GOVERNMENT OF RAJASTHAN

DESIGN MANUAL

FOR

CONSTRUCTION OF BRICKLINED RECTANGULAR SECTION WATER COURSES
INDIRA GANDHI NAHAR PARIYOJNA STAGE-II (BELOW KM. 189 OF IGMN)

OFFICE OF THE

CHIEF ENGINEER COMMAND AREA DEVELOPMENT
INDIRA GANDHI NAHAR PROJECT
BIKANER

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PREFACE

The Design Manual for brick lined rectangular section Watercourses has been prepared to provide guide lines, standards and specifications for planning, designing and estimating the O.F.D. Works in the Area below Km. 189 (Stage-II) of Indira Gandhi Mukhya Nahar.

The recommendations of World Bank Team of IFAD Mission for watercourses for Stage-I of Indira Gandhi Mukhya Nahar (below km. 74) have in general been followed while framing this design Manual. The amendments issued upto Oct. 1992 have been incorporated in this issue.

The Officers and Staff engaged on the Command Area Development Works would make use of this manual for preparation of Chak Schemes of O.F.D. Works below Km. 189 of Indira Gandhi Mukhya Nahar. Any suggestion for future improvement from the Field Officers will be appreciable.

Dated: 22.10.1992

Chief Engineer
Command Area Development,
I.G.N.P., Bikaner.
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CHAPTER I

INTRODUCTION

This manual lays down guide lines for planning and design of lining of water courses under the Command Area Development Programme of Indira Gandhi Nahar Pariyojana below km. 189 (Stage-II) of Indira Gandhi Mukhyta Nahar. Guide-lines for design of lined water courses are dealt in Chapter No. 3, paras 3.01 to 3.14. Instructions regarding preparation of schemes/estimates for technical and financial sanction have been given in Chapter No. 4, paras 4.01(a) to 4.01 (d) and in Chapter No. 5.

Standard designs for water courses rectangular section with brick lining have been worked out for different bed slopes and bed widths with maximum full supply depth of* 0.55' (168MM), 0.81' (248MM) and 1.07' (328MM) for adoption of suitable sections for different discharges.

The typical X-sections of the brick lined water course adopted in this manual are based on local field considerations and experience gained by the construction of the lined water courses and distribution systems of the Indira Gandhi Nahar Pariyojana.

* Amended vide this office order No. F/DM/D-III/300/CE/CAD/115 dated 22.1.1990 in place of 0.78' (238MM) and 1.04' (318MM).
2.01 Chak: It is the area under Command which receive irrigation from a Single outlet of the canal. It generally comprises an area of 200 hectares to 250 hectares.

2.02 Square (Murabba): It is a measuring unit of land square is measured as 825' x 825' (251.46 x 251.46 meters).

2.03 Bigha (Killa): Each square is further sub-divided into 25 bighas. Each bigha is measured as 155' x 155' (50.29 x 50.29 meters).

2.04 Water Courses (Khal): It is a small irrigation channel which carries water from the outlet of a canal to different squares of a chak. Generally it has a carrying capacity of 1.5 cusecs to 2.50 Cusecs.

2.05 Naka (Turn out): It is a feeding point from water course to various squares. It is generally provided at the highest point along the alignment of water course so as to irrigate the maximum command area.

2.06 Field Channel: It is a katcha channel excavated and maintained by the Cultivators in their own land for irrigation water from Naka point of the water course.
2.07 Outlet (Mogha): An outlet is a device at the head of a water course through which designed discharge is taken as per the culturable commanded area of the chak.

2.08 Gross Command Area: It is the total area of the chak which includes "GAIRMUMKIN" land like, public Roads etc. Culturable and un-culturable area. Thus gross command area = Culturable Command Area + Unculturable area.

2.09 Culturable Command Area: It is the portion of the gross command area which is culturable or cultivable.

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NOTE: In special cases chak size may be relaxed from 100 hectare to 350 hectare.
CHAPTER III

WATER COURSES

3.01 Introduction: All the water courses (Khalas) in area below km. 189 (Stage-II) I.G.M.N. will be lined to reduce water losses. The guide lines for design and framing cost estimates for brick lined rectangular section water course are out-lined in the following paras: -

3.02 Criteria for adoption of F.S.L. at Naka Points:
The F.S.L. of Naka points shall be determined by adding 0.25' (7.62Cm) to the average highest killa (Bigha) level of the square allowing slope of 0.04' (1.22 Cm) per bigha length in the field channel.

3.03 Grades in water courses: The planning and design of the water courses should be such as to command, as far as possible, maximum area in a chak commensurate with economic cost. The grades should be such that the velocity should not be less than lacey's critical velocity. In any case, the slope should not be flatter than 0.20' per square length. Wherever possible as per topographic conditions of the chaky, such steeper slopes shall be provided so that the velocity should not exceed: -

(a) 2 ft. per second.
(b) 2.5 ft. per second for continuous cutting reaches where natural surface level (N.S.L.) is higher than full supply level (F.S.L.) of water course. The length of such cutting reaches between the two control points (Nakas) should not be less than one square length.
(c) In very steep terrain which would involve many drops, the slope can be increased. The channel then becomes a chute.

3.04 Outlet size: The chak size should be such that the discharge of outlet should generally be between 1.50 to 2.50 cusecs. Outlet with discharge below 1.50 cusecs and above 2.50 cusecs should be considered in special case only and provided if un-avoidable possibilities of having common feeder water course in some length and then, bifurcating the same by providing a proportional distributor, should also be examined in case where discharge is more than 3.00 cusecs.

3.05 Working Head: Working head of less than 30 Cms (1.0') should not generally be adopted. The working head should preferably be around 60Cms (2.0'). However, in case of tight command and where area already under command and being irrigated is likely to become un-command, *"Lesser working head upto 25 Cms (10'') for other than tail chaks and Zero working head for tail chaks only can also be allowed as a special case." In case, where working head available is less than 30 Cms (1.0') crumps open flume outlet should be provided.

3.06 Criteria for cutting/filling: The criteria for cutting/filling keeping in view the topographic conditions have been framed as under;

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*Amended vide office order no. F-300/DM/Stage-II 3536-37 dated 7.1.1991 in place of "Lesser working head upto 10" (25 cm) and 6" (15cm) for tail chaks only can also be allowed as a special case".
(a) The alignment of the water course should be so determined that it commands maximum area in the chak. The maximum filling and cutting in the alignment of the water course should not normally exceed 5' (1.50 metres) in filling from average N.S.L. to top of bank and 7.50' (2.50 meters) in cutting (from average N.S.L. to bed level of water course).

Alignment with higher filling and deeper cutting than above, if necessary, shall be provided only after detailed site inspection by the Executive Engineer and obtaining special prior-approval of the Superintending Engineer, who will give his decision after considering different alternative proposals of alignment "Keeping in view the economy and practical feasibility of running and maintenance of the water course."

(b) Efforts should be made to align the water course along fringe of the command and uncommand area, and along square-lines as far as possible to avoid splitting of cultivator's holdings.

3.07

(a) **Location of Naka points**: As far as possible, only one Naka point should be provided in one square. The location of the Naka point should be at the highest ground level along the alignment of water course.

(b) **Masonry structures**: (i) Suitable allowance for head loss due to syphon and syphon-culverts be considered before finalisation of longitudinal section of water course by the Superintending Engineer. However the losses due to bends, Naka points etc., being negligible may not be accounted.

(ii) The typical drawing of masonry structures i.e. bridge falls, syphon culverts Naka and Naka with fall are enclosed. (See plate V to VII).
3.09 Culturable Command Area: (i) The culturable command area of a farm for purpose of preparing cost estimates and calculating water allowance, would be arrived at by deducting the "Gairmumkin" land like public Road etc. from the gross command area of the farm. No deduction would be made for the land that would come under the water course and farm tracks *(24' - 9" wide). 7.544 Metres.*

The "Gairmumkin" land would be determined on the basis of records maintained in Colonisation Department.

* Amended vide this office order no. F-300/D.M./Stage II/3402 dated 20/12/90 in place of no separate water course or a naka need to be provided for small patches at the tail end of CCA upto 5 bighas of a square, such small patches will be irrigated from the nearest naka of adjoining square. For patches more than 5 bighas and upto 10 bighas at the tail end of a square, suitable naka and unlined watercourse will be provided, the alignment of such water course (in both cases) should clearly be marked on the chak plan."

** Amended vide this office order No. F-300/D.M./Stage II/2520 dated 10.10.90 in place of 16'1"-6" (15½'),
As far as possible, no areas, which have received irrigation through katcha water course, shall be de-commanded due to construction of lined watercourse. To ensure it, the existing F.S.L. of each square should be clearly marked in the chak plan.

(ii) Farms under the "Nursery" programme of the forest department will be classified as CCA if their ground levels are lower than the designed F.S.L. of the water course at relevant point.

(iii) While land under "Abadi" may not be classified as CCA, but water allowance equivalent to one square for every four squares of "Abadi" with a minimum provision equivalent to one square may be kept in the water course to meet the drinking water requirements. "As far as possible, Abadi should be planned on uncommand land".

3.09 (b) Uncommand: Only such bighas be classified as uncommand whose weighted average ground levels are higher than the F.S.L. at the relevant point.

3.10 Cross-Section: (a) For calculation of discharge in a water course, the CCA will be determined as per criteria stated in the para 3.09 (a) (i) to (iii) and due allowance would also be made for "Nurseries" as per para 3.09 (a) (ii), for Abadies as per para 3.09 (iii), the discharge will be calculated at the rate of 3.00 cusecs per 1000 acres of CCA at the outlet head plus 5% extra for future development. The designed free board of 0.5 ft. (152MM) will be provided in the lined water courses.
(b) The cross-section of the water course shall be designed as rectangular section. The top of embankment should be same as top of side walls of lined water course. The top width of the embankment at the level of top of side walls of lined watercourses should be one metre excluding the width of side walls.

(c) (i) The outer slope of embankment in filling should be provided as 2:1 or as per angle of repose which ever is flatter. The top width of bank should be **1 metre. The outer cover of embankment in a thickness of 9" (22 Cm) should be provided with selected soil available from deeper digging of borrow pits.

(ii) The earthen profile to the designed section should be made in advance at an interval of half murrabba length.

*** (iii) The D.B.D. of the Sub-grade of lined water courses is to be observed in cutting as well as in filling reaches at an interval at about 50 Metre and it should not be less than 1.55.

* Amendement issued vide this office order no. F-300/DM/CE/CAD/116 dated 22.1.90 (As per drawing of cross-sections) in place of the cross section of the water course shall be designed as rectangular section. The total free Board of 1' shall be provided out of which minimum lined free Board of 0-5' (152MM) and the remaining earthen free Board of 0.50' (152MM) shall be provided.

** In place of 2' (60 Cm).

*** 3.10 C (iii) - freshly added vide order No. 116 dated 22.1.90.
(d) In cutting reaches *1 Metre berm at the bank level, with 2:1 slope of cutting should be, provided upto a height of 5' (1.5M) after 5' height another berm/bench of 5' should be provided.

The total cutting should not be more than 8' (2.5M) in exceptional cases, where cutting/filling is more than 8', the slope and berm must be loaded with kankar available at the nearest source "with the permission of SE".

(e) Intensive green and dry mulching on banks and slopes in cutting sections should be provided "to stop erosion and accumulation of sand" for stabilisation of the soil.

3.11 **Standard Tables**: The design of the brick lined rectangular water courses is based on Manning's formula with co-efficient of Rugosiy (N) as 0.018. The suitable section of the water course for designed discharge and bed slope should be adopted from the standard tables enclosed at Annexure 1 (Page 1 to 25).

**Lining**:

(a) The water course would be a rectangular bricks lined section with well-burnt clay bricks of size 23Cm x 11Cm x 7Cm. **The typical cross-sections with different bed widths and depths are enclosed in plate no. 1.1 (a) & 1 (b)**

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* 3.10 d "replaced in place of 5".

** Ammended vide order no. 116 Dated 22.1.90 provided eight sections in place of six and in partial modification of sections approved vide no. F-300/DM/CAD/1361-65 dated 24.11.89.
(b) * 7.8 Cm thick brick masonry in bed and 11 Cm thick in sides would be in 1:5 cement mortar. Before laying bricks on bed, a layer of 8mm (5/16") of cement mortar (1:5), should be spread on the sub grade and bricks will be laid flat with their frogs **upward. The frog shall be properly filled with mortar before laying the bricks in bed. The joints should be 10MM (3/8") thick.

(c) 10mm (3/8") thick cement plaster in 1:3 cement mortar would be on bed inside upto top.

3.13 ***(i) Reduction in height of side walls in last square length of lined water courses:

Where there is sudden fall in level of water course at the entry point in the field, the height of side walls of water courses in last square length can be reduced. We have 8 different sections for water courses being constructed in Stage-II of IGNP in which the height of the side walls varies from 4 bricks to 6 bricks. Wherever there is possibility of sudden fall at the point of entry of water from water course into field, the height of side walls in the last square length may be reduced as under:

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* Amended vide order no. F-300/D.M./Sta.II/428-33 dated 31.12.88. In place of 7cm thick brick masonry in bed, and 11cm thick in sides would be in 1:5 cement mortar. The joints should be 10mm (3/8") thick.

** Amended vide order no. 116/dated 22.1.90 as **upward** in place of downward which was conveyed vide order no. 428-33 dated 31.12.88.

*** Instructions issued by CE/CAD/Bikaner vide F-300/D.M./Stage-II/3584-85 dated 11.1.91 para 3.13 (freshly added).
(a) Height of side walls 320mm (4 bricks):
150 metre length of the water course from tail end with 3 bricks and rest 100 metre with 4 bricks.

(b) Height of side walls 400mm (5 bricks):
100 metre length of the water course from tail end with 3 bricks, next 100 metre with 4 bricks and remaining 50 metre with 5 bricks.

(c) Height of the side walls 480mm (6 bricks):
75 metre length of water course from tail end with 3 bricks, next 75 metre with 4 bricks, next 50 metre with 5 bricks and remaining 50 metre with 6 bricks.

3.13  * (ii) Wing walls for structures:
Wing walls and retaining walls of Road crossing such as wells (these should be mono-lithic with lining of water course) and other structures should be properly designed to retain the backfill and provided as per requisite site conditions.

** (iii) VRB for Rastas/Road be provided where total filling is upto 1 metre otherwise this be replaced by syphon of 2' dia RCC pipes with well or cistern (mono-lithic with lining of water course) for smooth plying of carts etc.

(iv) A sloping apron with cistern (as a mono-lithic structure with water course lining) be provided to cater the requirements of energy dissipation and retrogression at every 5 ft. level difference for safe conductance of water from Naka point to Average Natural Surface Level (NSL) of the fields. Practical views be also accounted for.

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ICNP


** Instruction issued by CE/CAD/IGNP, BKN vide F-7/EE (D-1)/199-200 dated 17.3.92.
3.14 Marking of name of chaks on road crossings

The chak name be marked on the V.R.B./D.R.B./State highway/National highway on the left side of parapet wall/wing wall while negotiating in both the direction of the road-crossings.

Specifications be adopted as:

i) Width of the block : 356 mm (14"

ii) Height of the letters : 152 mm (6"
(Height of block can vary depending upon no. of letters involved in the name of chaks)

iii) Colour used for base : White (With enamel or good quality paint.

iv) Colour used for letters : Black paint.
CHAPTER IV

INSTRUCTIONS REGARDING PREPARATION OF SCHEMES/ESTIMATES FOR TECHNICAL AND FINANCIAL APPROVAL:

4.01 (a) The funds for the lining of water course are made available to this organisation through the State budget under Centrally Sponsored Scheme. The expenditure is shared by the central and state Gov'ts. equally.

(b) (i) Chaks where the cost per hectare is less than Rs. 8000/- will be sanctioned by competent technical Authority as at present (i.e. as per schedule of power item no.1). Chaks where cost per hectare is more than Rs. 3000/- and upto Rs. 11,000/- should be submitted to Advisory Committee, constituted by the Area Development Commissioner, IGNP, Bikaner vide order no. 443/F-11 (Plan)/ADC/OFD/cost/stage-11/88-89 dated 17/18.1.90 for its approval.

* (ii) All the cases where per hectare cost exceeds Rs. 11000/- would be submitted to the Government for approval/decision after consideration and on the recommendations of the Advisory Committee.

** (c) While preparing and finalisation of the chak scheme, following points be kept in mind and should be strictly followed:-

1. The alignment of W/C, canals, Roads, uncommand and command area, chak boundary etc. should be marked with prescribed notional colours as under :-

(a) Alignment of W/C : Red Sketch colour

(b) Rasta/Road : Black Sketch colour

(c) Uncommand area : Red pencil colour

(d) Chak boundary : Green sketch colour

(e) Canals : Blue sketch colour (For Amonia prints)

(Violet sketch colour for Blue prints)
(f) Key plan : Chak boundary with green, off-take point with Red, canals with Blue Sketch colour.

(g) Area Decommend due to : Red pencil colour hatching with boundary.

2. Possibility of providing next lower section by providing steeper slopes may be examined in main W/C as well as in Laterals keeping in view the command area, such as steeper-slope may not effect CCA.

3. Possibility of reducing heavy cutting/filling by change/shifting of alignment may be examined and it may be ensured that such heavy cutting/filling is unavoidable even after exploring alternative alignments.

4. Bifurcation of squares may be avoided by change of alignment of Water course.

5. It may be ensured that water course alignment has been checked to ensure economic consideration and to cover maximum no. of beneficiaries and command.

5. In case the scheme is old, then existing FSL should be marked on each squares and ensured that planning has been done with the view that no area remains out of command which was previously getting irrigation by katcha water course.

7. It may be ensured that the chak boundary of the chak has been compared with adjoining chak and found correct and there is no omission or square taken in two adjoining chaks simultaneously (i.e. there should not be over-lapping).

8. It may be ensured that chak plan has been prepared as per design manual and other norms laid down in this regard envisaging minimum length of water course with maximum irrigation efficiency.

9. The adjoining chaks should be clearly shown in the key plan.
10. Prescribed certificates should be given by Executive Engineer on the Chak-plan.

11. Certificate of technical checking by Executive Engineer (D & P) of circle office should be given.

12. Cultivators list should be enclosed with the scheme.

13. Canals, Roads, Rasta, Culverts etc. should be shown in the chak plan.

14. Syphons should be shown in the chak plan.

15. Economical trial should be enclosed with the scheme.

16. The following certificates should be given on the chak plan :-

   (i) Area of adjoining chak has been compared and found correct. There is no omission of land.

   (ii) The chak plan has been prepared by WAPCOS as per design manual and other norms laid down in it. The chak plan envisages minimum work length of water course with maximum irrigation efficiency.

   (iii) The cutting & filling proposed in L-section are unavoidable.

   (iv) No area is decommanded which is already irrigated.

   (v) Rastas, Roads, Culverts, Abadi and Nursery etc. have been marked with the consultation/record of the Colonisation department.

   (vi) Alignment has been checked 100% by the Executive Engineer, at site as well as on chak plan prepared by WAPCOS.

   (vii) FSL of disty. is as per the existing FSL in channel.
(d) Following documents should be enclosed with the chak scheme:-

(i) General abstract of cost.

(ii) Design calculations of adoption of particular lined section.

(iii) CCA statement duly certified by the Executive Engineer that it tallies with the cultivators list, naka point statement, earth work statement indicating cutting, filling & quantity, Bench-Marks statement, statement of locations of falls, VRB syphons etc.

(iv) Cultivators list duly certified and compared with the record of Colonisation Department.

(v) Typical cross-section of watercourse adopted.

(vi) Chak plan with key-plan duly approved by the Superintending Engineer. One copy of the chak plan will bear the names of the cultivators along with their holdings (If allotments made by the Colonisation Deptt. prior to approval of chak scheme).

(vii) L-section of the main water course and laterals duly approved by the Superintending Engineer.

* As per Area Development Commissioner, IGNIP, Bikaner order No. 389 dated 15.02.1990.

** Instructions issued vide this office letter no. F-7/EED-1/199-200 dated 17.03.1992.
CHAPTER V

ESTIMATE FOR TECHNICAL SANCTION

5.01 The procedure of framing and submitting technical estimate will be similar to prevalent practice in the CAD, IGNP, Organisation.

5.02 The technical estimate will consist of:-

3. Analysis of rate.
4. Lead statement for materials. A certificate be given that source of brick is as per approved brick planning.
5. Statement of material, quantities of tiles/Brick, Cement, Bajri and any other constructions materials.
6. Detailed estimate.
   (a) For water course lining as per standard detailed estimate form.
   (b) Details of earth work estimate for water course.
7. Design of water course section for the required discharge.
8. Details of pucca structures showing their location and data, alongwith a typical drawing of sloping apron with cistern to cater the requirement of energy dissipation and retrogression at every 5ft. level difference for safe conductance of water from Naka point to average ground level of the fields.
9. Economical trials be enclosed with estimate.

5.03 The following drawings should accompany the technical estimate.

1. Chak plan showing a key plan on the right hand top corner (Plate-III).
2. Longitudinal section of water course (plate-IV).
3. Cross sections of water course at 412.5' interval.
4. Typical cross section of lined water course adopted.