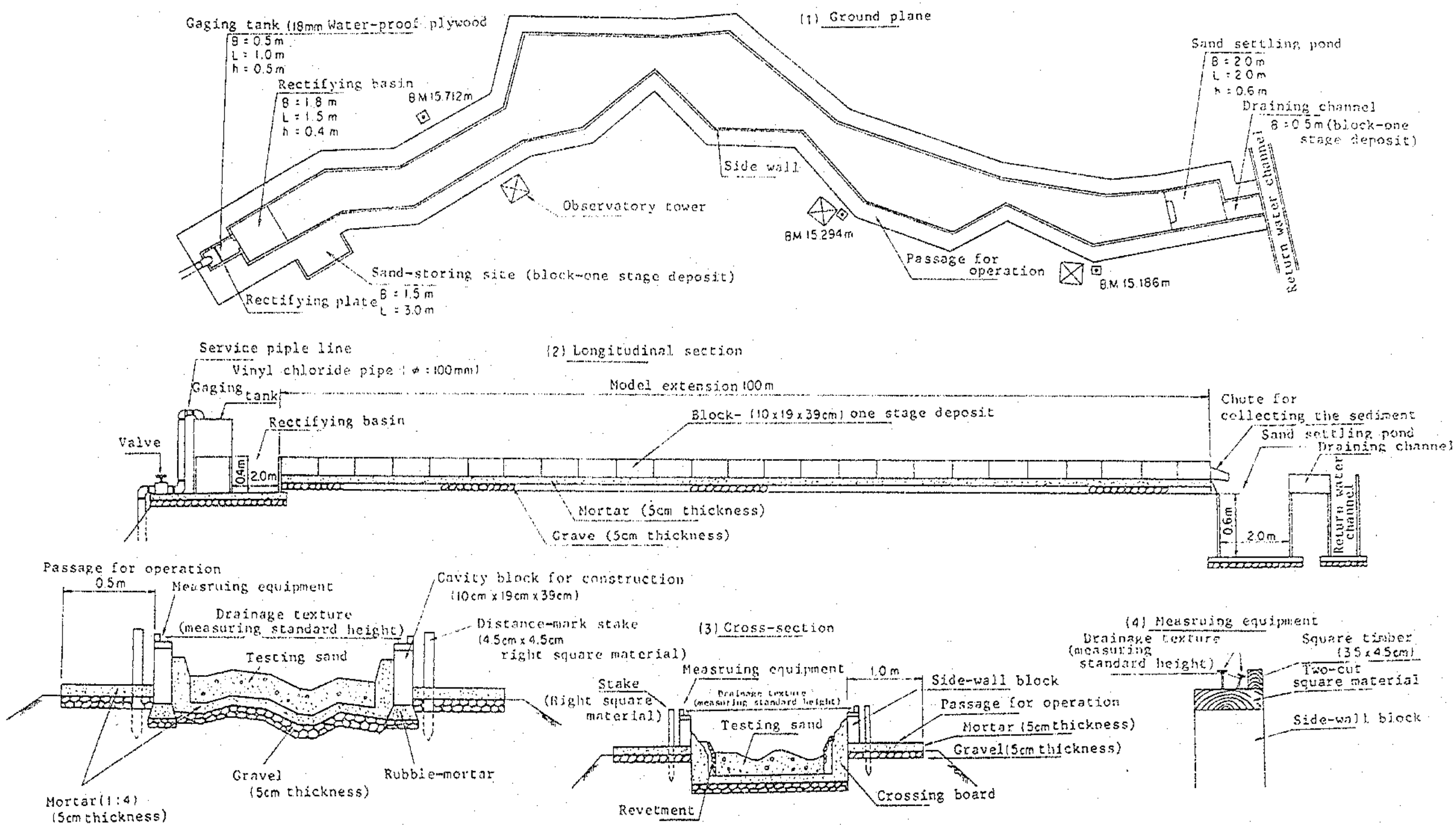


Fig. 8 Outline diagram for model-structures

The end part of the model channel is provided with sand settling pond and drainage channel. Passage for operation is provided at left and right ends of model.

(1) Gauging tank is the equipment giving a specified flow (discharge) on the model by low of similarity, and the gauging tank is provided with the sharp-crested weir and rectifying plate.

The shape of gauging tank and weir is decided by the flow (discharge) given to the model, and it can be designed with reference to the standard of JIS, while the reference with the conventionally designed shape dimension is as follows. Rectangular weir is used for that of rather big flow (discharge), and triangle weir is used for that of smaller flow (discharge). Table 5 shows the relation between flow and the shape of weir, since the flow by hydraulic model test on channel works is given in the range of 1ℓ/sec. 30ℓ/sec., in many cases, the triangular weir (45° - 90°) is used.

Table 5 Flow (amount and shape of weir)

Flow	Weir		
ℓ/sec	Type	Width (m)	Angle (°)
3,000	Definite type	3.0	
1,000	〃	2.0	
400	〃	1.5	
150	〃	1.0	
40	〃	0.5	
10	Triangle		90
5	〃		60
1	〃		45

Table 6 shows the shape of gauging tank and flow (discharge), and as shown in Table 6, block or wood (lawan plywood) is used as material for gauging tank by the flow and shape.

For measuring the flow, rectifying plate is necessary to make uniform flow approaching the sharp crested weir and to reduce the vibration of water level, and this plate is made of lawan plywood with multi-pores staggered at the center-interval of 30mm with the diameter of 20mm (pore).

Table 6 Flow and shape of gauging tank

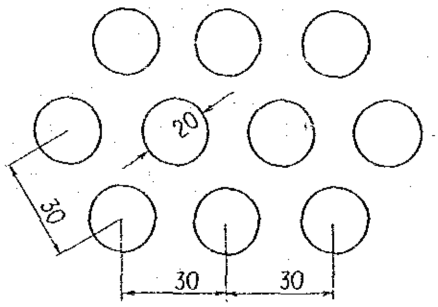
Flow (ℓ/s)	Scale L × B × h	Material	Standard	Remarks
20~50ℓ/s	300×150×80 cm	Ordinary type block	150×390×190 mm	Floor plate Gravel(rubble)
5~20ℓ/s	200×100×80	〃	100×390×190	Mortar 5cm thickness
5ℓ/s or lower		Floor plate	1820×910×15	

(2) Water-supplying facilities are provided with the valves for adjusting the flow and service pipeline for supplying water to the gaging tank. Dispersing pipe having the hole in its size 1/2-1/4 times as big as pipe-sectional area at the tip of service pipeline for the delivery of water from the pipe over the whole width of gauging tank. The material of service pipeline is vinyl chloride, and the diameter is different by flow (discharge).

When the flow is over 50ℓ/sec, 300mm-diameter is used generally, however, in considering the rectifying of flowing water in the gauging tank, it is recommended to use 2 pipes of vinyl chloride with its diameter 150mm.

For the valve, use the diameter corresponding to the pipe-diameter. For the type of valve, it is recommended to use the sluice valve for easier control of flow (discharge).

Fig. 9 Rectifying (conformity) plate (mm-unit)



(3) Rectifying (conformity) basin and rectifying device

It is necessary to feed the rectified flowing water overflowing from the gauging tank, thus a rectifying pond is equipped by connecting to the gauging tank. Table 8 shows the relation between the flow and the shape of rectifying basin. It plays a role for elevating the similarity of flow in the model, therefore, it is important to decide the setting position and angle of the rectifying basin by considering the characteristics of river channel.

In the rectifying basin, flowing water should be actively rectifiled and it is desirable to set a rectifying (conformity) device (rectifying plate, block) for elevating the similarity in the model.

Table 7 Flow (discharge) and diameter of vinyl chloride pipe

	Flow(discharge)	Diameter
Service equipment	50ℓ/s以上	φ300mm
	20～40ℓ/s	φ150mm
	5～10ℓ/s	φ100mm
	5ℓ/s or lower	φ 50mm

Table 8 Shape of rectifying basin and flow (discharge)

Flow	shape	Material	Standard	Remarks
20～50ℓ/s	300×River Width×40	Block	100×390×190	Floor plate rubble 5cm thickness
6～20ℓ/s	200×River Width×40	〃	100×390×190	Mortar 5cm thickness
5ℓ/s		Wood	1820×910×15	

(4) Sand is supplied in balance as a rule for preventing the change of the slope and level of river bed at the upstream of model. Thus, it is desirable to supply the sand at the position to obtain the similarity of tractive force in model, and it is recommended to take distance which is 3 times as long as the width of channel at the upstream from the starting position of measurement for the sand—supplying section (interval).

(5) Sand settling pond is equiped at the end part of the model, and water—flowing discharge by the deformati force should be reduced, and also, the whole sediment should be deposited. Sediment discharge of model river/bed is estimated from bed load formula, and the relation between the flow and scale of sand settling pond is shown in Table 9.

Table 9 Shape of settling pond and flow (discharge)

Flow	Shape of sand settling pond (cm)	Material	Standard (cm)	Remarks
20～50 ℓ/s	500×River Width×60	Block	100×390×190	Floor plate rubble 5cm thickness
5～20 ℓ/s	300×River Width×60	〃	100×390×190	Mortar 5cm thickness
5 ℓ/s or over	200×River Width×60	〃	100×390×190	

(6) Drainage equipment is used for draining the flowing water after treating the sedimet at the sand settling pond towards the return－water route, and draining is performed by the pump, siphon, and settling of drainage channel.
In general, drainage channel is equiped, and its design is done for the alignment and bed slope of water channel and passable section area of draining discharge. Experimentally, in many cases drainage channel forms the shape as shown in Table 10.

Table 10 Flow and drainage channel equipment

	Flow(discharge)	Shape of water channel	Material	Material-specified dimension	Remarks
Drainage channel equipment	20～50 ℓ/s	100×20	Block	100×390×190	Floor plate rubble
	5～20 ℓ/s	50×20	〃	〃	Mortar 5cm thickness
	5 ℓ/s or lower	50×20	〃	〃	

CHAPTER 5 Model Manufacture

5.1 Model manufacture and its procedure

(1) Land grading

New model is manufactured on the bank-slope or after breaking the old model, while the testing area is limited, thus in many cases, new model is manufactured after breaking the old model. In such a case, it is necessary to consider the treating method of the generated materials such as mortar-pieces, etc.

(2) Skeleton survey of the model-intake range

Since it is finished to make rough skeleton survey for reviewing if the model is taken in the testing site at the stage of designing the model, here, model-skeleton position is dropped at the testing site more in detail by performing the offset survey.

Model is set at the testing site by performing the level survey for the base level of the model bed based on the instruction-manual designed by paying attention to the favorable relation with the water-supplying/ draining equipment and to the relationship with the adjacent cross-model (type) as well as to take the balance of cutting and banking. Model floor is prepared by the use of bulldozer in conformity with the base level of model bed (Photo 1). Base level of model bed is the height induced by deducting the mortar-thickness and the laid-gravel thickness from the average height of the river bed. Also, level-base point of model bed is necessary for setting the base height for measuring the hydraulic various dimensions by test, for setting the base level and for setting the cross board. It is recommended to set about 3 points for level base point although the number depends on the different model-lengths.

(3) Basic line is set.

Setting state of the basic line is shown in Photo 2. For setting the basic line, it is desirable to finish the crown face horizontally in the longitudinal direction in order to elevate the acuracy in setting the distance mark, and it is recommended to set it at the same height as that of the distance mark stake.

(4) Distance mark is set.

The main distance which is converted into the model value is taken on the basic line, and sub (slave) distance is dropped by rectangular swing for setting the distance mark by offset survey. This distance mark is used for deciding the installing position of the crossing board, or it is a measuring line for hydraulic dimensions in test. A nail is driven at the top end of the distance-mark stake at left and right banks of the river, and it is used for the basic line in case measuring the height of river bed or water level by deciding the basic height for each measuring line, thus it is necessary to fix the stake firmly. Setting state of the distance mark is shown in Photo 2.

(5) Basic line is withdrawn.

By setting the distance mark stake, and after test, basic line is withdrawn by confirming the obtained accuracy as specified.

(6) Side wall is manufactured.

Figure 8(3) shows the lateral profile of model. After withdrawing the basic line, side wall is manufactured at the inside of the distance mark stake, by paying attention to the distance-mark stake not to damage it. As shown in Figure 8(3), the side wall can be used for following purposes that is in the latelal prodile of measuring lines left and right ends are fixed a measuring stand is put on the side wall as a stand, water leak is prevented, the necessary basic line is set to measure the river-bed height and flow rate, and also, it is used as distance mark for observing and measuring the flowing state (Photo 14).

The side wall having the above purposes should be manufactured by the following cautions.

1) Side wall should have high durability with better appearance. It should be light in weight and easily executed, thus generally, it is made of hollow concrete block for construction coated with mortar on the inside and crown of the side wall.

2) The height of side wall should be higher than the highest level of water on the crown in the test model. Too high side wall will

disturb the survey and affect the measuring accuracy. The side wall should have the following standard dimensions in piling.

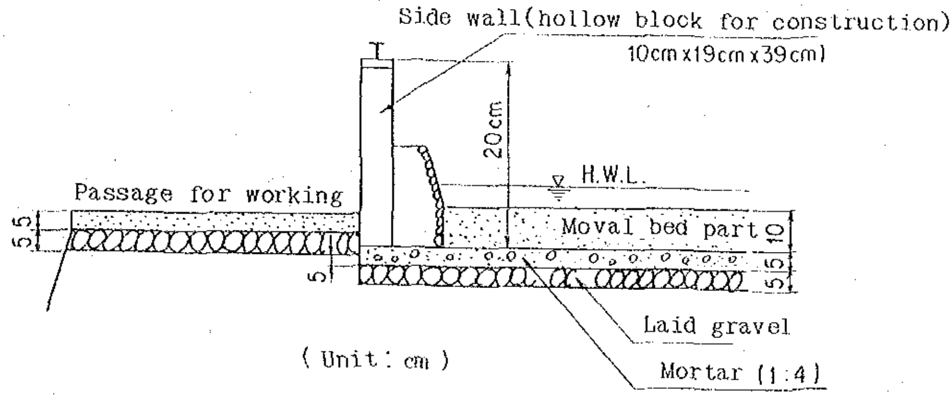


Fig. 10 How to pile the standard side wall

The maximum scouring depth of model value with the reduced scale of the model is less than 10cm experimentally, thus the standard thickness of sand (moval bed) is 10cm. Also, the maximum value of mean water depth is about 5cm from experience, thus the crown height of the side wall is set to the level 15 - 20cm higher than the floor-bottom level of mortar-river bed.

3) As shown in Fig. 8(4) and Photo 14, it is convenient to fix the square timber at the crown of block for setting the basic line to measure the water level, river-bed height, and flow rate. Moreover, for setting the basic level for measurement, it is recommended to match the crown height and slope of left and right banks to the longitudinal direction.

(7) Working passage should be constructed.

This passage should have the width for easy movement by measuring operators, and its standard with is 0.5 - 1.0m from the outer slope of the side wall.

The working passage is used for movement of operators and for protecting the model-bed surface by mortar. (Photo 14).

(8) River channel is manufactured with mortar.

1) Cross-sectional plate is used for natural river bed crossing board to form the cross-sectional shape of actual river and the design river bed crossing board to form the design sectional shape.

For the manufacture of natural river bed crossing board, it is prepared by plotting the cross-sectional shape on the lawan-plywood by the cross-sectional instruction manual with geometrical simularity by the reduced scale to give the cross-sectional shape of the actual river.

Design river bed crossing board is manufactured by the instruction manual for setting the level of smooth design, river bed and shape of revetment (Photo 3). The design river bed crossing board has less changing points than those of natural river bed crossing board.

Lawan plywood should be as a rule the material with its thickness over 5.5mm without deformity of crossing board in connecting the river channel between crossing board with mortar or installing crossing board. Moreover, the minimum width of crossing board shall be 5cm as standard by deciding it from executability in manufacturing the channel between crossing boards with mortar and from the adhesiveness of lawan plywood with the laid gravel as well as the connecting face of the mortar with lawan plywood.

2) Crossing board is installed.

Crossing board is exactly installed to match the position of the cross-sectional distance mark stake. The stopping stake is driven into the earth for cross sectional plate to prevent it from its movement, being fixed with mortar (Photo 6).

After installation, it is necessary to confirm the installed level as shown in the instruction manual.

For producing the present state river bed with the moval bed sand at the time of river-bed conformity from the flat river bed, match the crossing board to the position of the distance mark stake as the manner for producing the present state river bed by the use of mortar, level is set, and crossing board is temporarily fixed, then, river bed between the crossing boards is connected, thus, it is convenient to set the basic level at the time installing the design crossing board for installing the natural river bed crossing board.

3) River bed is produced.

i) Ground levelling and conformity between crossing boards are done.

For ground levelling between crossing boards, 10cm thickness is estimated for placing the mortar and for laying the gravel. By taking the difference over 10cm from the crown of crossing board, conformity with leveling ground is done for the bed along the sectional shape of crossing boards and full compaction is done.

ii) After ground-levelling and conformity, compaction is done by laying the gravel with its mean thickness 5cm (Photo 7).

iii) River channel is produced with mortar.

Natural river channel and design river channel will be finished with mortar in its mean thickness 5cm over the laid gravel. For natural river channel, make precise connection for micro-topography between crossing boards in application of aerial photos, ground planes or local snap-pictures (Photo 9). River bed of the design river channel is finished flat in many cases.

Mortar compaction should be done fully, and it is necessary to make execution carefully while preventing the leak of water at the connected part between crossing boards or side-wall blocks.

4) River-channel structures are manufactured and installed.

The structures such as bridge pier, erosion-control dam, groundsel, bed girdle, and groyne shall be manufactured in conformity with the instruction manual. As a rule, timber is used as material of them. For installation, make it exactly without error for the setting position and height. Also, it is sealed tightly with mortar without any water leak. (Photo 8).

5.2 Manufacture of model-appurtenant structures

Gauging tank, rectifying basin, sand settling pond and drainage channel shall be manufactured in conformity with a design draft and text (Photos 11, 12, 13).

For these materials, block is numerously used, while execution, it is necessary to pay particular attention to the water leak. For the bottom of the structure, lay the gravel in its thickness of average 5cm, on which, mortar is placed in the mean thickness 5cm, being finished flat.

Block is coated on the inside face. In piling the block over 2 stages, mortar joint is given in its degree about 1cm for close attachment of blocks. In case of block-piling over 4 stages at sand settling pond or gauging tank, steel frame should be inserted, and in some cases, it is needed to review the countermeasures such as reinforcement with french timbering, etc.

CHAPTER 6 Preparation for test

6.1 Measuring method and Setting of measuring equipment

(1) In measuring the river-bed height or water level of crossing direction at each measuring line by the use of scales, it is necessary to set the basic height (altitude) and basic line (measuring line). In measuring the water level and river-bed level by scales, the level value is read from the basic level to the water surface or river bed (Photo 19).

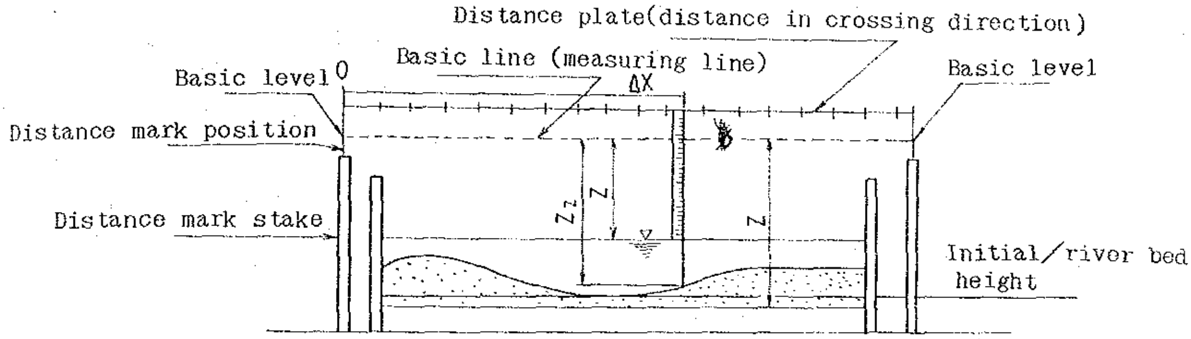


Fig. 11 How to measure the river-bed level, water level

Basic line is set by stretching a thread for water horizontally by setting the basic level (same altitude for both left and right banks of river) at the crown of the side wall or distance-mark stake. Also, a distance is prepared plate for measuring the distance in crossing direction (extending 1mm-scale tape on place) (Photo 14 & 19).

For measurement, set 0-point of distance plate to either one of left or right bank (unifying for each measuring line, each case of all tests, and match it to the basic line.

Use the scale made of steel with 1mm-graduation.

Measuring operators shall record the measured values of the distance (Δx) from the basic point and the distance up to the river-bed surface, water level from the basic line matching the basic height. In Figure 12, the difference between the initial height of river bed and that of basic line is regarded as "Z", the difference of the level between basic line and water level is regarded as "Z1", and the difference with river-bed level is regarded as "Z2", then, the water level (H) with the standard of initial height of river bed and river-bed height (S) can be measured by the following related formula.

$$\left.\begin{array}{l} Z - Z_1 = H \\ Z - Z_2 = S \end{array}\right\}$$

For measurement, scale is used, and sometimes, level is used. For measurement of the changes in time course of river-bed height and the water level of fixed point, it is recommended to use an auto-meter. Measuring method and using instruments can be selected by the measuring purpose and necessary measuring accuracy.

Flow-meter is dividedly used by hydraulic conditions and necessary measuring accuracy. Table 2 shows the generally used types of flow-meter and their measuring ranges.

Flow rate is measured by the use of the same equipment as that of the measurement of water level and river-bed height (Photo 20).

(2) Facilities for observation and measurement of flow regime.
Even in case of over 1m of interval of distance marks (standard line) in measurement by tracing the changes in time-course and on plane of the trench or river bed, it is convenient to set the distance mark for distinguishing it with different color with the unit of 30 - 50 cm (Photo 14).

In photography of the flow regime, mark-plate is necessary for recording the phenomenon and its position. The mark plate at this position is matched to the measuring point No. of the actual river and the size should be the one to read clearly on photo. Also, this mark plate at this position is necessary for measuring the flow rate, river bed and water level (Photo 14).

(3) Measurement of flowing direction

Camera type or the setting of photographic stand is different by the purpose.

1) In photography with a constant time interval for the continuous plane changes of the river bed and trench of the whole model, vertical photography should be made as much as possible, and phenomena should be read on photo, while whole phenomena on model should be overlapped. By paying attention to the above, set the equipment by deciding the simultaneous photographic method in the use of several cameras, the photographic position and the height of the photographic stand. The standard using camera should be of 35mm (semi-wide lens).

2) For a partial photography, no particular equipment is necessary because of the use of the above mentioned photographic stand or by moving photography by operator.

3) Using cameras are (1) motor-driving camera; (2) memo-motion camera; and (3) ordinary (35mm) camera.

(4) For the measurement of sediment discharge, prepare the sand-collecting boxes and measuring cylinders.

For measuring the time-course change of sediment discharge, receive the sediment and water simultaneously, and drain the water for collecting the sediment, then, measure the volume by measuring cylinder.

For separating the water from sediment, prepare the bottom-surface of the sand-collecting box with steel net of ϕ0.08mm.

Collecting time can be decided by the capacity or volume of sediment and measuring accuracy. (Photo 21).

(5) Measuring equipment for discharge

By the use of discharge formula of sharp-crested weir provided at the gauging tank, calculation is done for correlation between overflowing water depth (H) and overflowing discharge (Q) at each interval of 1mm in the range needed for the test. When shap of weir is deviated from the discharge formula of sharp-crested weir, it is necessary to make actual measurement of the relation between "Q" and "H".

6.2 Arrangement of testing conditions

(1) Selection of river-bed materials

Select the grain-size distribution accumulation curve representing the actual river, mixed sand which is geometrically simulated with it is used as testing material.

1) Survey the materials of river bed at actual river in the objective interval of model test and its upstream and downstream. The grain size at upstream is useful for deciding the material of the supplying sand. Also, the grain size at downstream is useful for measuring the sorting effect. At the river forming the alternating bar, select the deposit without disturbance with the interval of 5 - 10 times wider than width of channel width. At the survey, there is a river where the gravel over 10cm is excluded but for the gravel over 10cm, data should be obtained by taking the calculating method of mean diameter by measuring the long, medium and short axis respectively.

For each surveying position, prepare the grain-size distribution accumulation curve diagram, and calculate the average grain size. Then, overlap this diagram. When a big difference is induced between the upper and lower limits of mean grain size and grain-size distribution accumulation curve diagram, check the cause, and if it is unnatural, remove the data. However, when the surveying objective interval is long and there is a big change of mean grain size in the flowing direction it is necessary to divide the interval of model intake.

As in the above, the grain-size distribution accumulation curve diagrams and the average grain-size distribution accumulation curve are overlapped with the curve-diagram for each surveying position, and select the average one on the diagram.

2) Mixture of river bed material is selected as the one representing the actual river. Several types of sand with different grain size are mixed so that testing sand should be simulated geometrically with grain-size distribution accumulation curve representing the actual river (Figure 12).

The minimum filter mesh adjustable in case utilizing the natural sand as testing sand is 0.088mm, and it is impossible to simulate up to the very fine particle in some reduced scale of model (for instance, limit is 6.2mm locally in case of reduced scale 1/70 on the model).

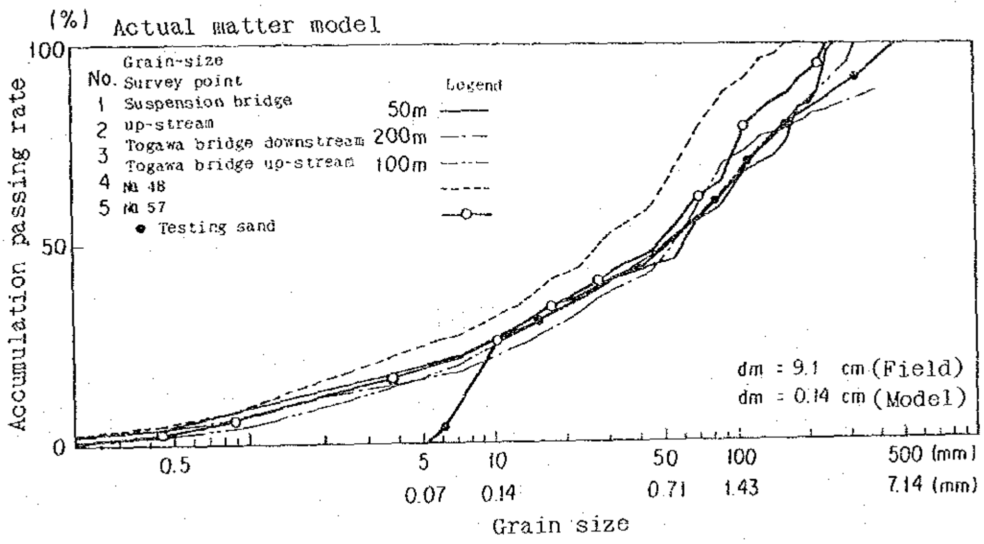


Fig. 12 Grain size accumulation curve diagram

At erosion-control river, generally, there is less rate taken by such small particles at grain-size distribution accumulation curve, and it becomes suspended sediment at the flow in test, and its effect on the deformation of river-bed regarded as very little, thus the particle with less than the minimum filter mesh is disregarded in many cases. However, when there is difference in mean grain size with that of actual river by disregarding the particle at the model because of smaller mean grain size of actual river, even if it is uneconomical, it is necessary to make similarity up to fine particle by the use of fly ash, as an example, as a material other than the natural sand with the same specific gravity.

(2) Adjustment of river-bed material

Adjust the sand of several specimens with different grain size to simulate the testing sand to the grain-size distribution accumulation curve of actual river. Check if the adjusted sand is simulated or not by the use of the sieve test, and combinedly describe the result on the grain-size distribution accumulation curve diagram of actual river. Moreover the average grain diameter is calculated.

(3) River bed conformity

1) Except the case of distinctly exposed rock at shallower position than that of the river-bed level or exposed rock in river bed for the river-bed material at wet state, convormity is made in its thickness 10cm as a rule along the river bed face finished with mortar (Photo 16).

2) For river-bed conformity producing the present state river channel, exactly finish the shape of alternative bar and water route. For hardly eroded bank or hardly moved alternative bar fixed at actual river, make fixation with cement paste after conformity of river bed. The state of river-bed conformity is shown in Photo 16.

3) In case producing the present state channel on flat mortar river-bed surface, match the position of crossing board to the distance-mark stake, and fix the crossing board to match the height to the basic height to set the crossing board. It means the conformity of the river bed while setting the crossing board, thus pay attention to the crossing board not to move at the time of conformity of river bed. After conformity of river bed between crossing board, pull out the crossing board, and adjust the river-bed face.

4) After conformity of river bed, measure the cross section of river-bed, and check if the conformity is made as shown in the instruction manual.

(4) Calculation of similarity of moval bed

Based on Froude's similarity, calculate the reduced rate of physical dimentions such as flow, time and flow rate.

(5) Reduce the scale of the flood-waveprofile flow (Q - T curve).

Flow-waveprofile of actual river changes continuously with the increase, peak and decrease in water, however, by considering the following listed items in view of the technology or testing facilities in hydrological model test, take the method to change the flow and time stepwisely (Figure 1).

1) Match the testing flood waveprofile total flow to the total flow of design flood waveprofile of actual river.

2) Do not try to make big change of the shape of flood-waveprofile flow curve.

3) The continuous time of stepwisely set flow is the measurable time.

4) Small flow without causing the deformation of river bed shall be excluded from the objects.

(6) Calculate the supplying sand amount by sediment discharge formula.

Calculate the supplying sand amount from the end of model upstream by the sediment discharge formula and secure the total supplying amount of sand and review the sand-supplying method.

CHAPTER 7 Purpose of testing case and setting of testing conditions

7.1 Purpose of each testing case

For each purpose, there are such tests as verifying test, present-state test, reviewing test of planning draft, reviewing test of the correcting draft for partial adjusting the planning draft, and reviewing test of the safety.

(1) Verifying test is performed for reviewing if reproduction is made on the model for the water level, sediment discharge, the deformation of river bed, roughness coefficient and flow rate which were measured in the actual river, thus it is performed for the following purposes, that is the measurement of reliability of solution obtained from the test or adequacy of giving methods of testing conditions, and how to consider the similarity of moval bed. However, for performing the verifying test, there are very few examples measuring the necessary dimensions at actual rivers, and verifying test is omitted, and there are many cases reviewing the adequacy of model test qualitatively by present-state test.

(2) In the present-state test, check is made if a disaster occurs by what cause of the flood under the present state river bed, and basic data can be obtained for preparing the planning draft.

Also, by comparing them with river-bed shape, coefficient of roughness meandering phenomena of flowing water, trend of the deformation of river bed, occurring points of disasters in the past, check of there is any same tendency between actual river value and model-experiment result.

(3) Reviewing test of planning draft is made by modelling of the planning draft of channel work on desk, or in order to review for the designed channel works if they are safe or not, if the functions are fully exerted, the major checking items are as follows:

1) If the design height of revetment is enough or if there is any overflow.

2) Check if the design revetment depth of embedment is enough.

3) Check if there is any point to become water-hammer part by the concentration of flowing water.

4) Check if the drift or meandering of flowing water can be well controlled by groundsel.

5) Check if the sand-controlling effect by groundsel is exerted well.

6) Check if the apron of groundsel is safe.

7) Check if there is any sedimentation in channel or lowering of river bed.

These problems are influenced by the fact that the deformation of river bed is influenced by the states of upstream or by the way of consideration for the plan on the revetment height, slope of design river bed, interval of groundsel, channel width or alignment shape.

(4) Make adjustment in case of occurred problem for the planned draft.

1) In shortage of revetment depth of enbedment with bigger local scouring at the bend and its downstream influenced by alignment shape of curved part, make adjustment for alignment-shape by its degree, and/or reduce the local scouring. Alignment plan is decided by considering the restricted conditions such as topography, using land, land-using plan, established river channel working facilities, thus alignment cannon be adjusted by only judging the result of hydraulic phenomena. Then, review the counter measure to reduce the local scouring caused by the meandering of flowing water, and consider the effect of counter measure, working cost, executability as a whole, and select whether the alignment should be adjusted or whether the counter-measure should be executed execute the measure.

There are the preventive counter measures against the local scour by the effect of curved alignment, such as groundsel, bed girdle, groyne, vane work, foot protection, therefore, decide the technique by hydraulic conditions, executability, and working cost, then, clarify the dimensions experimentally.

2) In lacking the safety of revetment with the lowering of river bed or sedimentation in the channel, make re-review of the adequacy of hydraulic conditions such as sand-supplying amount, then, review the adjusting draft of design river bed slope and sectional shape.

3) In case of the danger of revetment with the mandering and concentration of flowing water with the formation of alternating bar in the channel, adjust the interval of cross dykes (groundsel, bed girdle), or set the wing at the cross dyke, thereby, form the compound cross sectional river channel.

4) Adjust the case when the direction of groundsel affects the flowing direction of downstream adversely. In difficulty of the regulation of flowing water by the main groundsel alone, review the change of flowing direction by the vertical wall or sub-groundsel.

5) In case of severe local scour at the apron of groundsel, review the shape of necessary protective bed work.

(5) Review of safety of the adjusting draft.

Review the safety of the adjusting draft reviewed experimentaly against the flood of continuous occurrence, higher incident discharge of flood, discharge causing the disaster in the past, design high water discharge.

7.2 Setting of testing conditions

Set testing conditions such as discharge, sand-supplying amount and testing time by the purpose of testing case.

(1) Discharge

There are model experiment such as steady flow and unsteady flow. Select either one by the purpose of testing case, Steady flow experiment is beneficial for reviewing the partial adjustment or for grasping the problematic points of the planning draft, and characteristics of river channel can be grasped within a short time. On the other hand, hydraulic phenomena occur exaggerated by steady experiment test, thus for the flood, safe design dimensions of channel works can be obtained, but too safe counter measures may result in obtaining uneconomical dimensions of channel works, thus pay attention to the interpretation of the experiment result when applying it to the actual river. For reproducing the phenomena more similar to the flow of actual river, give the unsteady flow with the change in time course of the sediment discharge and discharge, as conditions. In unsteady flow test, reproducibility of actual river can be seen by present state test, or review is made for the design dimensions of more practical channel works. In longer interval of model object, the sediment from the upstream may not reach the end of downstream of river, thus it may be necessary to overlap the flood-waveprofile discharge for checking the change in time course at longitudinal section.

For setting the testing conditions, it is important to grasp the phenomena in the actual river properly and to estimate the future-occurring phenomena based on surveying data. For instance, single-line alternative bar is liable to be formed in the river channel in alluvial fan of steep slope where the channel works are planned and executed. The single-line alternative bar formed at big flood is fixed as it is, and numerous disasters of revelment occur by the meandering caused by the discharge which occurs once in a few years. Thus even if river channel is safe for the big floor discharge, it may be dangerous for less flow, thus it is important to set the testing conditions by checking the defree of discharge which caused the disaster at actual river or the continuous time of flood.

(2) Sand-supplying amount

This amount can be decided by considering the progress of work and the erosion-control planning or river-bed state at upstream of the planned point for channel work. For instance, there is a dam with less sand at the upstream of planned point for channel work, and in future, if there is estimated construction of a dam, give the condition with no sand supply. When the dam is filled with sand, the sediment is considered to be transported to meet the traction, set the slope of sedimentation at the dam, and supply the balancing sand to keep this slope. As mentioned before, if it is difficult to take the facilities such as a groundsel or a dam, select the interval where the deformation of river bed is small in actual river as the upstream end in model, and give the amount to keep this interval river bed level. Manufacture the model up to the upstream from the necessary model range, and sand may be supplied in its average sediment discharge of the nearby several sections. Flood flow at actual river may change the density of sand transported to the channel works in time course by the state of upstream area, but it is difficult to match the change of sand density of flood flow at the actual river as testing condition, thus sand should be supplied by supposing some conditions similar to the actual river. Thus, for seeing the effect of supplying amount, test is necessary by changing the sand-supplying amount.

(3) Testing time

At the unsteady flow experiment, set the testing time based on Q - T curve. In steady flow test against unsteady flow experiment, generally the tendency of the change of river bed or channel appears within shorter time, and its phenomenal tendency is exaggerated and clearly grasped.

In steady flow test, it is possible to grasp the problematic phenomena at the actual river, and it needs the time until the phenomenal tendency become constant, for instance, in watching the deformation of river bed of the special interval at actual river, it is suitable for checking the effect of the flowing out of the unstable deposited sediment on the change of river bed at downstream. Also, for reviewing the comparative methods of countermeasures or adjusting draft, a constant discharge is flown for settled time for measuring the dimensions or for grasping the phenomenal trend.

Water-passing time at steady flow experiment is different by the given discharge scale. By experience, one hour is enough for peak flow, but there are many examples needing 2 - 3 hours for passing the water in the object of melting time of snow or the discharge with higher incidence of flood at actual river.

CHAPTER 8 Test

8.1 Preparation before passing the water

Prepare the following contents before passing the water.

(1) Check if conformity of river bed is done correctly or if the river bed is kept on its fully wet state.

(2) Check if the measuring basic line is exactly stretched.

(3) Prepare the sand-supplying amount. Calculate the sediment discharge in a unit time for each discharge at the section to be supplied with the sand, and prepare the total amount of sand and for the planning to supply the sand to meet the discharge.

For making balanced supply of sand, set the level and slope of river bed with water texture in the interval section for supplying the sand.

(4) Set the basic point for setting the overflow discharge of gauging tank. Based on the H - Q curve diagram, match the reading of the point-gage to the overflow-water level.

(5) Make the testers know well the purpose of testing case, conditions, testing items, methods, sections and time.

(6) Set the meters and scaffolds, and prepare the measuring field notes. Check the instruments like the flowmeter, etc. Check the operation of camera, and install it.

8.2 Cautions for experiment

(1) For flowing the water, gradually increase the discharge.

(2) Set the starting time of test when flowing water reaches the end of model by matching the needle of a watch showing the progress of time.

(3) Stop the water flow rapidly, and try to keep the river bed in water passing. Supply the sand until water stops completely.

(4) In passing the water, pay attention to the unifying the discharge and the exact operation of samera.

(5) For exact measurement of deformation of river bed and water level changing in time progress, make measurement by skilfull testers.

(6) Do not disturb the shape of water-surface by supplying the sand near the water level as much as possible.

8.3 Measuring items and contents of data arrangement

Measurement is made during and after water passing. During water passing, measure (1) flow rate; (2) change in time of water level and height of river bed; (3) flowing regime observation; (4) change of sediment discharge sand; and (5) flowing direction. After water passing, measure (1) height of river bed and (2) total sediment discharge.

(1) Measurement of water level and height of river bed

1) Measure the change of crossing and longitudinal direction in time course of the water level and the level of the river bed in accordance with the removement of river bed and total amount of supplied sand. Measured results are used for preparing the crossing and longitudinal section of river-bed height and water level with combined description of initial level of river bed, also, and for preparing the draft of counter measures by grasping the moving state of sediment in flood. Moreover measured results are used for reviewing the shape of apron-protective work for groundsel, slope of crown at revetment, allowance height of revetment, overflow depth of water at revetment, scouring depth along the revetment.

(2) Flow regime measurement and observation

1) In preset state experiment, place the importance on moving state of sediment, meandering and water-hammer part of flowing water, flood state (points), erosion state of the bank, and local scour of river bed, thus make quantitative observation and measurement on the present river channel for its problematic points and the causes, will making the review on similarity with the actual river.

2) In reviewing experiment of planning draft, make observation and measurement by placing the importance on whether the problem could be solved at the present channel and what the problematic point and its cause are.

3) In the test for adjusting the planning draft, problems of planning draft could be solved, but, make observation and measurement by placing the importance on how the problems of the planning draft were solved and what the considerable points for the channel works are.

In observation and measurment of the flow regime make continuous observation and measurement on the problematic points as well as those causes. For that purpose, measure the flow rate, longitudinal and cross sections as well as water level other than the specified section area in accordance with the occurring phenomena. And take photos of the characteristic phenomena. According to the situation take photos by cameras for the changes in time course on phenomena.

For the measuring results, clearly arrange and describe the major channel on the plane of flow regime, time-change of sediment moving the depth of local scour, overflow at revetment, and flow rate with the measured time and position, while grasping them continuously on the characteristic phenomena, and also, describe the problems and causes for each case. Clearly describe the phenomena, position and time on photos.

(3) Measurement of flow rate

It is done for checking the change of flow rate along the revetment at bend by setting of groundsel, difference of shape of wing at the groundsel, and setting of groyne. Standard measurement is made for flow rate at bottom and surface, while flow-rate distribution may be measured in water-depth direction in accordance with the purpose of the testing case.

For the results, arrange them in lists, and changes of flow rate on longitudinal profile or plane (insert the lateral profile into the according position of the plane).

(4) Measurement of sediment discharge

Measure the sediment discharge without estimating the air porosity from the end of the model during water-passing. Take the time interval (3 minutes by experience) for measurement to grasp the actual state of changes in time course of the sediment discharge. Decide the collecting time by considering the measuring accuracy in accordance with the sediment discharge.

After passing the water, measure the total volume sediment flowed into the settling pond with the fixed receptacle. For the results, calculate and arrange the ratio with supplying sand amount, sediment discharge per second, sediment concentration in lists, and prepare the changing diagram in time course.

(5) Measurement of flowing direction

Make photography for the whole model or channel at specific interval sections, the change of sediment movement including alternating bar in time course by cameras. In steady flow experiment photography is interval of 10 minutes. In unsteady flow experiment, take pictures for each change of discharge as standard, but in case of measuring the moving speed and formation of diagonal bar according to the tester's instruction, and in case of change of flow regime in short time by characteristic phenomena, it is important to take pictures of them even in other time than the specified time.

For the results, pay attention to the major flow line and shape of the alternative bar, and prepare the continuous photos, then, arrange and describe the taking time of photo, hydraulic conditions, measuring line and No.

(6) Measurement of river bed level

Do masurement of longitudinal or crossing section for grasping the longitudinal and crossing changes of river bed before and after flood. Also, measure the level of the river bed within the specific ranges such as the surrounding of river channel structures.

For the results, prepare the lateral profile in accordance with the uses of the results, or arrange the longitudinal profile and plane (insert the lateral profile into the according position on plane).

CHAPTER 9 Preparation (production) of reports

9.1 Phenomenal analysis

Make analysis in accordance with the testing purpose according to the results of data arrangement.

(1) Review of reproducibility (similarity) of test

By using the surveyed data at the actual river, consider the reproducibility of meandering of flowing water, water hammer part, trend of deformation of river-bed, relations with past disasters, roughness coefficient, sediment discharge, water level of flood, etc. However, there are many cases with no collection of enough data for reviewing the reproducibility at actual river, thus it is possible to consider them on qualitative plan-view phenomena in many cases.

(2) Comparative review of river-bed change

Make comparative review of the reflects on flow-states (shape of river bed, meandering of flowing water, concentration and local scour, flat moving state of alternating bar, jumping phenomena of water, flow rate, etc.) by the changes of hydraulic conditions such as the discharge, differences of shape of river channel structures, setting of them at river bed, and problematic phenomena and causes at present river channel.

(3) Analysis of change in river bed

Analyse the following changes for reviewing the movement of sediment or effect of facility.

1) Prepare the diagrams of mean level, highest level and lowest level of bed and the longitudinal section. For the data reviewing the level of revetment foundation and that of groundsel, and shape of apron-protective work, prepare the longitudinal profile of lowest height of river bed measured in water-passing. In longitudinal profile, describe the initial level of river bed and structures of river channel.

2) Obtain the changes against the analyzing objective river bed such as the initial river bed, or design river bed, scour interval and deposit amount at specific interval section. Also, estimate the sediment discharge into specific section and that from the section (interval), and review the adequacy of changing amount.

3) Calculate the scour depth and deposit depth against the initial level of river bed (mean height of river bed at present channel), then, prepare the plane for scour and deposit.

4) Longitudinal section for water level

As data for reviewing the height of revetment, prepare the longitudinal section of mean water level and the highest level described combinedly with the ground level of hinter-land of river-channel structures such as groundsel and revetment.

9.2 Arrangement of test results

(1) Arrangement of test result

1) Consider the similarity from the field data and test results. Arrange the problematic points and causes at present channel, and consider the dimensions and drafts of counter measures to meet the shape of disaster.

2) For the reviewing experiment on planning draft, consider and arrange the following things, that is, what is the problematic points of planning draft? What considerations (methods) and reviewing process against the probrementc points was the adjusting draft made through? How is the flow regime or the deformation of river and influenced by the alignment shape, channel width, arranged of cross dykes, difference of their shape, discharge or supplied sand amount distance, difference of continuous time of flood?

3) Combinedly describe the shape of best draft reviewed from model test on the initial design plane, crossing and longitudinal profile.

① On the plane profile, describe the adjusted alignment shape, channel-width, arranged position of facility, and its direction.

② On tateral profile describe the adjusted level of design river bed, revetment level, water-profile of experimental value, or crossing shape of river bed.

③ On longitudinal profile describe the adjusted level and slope of design river bed, addjusted distance by alignment correction, position and altitude of cross dykes, average and highest water levels at each section, and revetment level average and highest lvels of river bed as well as the design foundation level.

④ Also, prepare the detailed diagrams on spillway, shape of wing, front apron, and protactive bed work of the groundsel

9.3 How to summarize the reports

Reports shall contain the following items.

(1) Outline of drainage basin problems of present channel and disaster-results.

(2) Flood profile discharge yearly (annual) probability discharge hydraulic conditions like sediment discharge etc., basic way of consideration for channel work.

(3) Experimental purpose, model outline, experimental method, content of experimental case.

(4) Arrangement of test results and consideration of test.

(5) Suggestion to the planning of channel works.

CHAPTER 10 Application of the result of the experiment for actual river.

In application of results, for actual river, grasp how the model experiment is performed by what experimental condetion, how the similarity is satisfied, how the measured accuracys, how the conclusion of the experiment is obtained through what process, as well as grasp the state and result of the experiment on actual river.

For effective use of the result of the experiment on actual design, it is recommended to start the design at the stage of rather advanced test, for instance, clarify the indistinct contents for actual design. Even if the reviewed dimensions are safe hydraulicly, revew the other techniques when problems are clarified on the fact that it is not suitable for the local site because of huge cost. The result of the experiment is meaningless if the experiment is finished without clarifying the problems on design.

POST SCRIPT

Description has made on the roles and techniques on hydraulic model expreiment planning design channel works. For obtaining the maximum results by model experiment or in the use of limited cost, make full field survey and review the way of consideration for basic chennel works planning for clarification of experimental purpose. Upon adjustment for the planning draft, the tester should check if the adjusted draft is suitable to the actual river, and pay attention to the trouble not to occur.

It is a pleasure for the author if this text would be a handbook for model for deepening the understanding of field technology and diffusion of model experiment.

JICA