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“Knowledge is such a treasure which cannot be stolen”
Indian Standard

GLOSSARY OF TERMS RELATING TO RIVER VALLEY PROJECTS

PART 18 ENERGY DISSIPATION DEVICES (STILLING BASINS)

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NEW DELHI 110002

Gr 5 April 1984
Indian Standard

GLOSSARY OF TERMS RELATING TO RIVER VALLEY PROJECTS

PART 18 ENERGY DISSIPATION DEVICES
(STILLING BASINS)

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GLOSSARY OF TERMS RELATING TO RIVER VALLEY PROJECTS

PART 18 ENERGY DISSIPATION DEVICES (STILLING BASINS)

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 25 November 1983, after the draft finalized by the Terminology Relating to River Valley Projects Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 A number of Indian Standards have already been published covering various aspects of river valley projects and a large number of similar standards are in the process of formulation. These standards include technical terms and precise definitions of terms which are required to avoid ambiguity in their interpretation. To achieve this end a series of standards on glossary of terms relating to river valley projects is being published. This part (Part 18) contains definitions of terms relating to energy dissipation devices (stilling basin) and to their various parts.

0.3 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by deriving assistance from the following publications:


INDIA. INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE. Multilingual technical dictionary on irrigation and drainage. 1967.


0.3.1 All the definitions taken from ‘Multilingual technical dictionary on irrigation and drainage’ are marked by asterisk (*) in the standard.
1. SCOPE

1.1 This standard covers the definitions of the terms relating to energy dissipation devices adopted in river valley projects.

2. DEFINITIONS

2.1 Arrows* — V-type blocks kept with their vertex on upstream side in the path of flow (see Fig. 17).

2.2 Baffle Wall, or Baffle — A vane, wall, guide, grid, grating, screen, pier or similar device constructed or placed in flowing water, to (a) check or effect a more uniform distribution of velocities; (b) absorb energy; (c) divert, guide or agitate the liquids; or (d) check eddy currents.

2.3 Baffled Apron or Baffled Chute — Baffled chutes are used to dissipate the energy in the flow at a drop and are most often used on canal waste-ways or drops. They require no initial tail water to be effective although channel bed scour is not as deep and is less extensive when the tail water forms a pool into which the flow discharges. As the multiple rows of baffle piers on the chute prevent excessive acceleration of the flow and provide a reasonable terminal velocity regardless of the height of drop, no stilling basin is required. The chute is designed on 2:1 slope or flatter and its lower end is constructed to below stream bed level and back filled as necessary. Degradation of scour of the stream bed, therefore, does not adversely effect the performance of the structure.

2.4 Blocks, Baffle Piers, Friction Blocks, Control Blocks* — Obstructions set in the path of high velocity water, such as piers, on the apron of an overflow dam, weir or drop and to dissipate energy thereby preventing scour downstream to control the position of hydraulic jump (see Fig. 16).

2.5 Bucket — A curved surface provided at the toe of an overflow dam to deflect the flow horizontally.

2.5.1 Ski-Jump Bucket, or Ski-Jump Dissipator — A bucket which enables the high velocity jet of water to be thrown into the air.

2.5.2 Slotted Roller Bucket Dissipator* — A bucket type energy dissipator in which the lip wall is made up of alternate teeth and slots and below which a sloping apron is provided. This construction of the bucket materially reduces the intensity of surface boil and ground rollers (see Fig. 9).

2.5.3 Solid Roller Bucket Dissipator* — A bucket type energy dissipator which consists of a bucket like apron with a concave profile of considerable radius and a lip which deflects the high-velocity flow away from the
stream bed and upward forming elliptical hydraulic rollers, namely, submerged rollers in the bucket, and ground rollers downstream of the bucket. Energy dissipation is accomplished by the interaction of the submerged roller in the bucket and the high turbulence created on the water surface above and below the bucket. Suitable when the tail water depth is moderately in excess of that required for the formation of a hydraulic jump (see Fig. 8).

2.5.4 Super Elevated Bucket — The bucket invert elevation changing along the width of the bucket (see Fig. 27).

2.5.5 Trajectory Bucket, or Flip Bucket Dissipator* — A type of energy dissipator, employed in cases where the tail water depth is less than that required for the formation of hydraulic jump, by throwing water away from the toe of the dam in the form of projectile into the air (see Fig. 12).

2.5.6 Tunnel Spillway Bucket or Tunnel Deflector* — A device to deflect and spread the high velocity flow high into the air and permit the dissipation of energy at a safe distance downstream from the tunnel outlet.

2.6 Bucket Angle — The angle subtended between the radii at bucket invert and bucket lip (see Fig. 10).

2.7 Bucket Apron — Apron laid downstream of the teeth of the bucket (see Fig. 11).

2.8 Bucket Invert or Bucket Arch* — The concave surface of the bucket (see Fig. 10).

2.9 Bucket Invert Elevation* — The elevation of the lowest concave surface in the bucket invert (see Fig. 10).

2.10 Bucket Lip* — The top surface of the invert wall (see Fig. 10).

2.11 Bucket Teeth* — The protruding parts between the two slots of the slotted bucket (see Fig. 11).

2.12 Bucket Type Energy Dissipator* — A type of energy dissipator in which bucket is used in place of sloping apron or stilling basin. Applicable in case of spillways below which stream bed is composed of rock.

2.13 Chute Blocks* — Blocks provided at the entrance of the stilling basin to stabilize the formation of hydraulic jump, to increase effective depth, to break up flow into a number of water jets, to create turbulence and to lift the jets off the floor to reduce basin length (see Fig. 16).

2.14 Contra Jet Energy Dissipator, or Interacting Jets Dissipator* — In this type of dissipator, jets of water from two openings or nozzles are
directed against each other in a basin. In the plane of contact of the colliding jets, water flows radially outward from the axes of the jets in the form of a disc, and induces the formation of hydraulic rollers.

2.15 **Cross Sill** — A solid sill extending across the stilling basin apron to deflect the bottom currents, to assist in the dissipation of energy and to control erosion downstream from the stilling basin.

2.16 **Deflector or Triangular End Sill** — A sloped continuous wall provided at the end of a rigid apron to deflect the high velocity jet emerging from an outlet for the purpose of flaring out the jet laterally into a fan shaped sheet.

2.17 **Deflector Blocks** — These are large blocks, similar to but larger than chute blocks, placed on the chute. Their function is to direct a jet into the base of the roller in an attempt to strengthen or intensity and thereby stabilize the jumps. Mainly applicable for flow with Froude number between 2.5 and 4.5 to eliminate the wave at the source.

2.18 **Deflector Hood** — A curved deflector, used in jet diffusion method, to prevent the jet from being torn apart by induced eddies until it is well submerged (see Fig. 2).

2.19 **Dent, Dental or Tooth** — A tooth-like projection on an apron, or other surface, to deflect or break the force of flowing water; a form of baffle.

2.20 **Dentated Bucket Lip** — A bucket lip having protruding teeth over its length.

2.21 **Dentated Sill** — A notched sill at the end of an apron to check the force of flowing water and thus reduce erosion below the apron. The sill also reduces bed velocity.

2.22 **Diffusion** — The process by which a fluid permeates its environments.

2.23 **Diffusion Blocks** — Blocks constructed on upturned apron in case of varying tail water level to help increase diffusion activity and reduce velocity. The blocks are of special design.

2.24 **Drop Type Energy Dissipator** — This type of dissipator is used for reducing wave action at the source, for values of the Froude number between 2.5 and 4.5 and is particularly applicable to small drops in canals. A series of steel sails, channel irons, or timbers in the form of a grilly are installed at the drop. The overfalling jet is separated into a number of long, thin sheets of water which fall nearly vertical into the canal below. If the tails are tilted downward at an angle of 3 degrees or more, the grill is self-cleaning.
2.25 End Sill or End Baffle — A vertical, stepped, sloped or dentated wall constructed at the downstream end of a stilling basin. It may be rectangular (Fig. 20), trapezoidal (Fig. 21), Hornsby (Fig. 22), Schoklitsch (Fig. 23), Smetana (Fig. 24), or Rehbock type (Fig. 25).

2.26 Energy Reducing Action or Energy Dissipation Action* — A phenomenon, such as hydraulic jump, jet diffusion, ski-jump, which dissipates energy mainly by turbulence. Energy dissipation actions are accordingly named as hydraulic jump action (method or principle), jet diffusions principle of ski-jump principle.

2.27 Fine Grain Turbulence* — Small energy dissipating eddies, such as created by jet diffusion.

2.28 Free Jet* — A jet having atmospheric pressure all along its surface.

2.29 Free Jet Chute, Free Jet Parabolic Drop or Parabolic Chute* — A chute having the profile of a free jet (parabolic) provided in cases where the centre line of jets is above the stream bed elevation.

2.30 Froude Number — A dimensionless number characterizing the inertial and gravitational forces in an open channel flow and for rectangular open channel flow is defined as follows:

\[ F = \frac{V}{\sqrt{gD}} \]

where

- $F =$ Froude number,
- $V =$ velocity of flow,
- $g =$ acceleration due to gravity, and
- $D =$ depth of flow.

2.31 Ground Roller* — A reverse flow in the form of rollers in an upstream direction along the stream bed, usually formed downstream of the end sills, deflectors and lip walls.

2.32 Height of Bucket Lip* — The distance from the lowest concave surface of the bucket to the top of the lip (see Fig. 10).

2.33 Hollow Jet, or Annular Jet* — A jet having an annular cross section, with little or no flying spray, and the central core, composed of air, is ventilated.

2.34 Hydraulic Jump* — The sudden and usually turbulent passage of water from low level below critical depth to high level above critical depth during which the velocity passes from supercritical to subcritical. It represents the limiting condition of the surface curve wherein it tends to become perpendicular to the stream bed.
2.34.1 Forced Hydraulic Jump/Ripelled Jump — Jump formed when the tail water depth is less than the conjugate depth.

2.34.2 Free Jump — Jump formed when the tail water depth equals the conjugate depth.

2.34.3 Oscillating Jump — A type of hydraulic jump where the entering jet oscillates back and forth, from the bottom to surface and back again with no periodicity. The Froude number of the incoming flow in this case is between 2.5 and 4.5.

2.34.4 Ski-Jump — An action occurring when a high velocity jet is thrown into air from a spillway.

2.34.5 Steady Jump — A type of hydraulic jump in which a stable and well balanced jump occurs. Turbulence is confined to main body of the jump and the water surface d/s is comparatively smooth. The Froude number in this case, of the incoming flow is between 4.5 and 9.0.

2.34.6 Submerged Hydraulic Jump — A submerged hydraulic jump is formed when the tail water depth is greater than the conjugate depth; also called submerged jump.

2.34.7 Undular Jump* — A type of hydraulic jump in which the water surface shows undulations. The Froude number of incoming flow in this case is between 1 and 1.7.

2.34.8 Weak Jump* — A type of hydraulic jump in which a series of small rollers develop on the surface of the jump, but the downstream water surface remains smooth. The velocity throughout is fairly uniform and the energy loss is low. The Froude number of the incoming flow in this case is between 1.7 and 2.5.

2.34.9 Origin of the Jump — The origin of the jump is the point where the roller turbulence begins and the water becomes white and foamy because of the large amount of entrained air.

2.34.10 Length of Hydraulic Jump — The distance from the beginning of the jump to a point downstream where either the high velocity jet begins to leave the floor or to a point on the surface immediately downstream of the roller, whichever is the longer.

2.34.11 Throw Distance of Ski-Jump — It is the horizontal distance from bucket lip to the centre point of impact with tailwater.

2.35 Hydraulic Rollers* — Flow having circular or elliptical motion round a vertical, horizontal or an inclined axis and giving appearance of a roller. The roller formation may occur within or at the surface of the stream. According to their shapes, they are named as circular and ellip-
tical rollers. According to the direction of axis are designated as vertical, horizontal or inclined rollers and according to location are called as submerged or surface rollers.

2.36 Invert Wall, or Bucket Lip Wall* — The upturned portion of the invert having lip (see Fig. 10).

2.37 Jet* — The stream of water issuing at high velocity from an orifice or nozzle of similar opening.

2.38 Jet Deflector* — A sector-shaped block with a sloping arris which cuts the high velocity jet emerging from an outlet for the purpose of flaring out the jet laterally into a fan-shaped sheet.

2.39 Jet Diffusion* — A method of energy dissipation, used in the case of high velocity jets. It is accomplished by directing the water jets from an outlet sharply towards the bottom, rather than over the tail water surface.

2.40 Jet Trajectory* — The profile of the free jet.

2.41 Jump Height Curve* — A curve showing relationship between discharge intensity and the subcritical conjugate depth determined for hydraulic jump formation.

2.42 Kreuter Dissipator, or Kreuter Brake* — An energy dissipator used for pipe flows. The water flows out of the pipe radially in the form of a disc. Hydraulic rollers from on and under the disc, dissipating the energy of the water to such an extent that it flows quietly over the edges of the basin and safely join the tail race. It is of two types:
   a) Top inlet type in which the flow from the pipe falls down on the disc; and
   b) In the bottom inlet type, the flow shoots upward on the disc (see Fig. 13).

2.43 Partially Submerged Jet or Partially Drowned Jet* — A jet whose central line is below the tail water level, but not too far below to cause the jet to be drowned out by the tail water during operation.

2.44 Pfeiffer Energy Dissipator* — It consists of a stilling pool without end sill. Water is also drawn from the reservoir through gate valves provided in the bottom of the dam and is admitted to the apron through openings from below (see Fig. 15).

2.45 Schoklitsch Dissipator* — An energy dissipator designed by Prof. Schoklitsch for spillways and drops. In this case, slightly battered drop is provided at the downstream end of the bucket and a sill is provided at the end of the stilling pool. The dimensions of different parts are determined by curves given by Prof. Schoklitsch (see Fig. 14).
2.46 Sloping Apron* — A sloping floor used to gain satisfactory formation of hydraulic jump over a wide range of tail water conditions.

2.47 Solid Jet* — A jet having no annular space or cavities.

2.48 Spillway Bucket Splitter* — A bucket type projection along the downstream face of the spillway to dissipate energy (see Fig. 19).

2.49 Spillway Splitter* — A horizontal block fixed on the downstream face of the spillway to split the stream (see Fig. 18).

2.50 Splitter Wall, Divider Wall, or Vanes* — Longitudinal walls provided in open channels or basin expansions, for recovery of head and equalization of outlet velocity or reduction in expansion length.

2.51 Staggering of Blocks — It is the method of placing blocks in two rows in such a manner that the blocks of the second row face the spaces between the blocks of the first row.

2.52 Standing Wave — A sudden rise in the water surface, generally fixed in position, such as a hydraulic jump; a standing wave may exist, however, where the hydraulic jumps is not involved.

2.53 Stilling Basin, Tumble Way, Hydraulic Energy Dissipator, Water-Stilling Device or Energy Dissipating Device — A short length of paved portion in the exist course of an outlet structure or below a spillway, chute, or drop, in which all, or part of the energy of flowing water is dissipated, and water discharged into the downstream channel in such a manner to prevent damage to the structure or dangerous scour of bed or banks of channel.

2.54 Stilling Basin Appurtenances* — Structures, such as blocks, and sills, baffles, installed in the stilling basin to help improve its performance by increasing turbulence and obtaining desired flow conditions downstream.

2.54.1 Bhavani Stilling Basin — Type of stilling basin developed for lower Bhavani Dam (India) with depressed apron having T-shaped floor blocks (see Fig. 6).

2.54.2 Free Jet Chute Basin — A stilling basin in which the flow enters through a free jet chute, and energy is dissipated by hydraulic jump principle.

2.54.3 Free Jet Stilling Basin or Free Jet Basin* — A stilling basin in which the water jet emerging from an outlet discharges above the tail water level in air and then plunges into the basin, dissipating energy largely by turbulence (see Fig. 1).
2.54.4 Hollow Jet Valve Stilling Basin — The hollow jet valve stilling basin, about 50 percent shorter than a conventional basin, is used to dissipate hydraulic energy at the downstream end of an outlet works control structure. The hollow jet valves which operates and regulate flow, are inclined downward. The sloping floor, placed downstream from the valves protects the underside of the jet between them to give the resulting thin jet greater ability to penetrate the tail water pool. Sudden expansion of the jet as it leaves the converging walls, plus the creation of fine-grain turbulence in the basin, accounts for most of the energy loss in the flow. Thorough breaking up of the valve jet within the basin and good velocity distribution over the entire cross section of the flow account for the low velocities leaving the basin.

2.54.5 Hump Stilling Basin, or Hump Basin* — When the centre line of a jet emerging from an outlet is below the stream bed elevation, but not too far to be completely submerged by the tailwater, a hump in the stilling basin may be provided to spread the jet and permit the formation of a stable hydraulic jump. The stilling basin in this case is called ‘hump stilling basin’ (see Fig. 3).

2.54.6 Hydraulic Jump Basin, or Hydraulic Jump Dissipator* — A stilling basin in which energy is dissipated by hydraulic jump principle.

2.54.7 Impact Stilling Basin or Impact Basin — Energy dissipation is initiated by flow striking the vertical hanging baffle and being turned upstream by the horizontal position of the baffle and by the floor, in vertical eddies. The structure requires no tail water for energy dissipation. Tail water as high as \( d + \frac{g}{2} \), Fig. 4, however, will improve the performance by reducing outlet velocities providing a smoother water surface and reducing tendencies towards erosion. Excessive tail water, on the other hand will cause some flow to pass over the top of baffle.

2.54.8 Jet Diffusion Basin, or Jet Diffusion Stilling Basin* — A stilling basin in which the energy is dissipated by jet diffusion principle, to reduce the length of the basin normally required by the hydraulic jump (see Fig. 2).

2.54.9 Roller Type Stilling Basin* — A stilling basin having an end sill above which surface rollers and below which ground rollers form for energy dissipation; the tail water depth being usually greater than that required for hydraulic jump (see Fig. 5).

2.54.10 SAF Basin* — Stilling basins designed by Saint Anthony Falls Hydraulic Laboratory, U.S.A. for drainage structures. They have an end sill and a row each of chute blocks and floor blocks (see Fig. 7).

2.54.11 Submerged Jet Diffusion Stilling Basin* — A stilling basin in which the entering jet is completely submerged below the tail water level and its energy is dissipated by jet diffusion principle.
2.55 Stilling Pool, Water Cushion or Cistern* — A pool of water maintained to take the impact of water overflowing a dam, chute, drop, or other spillway structure.

2.56 Stilling Well — A chamber or a compartment provided with an inlet or inlets communicating with the river or canal. Its purpose is to dampen waves or surges in the parent stream while permitting the water level in the well to rise and fall with major fluctuations of the level in the river of canal. The gauge device is installed in this.

2.57 Submerged Jet or Drowned Jet* — A jet completely drowned under water.

2.58 Tailwater Rating Curve, or Downstream Stage Discharge Curve* — A curve showing relationship between the discharge and the corresponding tail-water stage.

2.59 Training Wall — Walls built at the sides of the structure with top set at an elevation so that maximum tail water for the design discharge will be contained with sufficient freeboard considering spray and air entrainment. The training wall may be at the side of the bucket or stilling basin for example, bucket training well.

2.60 Upturned Apron* — Any apron sloping upwards in the direction of flow.

2.61 Wave-Suppressors — The use of deflector blocks or drop-type energy dissipator is essential features of the stilling basin and means for eliminating waves at their source. When there are no means of eliminating waves at their source and for a greater wave reduction on a proposed structure or to an existing flow way, two types of wave suppressors are used. Both are applicable to meet open channel flow ways having rectangular, trapezoidal or other cross sectional shapes and may be used without regard to Froude number.

2.61.1 Raft Type Wave Suppressor — The raft arrangement consists of two rigid stationary rafts perforated in a regular pattern placed in the canal downstream from the stilling basin to suppress the wave heights (see Fig. 26).

2.61.2 Underpass Type Wave Suppressor — The structure consists of a horizontal roof placed in the flow channel with a head wall sufficiently high to cause all flow to pass beneath the roof. The height of the roof above the channel floor may be set to reduce wave heights effectively for considerable range of flows. When the under pass is to be used downstream from a stilling basin the under-pass must be placed sufficiently downstream to prevent turbulent flow such as occurs at the end of the basin, from entering and passing through the wave suppressor,
In highly turbulent flow the under pass is only partly effective.

2.62 Wing Walls — Wall constructed at the end of the training walls of the basin to prevent them from being undermined.

**FIG. 1**  FREE JET STILLING BASIN OR FREE JET BASIN

**FIG. 2**  JET DIFFUSION BASIN OR JET DIFFUSION STILLING BASIN

**FIG. 3**  HUMP STILLING BASIN OR HUMP BASIN

**FIG. 4**  IMPACT STILLING BASIN OR IMPACT BASIN

**FIG. 5**  ROLLER TYPE STILLING BASIN
FIG. 6  BHAVANI STILLING BASIN

FIG. 7  SAF BASIN

FIG. 8  SOLID ROLLER BUCKET DISSIPATOR
Fig. 9  Slotted Roller Bucket Dissipator

Fig. 10  Bucket

Fig. 11  Bucket Apron

Fig. 12  Trajectory Bucket, Flip Bucket Dissipator
Fig. 13  **Kreuter Dissipator or Kreuter Rack**

Fig. 14  **Schoklitsch Dissipator**

Fig. 15  **Pfeiffer Energy Dissipator**
Fig. 16 Chute Blocks and Deflector

Fig. 17 Arrows

Fig. 18 Spillway Splitter

Fig. 19 Spillway Bucket Splitter
Fig. 20 Rectangular End Sill.

Fig. 21 Trapezoidal End Sill

Fig. 22 Hornsby End Sill

Fig. 23 Scholitsch End Sill

Fig. 24 Smetana End Sill

Fig. 25 Rehbock Dentated End Sill.
All dimensions in millimetres.

**Fig. 26** Raft Type Wave Suppressor

**Fig. 27** Super-Elevated Bucket
### International System of Units (SI Units)

#### Base Units

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#### Supplementary Units

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#### Derived Units

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PUBLICATIONS OF INDIAN STANDARDS INSTITUTION

INDIAN STANDARDS

Over 11,500 Indian Standards covering various subjects have been issued so far. Of these, the standards belonging to the Civil Engineering Group fall under the following categories:

- Aggregates, concrete
- Apparatus for testing cement and concrete
- Asbestos cement products
- Bricks and blocks
- Builder's hardware
- Cement
- Concrete design and construction
- Concrete testing
- Construction equipment
- Construction practices
- Doors and windows
- Drawing office practice and equipment
- Fire fighting equipment
- Fire safety
- Flexible floor coverings
- Floor finishes
- Fluid flow measurement
- Fluid flow measuring instruments
- Foundation engineering
- Functional design of buildings
- Furniture
- Gypsum products
- Lime, building
- Loading standards, structural safety
- Measurement and estimation of civil engineering
- Modular co-ordination
- Multi-purpose river valley projects
- Pipes
- Planning regulation and control
- Plaster, paint and allied finishes
- Plywood and allied products
- Poles
- Pozzolanas
- Reinforcement concrete
- Roof and roof coverings
- Safety in construction
- Sieves and wire gauzes
- Soil engineering
- Stones, building
- Structural design
- Tar and bitumen
- Tiles
- Timber
- Timber design and construction
- Timber stores
- Wall and ceiling finish
- Waterproofing and damp-proofing
- Water supply, drainage and sanitation
- Water supply, sanitation and drainage fittings
- Wood-based materials
- Unclassified

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- Southern : C. I. T. Campus
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- F Block, Unity Bldg, Narasimharaja Square
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- 22E Kalpana Area
- 5-8-56C L. N. Gupta Marg
- R14 Yudhister Marg, C Scheme
- 117/418 B Sarvodaya Nagar
- Patliputra Industrial Estate
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