Management Of Aquatic Weeds At The Intake Of Power Stations

Emam A. Osman[1], A. M. Elfarouk[2], Hosam Ibrahim[3], and T. A. Elsamman[4]

[1] *Researcher, Channel Maintenance Research Enstitute (CMRI),(NWRC), Egypt.*
[2] *Researcher, (CMRI),(NWRC), Egypt.*
[3] *Professor, Deputy Director, (CMRI),(NWRC), Egypt.*
[4] *Professor, Director, (CMRI), (NWRC), Egypt.*

1- ABSTRACT

This study was carried out for evaluation the barriers constructions at the intake of power stations. Tebeen power station and North Giza power station intakes, which are located at El-Marazik territory on Nile River and the right side of El-Rayah El-Behary canal respectively. The existence of submerged aquatic weeds leads to breakdown the operation of power stations for several hours daily, which is not economically feasible. To overcome this problem, investigation and designing process were carried out for constructing specific barriers and trash rack at the intakes of power stations. The proposed specific barriers and trash racks will control the aquatic weeds from reaching the power stations. To fulfill the objectives of the study, several field measurements were carried out all over the two studied reaches upstream and downstream the location of each power station.

Keywords

Aquatic Weeds; Barriers; Trash rack; Power station; Physical model.

2- INTRODUCTION

Open channels in Egypt suffer from the spreading problem of aquatic weed. Moving of aquatic weeds with water current causes many problems for the hydraulic structures and power stations. The aquatic weeds decrease the operation efficiency and breakdown the operation of power station for several hours daily, which is not economically feasible. Channel Maintenance Research Institute, National Water Research Center (NWRC), has a long experience on the controlling of aquatic weeds and overcome the problems of weeds upstream hydraulic structures, lifting pump stations and power stations, such as designing barriers upstream hydropower station of new Esna Barrages ,new naga hamady barrages and El Alamain drink water station by [1], [2], and [3], upstream marazik bridge, and upstream El-Nasr lift station number 1 on El-Nasr canal.

Monitoring investigations upstream and downstream the studied two areas of El Tebeen Power Station and North Giza Power Station intakes which are located at El-Marazik territory and the right side of El-Rayah El-Behary respectively were concluded that the studied reaches have been suffering from submerged and floating aquatic weeds infestations. The percentages of infestations were evaluated in the two reaches. Also the navigation in El-Rayah El-Behary helps in the transferring of aquatic weeds towards the intakes of power station.

Field and laboratory studies were carried out to investigate and to solve the problem of spreading of the aquatic weeds, which could lead to the blocking of the intake of the power station. Physical model was built in the laboratory of Hydraulic Research Institute, (NWRC), in order to manag the aquatic weeds in the reach around North Giza Power Station.

The aim of this study is to investigate, design and construct specific weed control system of barriers and trash-rack upstream North Giza Power Station. Also, certain applicable solutions will be presented to increase the operation performance of power station by preventing submerged aquatic weeds from reaching the power station.

3- THE STUDIED AREA

North Giza Power Station is located on the right bank of El-Rayah El-Behary canal at coordinates of 302234.88 E and 33479.88 N at km 20 from the canal intake as shown in photo (1) and figure (1). It was planned to construct a water cooling system for the power station through pumping water from El-Rayah El-Behary by using pipeline intake. The total width of the power station intake is 60 m located at the right bank of El-Rayah El-Behary canal. Aquatic weeds of different types and species are considered the main cause for system clogging and breakdown.

4- METHODOLOGY

Towards achieving the objective of the present study is to prevent the aquatic weeds from reaching North Giza Power Station, field measurements, and physical modeling simulation were carried out to detect the hydraulic characteristics of the studied reach (Beginning and end border of the power station). Finally certain applicable solutions were designed to prevent floating and submerged aquatic weeds from reaching the power station intake.

4-1 Field Measurements

The extensive field measurements program can be summarized as follows:-

- Survey of the entire reach at the power station territory.
- Water velocities were measured for three cross sections located upstream the power station, cross-section1 (c.s.1), downstream the power station, cross-section2 (c.s.2), and parallel to the power station, cross-section3 (c.s.3) as shown in figure (2) by using Electro Magnetic Current Meter. For identifying water velocities distribution in the near- by of the power station with existence of remarkable amount of aquatic weeds infestation.
- Survey the mentioned cross sections by using Echo Sounder instrument to identify the cross sectional area and water depths for each cross section in the studied reach.
- Survey of the mentioned cross sections by using Echo Sounder instrument to detect the percentage of the submerged weeds infestation.
- Measuring the intensity of submerged aquatic weeds movement along the upper layer of water surface in the reach by using Weed Sampling Device as shown in photo (2), which was invented by Channel Maintenance Research Institute, (NWRC).
- Identifying the moving trend of floating aquatic weeds in the studied reach by using floating objects.

- Collecting three soil samples from bed of the canal to classify the soil type along the studied reach and identify the soil angle of friction to design the gravity anchorage block of the proposed barrier.

4-2 Physical Model Measurements

The hydraulic characteristics of the studied reach with and without existence of the proposed specific barriers were evaluated by using physical model with 1:50 longitudinal scale as shown in photo (3). Runs were carried out with annual minimum and maximum discharges on El-Rayah El-Behary canal with three positions of barriers, the first one is parallel to the water flow, the second and the third are inclined to the water flow by 3^0 and 5^0 respectively. The extensive model measurements program can he summarized as follow:

- Water velocities were measured by using Electro Magnetic Current Meter on five cross sections perpendicular and far from the right bank by 3.75m and 16.25m. The first one was located at the beginning of the power station entrance; the others were far from the first cross section by distances of 15m, 30m, 45m, and 60m respectively as shown in figure (3).
- Water levels were measured along the mentioned cross sections by using point gauges.
- Identifying the moving trend of floating aquatic weeds in the studied reach by using paper pieces.

5- RESULTS AND DISCUSSIONS

5-1 Field Measurement Results

The Research team conducted the field measurments in maximum water requirement period august 2010. The collected and measured data concerning this study will be briefly discussed.

5-1-1Water velocity

The water velocities were measured on three cross sections located upstream, downstream and parallel to the power station by using Electro Magnetic Current Meter. For each cross section the water velocities measurements were carried out for three different water depths from the water surface 0.2, 0.6, and 0.8 water depth for cross sections 1and 2. While for cross section 3 the velocities were measured at 0.5 m and 1.0 m under the water surface. Figure (4), (5) and (6) show the water velocities distribution along the three cross sections.

It was noticed that the maximum water velocity varied from 0.27 m/sec to 0.89 m/sec for the two cross sections 1 and 2 across the stream direction (upstream and downstream the power station). It was noticed also that the water velocity varied from 0.55 m/sec to 0.96 m/sec along the longitudinal section 3 which is parallel to the power station.

5-1-2 Aquatic weeds surveying

Surveying of aquatic weeds was carried out by using virtual inspection and the Echo Sounder through the entire studied reach. The mentioned three cross sections (c.s.1), (c.s.2), and (c.s.3) along the reach were also examined to detect the infestation percent of submerged weeds. Monitoring investigation of the aquatic weeds proved that the studied reach has been suffering from submerged and floating aquatic weeds infestation.

5-1-3 Submerged weeds intensity

The intensity of moving submerged aquatic weeds was measured along the upper layer of water surface in the studied reach by using Weed Sampling device. The device consists of rod 4.0 m length fixed with floating hollow cylinder for controlling the device balance and floating with flow. There are two movable light rods 1.0 m length installed on the long rod, each light rod supplied with several bolts 0.1 m length for capturing the moving submerged weeds in different water depths.

The submerged weeds intensity was identified by using the device in four different water depths from the water surface 0.5 m , 1.0 m, 2.5 m and 4.0 m in the period time of thirty minutes for each water depth. The device was examined along cross sections 1 and 2. It can be concluded that, no intensive submerged weeds were detected in the studied reach moving with the flow along the upper layer of water surface.

5-1-4 Floating weeds moving trend

The moving trend of flow lines of floating weeds was identified in the studied reach. The movements of four floating objects were monitored along the studied reaches by using surveying device as shown in figure (2). Four floating objects (track (1) ، (2) ، (3) and (4)) were placed and distributed on equal distances (around 20 m apart) along the first cross section upstream the power station. The first floating objects track (1) moved parallel toward the right bank nearby the power station. After operating the suction pump for the cooling system of the station, the flow and floating weeds could be easily attracted and trapped into the cooling system causing probable severe damage. The second, the third and the fourth floating objects (track (2) ، (3) and (4)) moved directly with the flow direction far away from the power station entrance. It can be concluded that, at least 20 % of floating aquatic weeds in the study reach moved toward the power station zone in case of pumping system is turned off, and 80% of floating weeds has moved directly with the flow direction far away from the power station zone with possibility of floating weeds percentage could be attracted to the entrance zone after operating the proposed cooling system.

5-1-5 Soil classification

Four soil samples from canal bed have been collected to classify the soil type along the studied reach. A series of laboratory tests were carried out for soil samples collected from the canal bed in order to get some of the soil properties and parameters. These experiments included grain size distributions by sieve analysis and by wet analysis. From sieve analysis of the soil samples, the four samples are classified as sandy and loamy sand with angle of friction $\Phi = 29^o$. The percentage of sand in the samples ranged between 58% and 99.5%.

5-2 Physical Model Results

5-2-1 Water velocity

A comparison was carried out between cases of not existence barriers and with installing barriers inclined on canal's main current by 0^0(barriers parallel on canal's main current), 3^0 and 5^0 respectively. The comparison as shown in tables (1) and (2) showed that the best installing barrier was inclined by 5^0 on canal's main current, because the average of measured water velocities outside barrier at minimum and maximum discharges were 0.45 m/sec and 0.90 m/s respectively, and increased than the average velocities of other cases. It is remarked that installing inclined barrier on canal's main current permits self-cleaning barrier with minimum exposition risk.

5-2-2 Water depth

Water depths have been measured in all cases of the experiments at distances of 3.75 m and 16.25 m perpendicular on the right bank during passing of minimum and maximum discharge as shown in table (1) and (2). The results showed that water depth during maximum discharge ranged between 5.90 m and 7.85 m, and the water depth in case of minimum discharge ranged between 3.55 m and 5.35 m.

There are no significant changes in water depth remarked before and after installing the proposed barrier.

6- ANALYSIS OF RESULTS

Through virtual inspections, hydraulically, chemical, and physical field investigation measurements, and physical modeling, the following facts could be stated:-

- For the moving floating aquatic weeds; the carrying layer is the upper layer of water surface (0.5 m water depth), at which any controlling utility should be installed.
- Weeds always follow the stream direction, and any desired obstruction must be installed against water current direction.
- The installed barriers must have an inclination on flow direction to facilitate moving of weeds with water flow and non accumulation of weeds around the intake of the power station.

7- BARRIER SELECTION

Referring to field investigation carried out on flow depth, floating trend, velocity pattern and weed infestation type, the barrier shape and type can be appropriately suggested. According to the bottom Echo Sounder survey; water depth doesn't exceed 3.0 m (variable). Also weeds infestation survey had shown only floating aquatic weeds infestation, with no significant submerged weeds. This permits shallow weed obstruction, i.e. using short racks (of a depth not exceeding 1.3 m). From the preliminary intake structure design, it is required to construct the barrier positioning in a longitudinal line, parallel to the shore, as shown in figure (7). It is recommended to propose an inclined alignment of barrier, permitting a self-cleaning opportunity.

7-1 Location and Alignment

According to the preliminary design and layout of the intake, and the area characteristics, the proposed barrier should be located at a specific separating distance out off the shore. This is to avoid overlaying with bed-vans and to permit vertical and horizontal heave of buoys. On the other hand, the barrier itself has its own requirements as it should enable easy construction and maintenance. Therefore, the inclined alignment was selected to permit easy construction and continuous weeds' washing out by the natural stream current itself. This is what we call “Self-Cleaning Barrier”. Figure (7) illustrates the proposed alignment criteria.

7-2 General Design Considerations and Criteria

There are several design considerations and criteria have to be taken in consideration as follow:-

- Analysis of neighborhood velocity pattern to demonstrate maximum and minimum velocity fields.
- Analysis of model – velocity components to demonstrate max-drag expected of barrier units.
- Simulation of flow pattern and stagnation plan to adjust barrier placement and obstruction plan- direction.
- Calculate drag and tensile force on buoys and mooring points.
- Conduct buoy’s unit design and buoy stability.
- Conduct mooring system & thrust in mooring device.
- Design fixing device or supports.

8- BARRIER DESIGNATION

To control the floating and submerged aquatic weeds in the studied reach in an efficient manner, a system of barriers supplied with racks have been proposed.

The barrier will be installed at the power station entrance at the right bank of canal. The barrier location is presented in figure (7), this barrier is simple floating buoys supplied with submerged trash racks as shown in figure (8), the buoys is fixed to the canal bed by using concrete blocks and to the canal banks by wires.

The proposed barriers will fulfill its purpose if sufficient maintenance and attention have been taken place. If the proposed system is installed in a complete way (with all components working together in a harmonic manner), and exerting sufficient active maintenance efforts. The system will be capable of controlling the floating and submerged aquatic weeds from reaching to the power station entrance.

8-1 Proposed Barrier Components

The barrier units had been suggested in a specified shape as shown in figure (8) to suite its purpose. The proposed barrier unit consists of:-

1- Floating unit (A).
2- Frontal trash-rack, which prevent weeds and defend the intake from aquatic weeds & debris (B).
3- Anchorage blocks (C).
4- Chain for connecting floating unit with anchorage block (D).

5- Pocket in the floating unit can be filled with sand for adjusting the barrier unit balance (E).
6- Top maintenance walk path for maintenance workers (k).
7- Hand - rail,
8- Safety utilities likewise; extra side anchorage, safety handrails, and buoy's inner foam filling (L).

8-2 Existing Forces on Each Buoy Unit and Gravity Anchorage Block

To ensure the safety of installing the proposed barrier in front of the intake of the power station, the required calculation and stresses checks have been carried out. The buoyancy of the barrier units was checked with the proposed buoy unit shape. Loads on submerged trash racks according to weeds existence and water current have been considered. Fixation devices have been designed in order to hold the barrier considering all the probable loads, the required fixing anchorage blocks, and mooring utilities (wires, chains, and locks). All related items such as canal bed material frictional capacity with anchorage blocks, water current velocity, and shear stress have been sufficiently considered.

As a dominant step of designing a floating barrier, expected loads and stresses must be determined as a starting step. Loads are usually including: own weight, buoyancy reactions, drag resulting from stream current and wind, and floating impacts including weeds, debris, or even ships or boats.

The effective forces on barrier's buoys as shown in figures (9) are**:**

- Drag Force due to current passing buoy units
- Shear Force due to shearing with cumulating weeds in front of barrier
- Thrust Force to anchors.

According to the given design of the Barrier;

- The Expected Clear Dead-Load of one Buoy = 700 kg.
- Total permissible loaded Barrier (Dead load + Live load) = 1000 kg
- Expected immersed depth of the Buoy = 20~ 25 cm

The buoys will be moored in current paths (as the canal main current and the power plant abstraction). This makes it exposed to friction and pressures forces resulting from normal and tangential shear existed by water currents on buoy surfaces.

- Drag force due to current passing buoy units by [4], and [5], and [6].

Then the drag force is predicted according the drag equation

$$F_D = \frac{1}{2} * \rho * C_{DN} * L_s * V^2 * b \quad \ldots\ldots (1)$$

Where: ρ = Density

L_S= Submerged length of the buoy unit

C_{DN} = Drag coefficient

V = mean effective velocity component

b = Width of the buoy unit

Drag coefficient depends on buoy shape, Drags force is estimated by the drag coefficient, which could be obtained from the designing tables, regarding buoy shape and location to current. Referring to the selected type, the drag coefficient is varied between 0.25 to 0.55 given as:

- For the Main Stream Direction **C_{DN} = 0.55**
- For perpendicular to the stream direction **C_{DN}= 0.34**.

Part (AB) of barrier is exposed to especial drag resulting from direct obstruction of the main canal streamline. Field investigation (Cross section in Fig 6) had shown the highest velocity recorded in the intake vicinity. This might require further drag chick for this part as follows:

- Drag coefficient for this direction C_{DN} = 0.34
- Then, according to equation (1), F_D = 0.414 ton / Buoy.

The middle part of barrier (BC) is exposed to two drag components resulting from direct obstruction of the main canal streamline, and the "North Giza P. P." intake abstraction. Field investigation and velocity analysis had yielded the highest velocity expected in the intake vicinity.

- Drag coefficient for this direction C_{DN} = 0.55

Then, according to equation (1) drag was obtained as, F_D = 0.945 ton / Buoy.

Part (CD) of barrier is exposed to especial drag resulting from direct obstruction of the main canal streamline.

- Drag coefficient for this direction C_{DN} = 0.55
- Then, according to equation (1), F_D = 0.947 ton / Buoy.

From the field measurements and survey; the dominant weeds are the floating aquatic weeds (Water Hyacinth), which impact and the pressure on Barrier could be estimated.

- Shear Force due to shearing with cumulating weeds in front of barrier by [7], [8].

$F_{\tau w} = (V^*_w)^2 \cdot \rho / g$……………………………………………………(2)

Where: - $F_{\tau w}$ = shear force;

V^*_w= shear velocity;

ρ = mass density of water;
g = acceleration of gravity;

$\therefore$ $F_{\tau w} = 0.010$ ton/m^2,

then $F_{\tau w} = 0.014$ ton/buoy unit (for max infestation by aquatic weeds in front of the buoy unit 50 m the length of aquatic weeds infestation in front of the buoy)

The total force exists on each buoy unit equal the summation of the drag force and the shear force.

$F_{total} = F_D + F_{\tau w}$ ……………………………………………………………….(3)

The buoy unit length = 2 m, therefore

F_{total} (max) = 0.947 + 0.014 = 0.961 ton/buoy unit.

And consequently the tension force on chain connected to the buoy unit T can be obtained.

$$T = F_{total} * Cos\theta \quad \text{……………………………………………………….(4)}$$

Where θ is the angle between the chain and the bottom surface of buoy unit or water surface, θ value is varied between 15^0 to 18^0. The tension force T will transfer to the gravity anchorage block through the chain.

T = 0.912 ton/buoy unit.

- Thurst Force to anchors by [9], and [10]. And the total resistance force on the gravity anchorage block = Fr + Ep

Fr is the frictional resistance force exists on bottom surface of gravity anchorage block with canal bed, and is defined by the following equation:-

$Fr = W \backslash * \mu$ ……… …………………………………………………......(5)

Where:

Fr = Frictional resistance force on canal bed;

W\ = Submerged anchorage block weight;

μ = Resistance coefficient of bed; function of (φ) The Soil angle of repose (28^0 to 34^0 for sandy soil).

By using the concrete gravity anchorage block with specified dimensions (1.25 m length, 1.25 m width, 0.7 m height) , the frictional resistance force on canal bed can be calculated Fr = 0.81 ton.

E_P is The passive earth pressure, and can be obtained by applying the following equation.

$E_P = K_P * \gamma_{sub} * d_{embedment}$ ……………………………………..........(6)

Where:

E_P = The passive earth pressure;

K_P = Passive soil pressure coefficient;
γ_{sub} = Submerged unit weight for canal bed soil.
$d_{embedment}$ = Anchored depth of the block in the soil bed;

Then the passive earth pressure can be calculated EP = 0.39 tons. And consequently the total resistance force on the gravity anchorage block = Fr + EP = 1.2 tons. This force is higher than the tension force on chain connected to the buoy unit, and the factor of safety is equal to 1.25.

8-3 Designation of Barrier Buoy Unit

The barrier buoy unit has been designed to obstruct the floating and submerged aquatic weeds directed by the stream. The barrier was suggested in several shapes, and different alternatives were compared to adopt the most suitable one. The developed barrier is a buoys system as shown in figure (10), each unit provided with labours walk, and a frontal inclined trash rack. Loads on submerged trash racks according to weeds existence and water current have been considered. A tight steel racks with removable adjustable were used. Rack was adapted to lay in a certain angel of inclination, and allow for easy weed collection. The rack dimension 1.3 meters height and 2.0 meters width for each buoy unit.

Each buoy unit can be installed or released easily from canal water for maintenance purposes. Buoys are built from steel sections and filled with foam for saving buoys from sinking. The buoy units are anchored to each other and to anchorage blocks on the canal bed, which are responsible for barrier fixation. Fixation devices have been designed in order to hold the barrier considering all the probable loads, the required fixing anchorage blocks is shown in figure (11), and mooring utilities (wires, chains, and locks). Each buoy unit is supplied with balance groove for adjusting the buoy balance (used only in special cases), the groove filled by sand until reaching to the horizontal stability of the buoy unit. Bollard at point (A) is illustrated in figure (12) for pile anchorage details, also big manual gear box crane buried in the soil can be used at this point for adjusting and holding the required tension on wires, which hold the entire barrier system. Bollard at point (D) is a manual gear box crane for adjusting and holding the required tension on wires. Point (B) and (C) have to be supplied with flashing light signals for the protection of barrier buoys from boats navigation in the canal. All related items such as canal bed material frictional capacity with anchorage blocks, water current velocity, and shear stress have been sufficiently considered.

The barrier units were designed to fulfill all the following requirements. Preventing weeds > 12 cm from passing through the trash rack, sustaining weeds load and water pressure on it (shear, drag and hydrostatic forces). To be held completely by the anchorage blocks on the canal bed considering all loads on the barrier, and the blocks' frictional resistance on the bed material. Validating safety for the barrier by using side anchorage between buoys units, and for the labours by using labours walk for maintenance availability.

8-4- Specification of Filing Material

Filling materials are used to fill buoys as an internal protection for the buoy's body, and a safety device against sinking. Many polymers, resins and plastic materials are classified as filling materials commonly; resins are used with fillers and plasticizers to produce filling materials with specific prosperities as flexibility, density, buoyancy, and thermo- prosperities.

Float's fillers are mostly selected from polymers and resins for:-

- Filling the inner space to resist the outer water pressure
- Protect the inner steel surface from chemicals reactions and corrosions.
- Safety against full or partial flooding in cases of body penetration due to exposition to the weather or accidents.

Used materials:-

- Expanded polystyrene with density of 20-25 kg/m3, used as filling blocks to the main space of the buoy invert.
- Injected polystyrene foam with density of 30 - 50 kg/m3 injection must be made by "solvent free / air purring" machines to fill all the inner space of the buoy.
- Application should be occurred under technical observation and following material using cautions & instructions.

9- ECONOMIC EVALUATION

The economic return will be evaluated as a result of design and installation of barriers to the North Giza power station which contain 2 units of 750 mega watt each. Through comparing total costs of design, installation the proposed barrier and annual cost for maintenance of this barrier and value of electricity generated losses from the breakdown of the electricity generation units.

Estimated cost of barrier design and installation is LE 200 thousand for estimated life 15 years, therefor the annual cost of barrier design and installation is LE 13.300 thousands. Estimated annual costs of barrier maintenance is LE 15 thousand, while the annual estimated cost of cleaning and removal of weeds and debris in front of barrier is LE 30 thousands. Therefore, average total annual cost of barrier design, installing, maintenance and cleaning is LE 58.300 thousands.

Breakdown the power station two units as a result of the weeds and debris accumulation leads to electricity loss. It is istimated that annually one unit will be brokendown for 200 hours, and estimated amount of electricity generated from power station is 750 megawatt/hour. Therefore, the annual amount of electricity lost is 150 thousands mega watt. The average mega watt market price for different services is LE 0.24 /K.WATT, the estimated annual average return for the power station one unit is LE 36 million. Comparing the average total cost for construction and maintenance the barrier during the year and the average obtained return in the case of non-stop these units. There is a significant return can be directed to the governmental treasury in case of installing of this barrier. Therefore, it is necessary to continue the installation of these barriers in other power stations located on the banks of the canals.

10- CONCLUSIONS

The presented research investigates the aquatic weeds problems upstream the intake of El Tebeen and North Giza power stations. The new station may suffer from severe infestation of submerged aquatic weeds upstream the intake of the station. The existence of submerged aquatic weeds leads to breakdown the operation of power station for several hours daily, which is not economically feasible.

The proposed protection barrier is of the buoys which permit the best floating and hydrodynamic properties, with minimum displacement and heave tendency. All buoys' components were designed with a suitable factor of safety to stand the maximum expected velocity components and working conditions. On the other hand the barrier was proposed to be located in an inclined position to the canal's main current in order to permits self-cleaning barrier with minimum exposition risk.

The barrier was provided with two fixing utilities; bed anchorage blocks that permit frontal and axial mooring, and side mooring by means of a side tieing wire, which permits an emergency mooring device. Moreover, the barrier entirely, was tied at end points to end mooring device such as; thrust pile cap at its upstream and downstream ends, and the bed embedding anchorage block at mid points.

The barrier units were designed to fulfill all the following requirements:-

- Preventing weeds > 12 cm from passing through the trash rack.
- Sustaining weeds load and water pressure on it (shear, drag and hydrostatic forces).
- To be held completely by the anchorage blocks on the canal bed considering all loads on the barrier, and the blocks' frictional resistance on the bed material.

- Validating safety for the barrier by using side anchorage between buoys units, and for the labours by using labours walk for maintenance availability.
- The barrier as proposed will enable weeds and debris exclusion with easy and sustainable workability and maintenance.

It is necessary to study the best method of weed management upstream power plants and hydraulic structures to get the highest return from the power plant and the hydraulic structures efficiency.

11- REFERENCES

[1] Hosam Ibrahim, Mohamed Bakry, and Sherif Saad, (2004), "Designing Barriers For Solving Aquatic Weeds Problems Upstream New Esna Barrage," World Conference on " Energy For Sustainable Development: Technology Advances & Environmental Issues", 6-9 December, Cairo, Egypt.

[2] Channel Maintenance Research Institute, (2011), " Management of Aquatic weeds upstream new naga hamady barrages".

[3] Channel Maintenance Research Institute, (2012), " Management of Aquatic weeds upstream El Alamain drink water station".

[4] Ko, S. C., and Graf, W. H., (1972), "Drag coefficient of cylinders in turbulent flow", J. Of Hyd. Div., proc. ASCE., Vol 98, No. Hy 5, May, pp. 897-912.

[5] Rouse, H., (1965), "Critical analysis of open channel resistance", J. Of Hyd. Div., proc. ASCE. Vol. 91, No. Hy 4, July, pp. 1-26..

[6] Mirajgaoker, A. G., (1964), Discussion on, "Resistance of cylindrical piers in open channel flow", J. of Hyd. Div., proc. ASCE., Vol. 90, No. Hy 5, Septermber, pp. 228-230.

[7] Ali, Reda M.(2000), "Hydraulic characteristics of open channels with floating weeds", M. Sc. Thesis, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

[8] Flashbart, O., (1932), Winddruck auf Gasbehalter. Reports of the Aerodyn. Versuchsanstalt in Gottingen IV the series, pp. 134. As quoted from H. Schlichting, "Boundary layer theory", McGraw-Hill Book Co., 1969. P. 21.

[9] Hsieh, T., (1964), "Resistance of cylindrical piers on open channel flow", J. of Hyd. Div., proc., ASCE., Vol. 90, Hy l, January, pp. 161-173.

[10] Khalil, M. B., (1969), "Resistance and behaviour of a cylinder placed on bed of an open flow", submitted to the Bulletin of Science and Technology, Assiut University for publication.

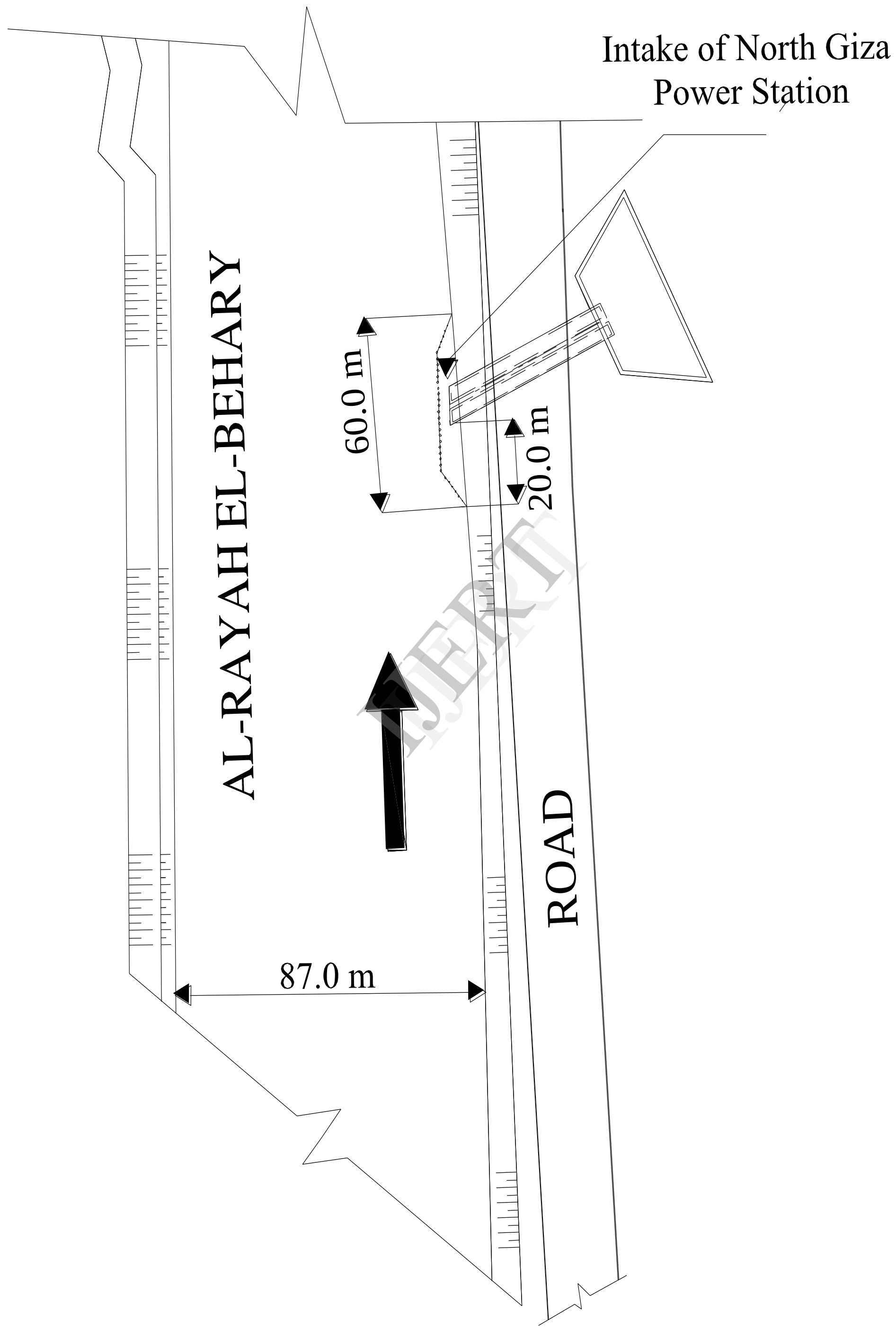

Fig.(1) General layout for the intake of North Giza power station

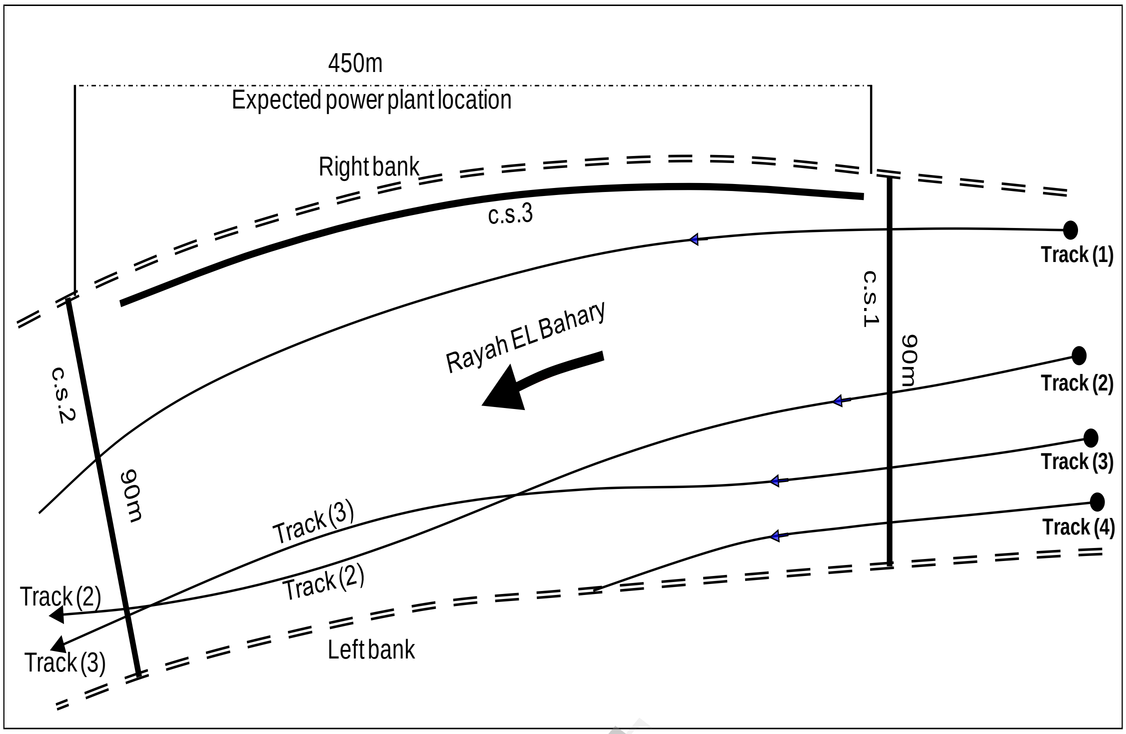

Fig. (2) Measured velocity cross sections and Flow lines pattern along EL-Rayah EL-Behary in front of the station

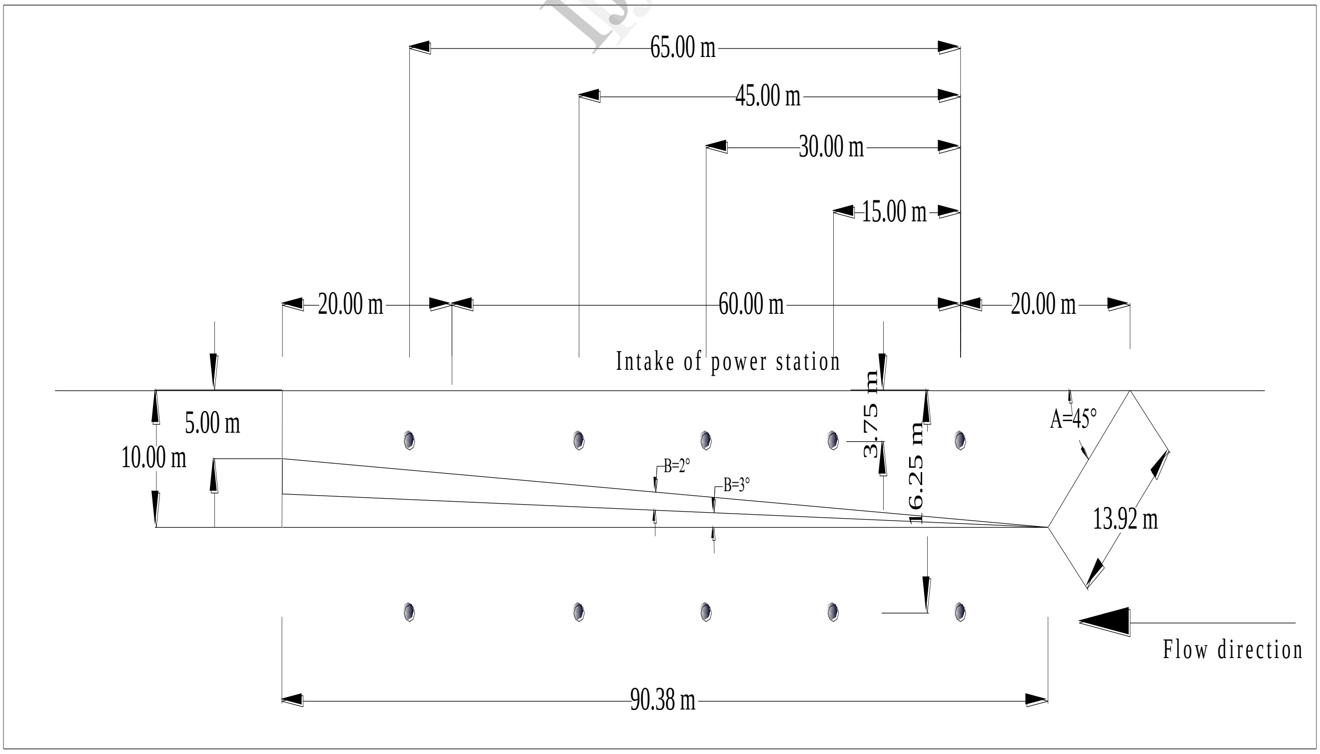

Fig. (3)Physical Model Measurements scenarios

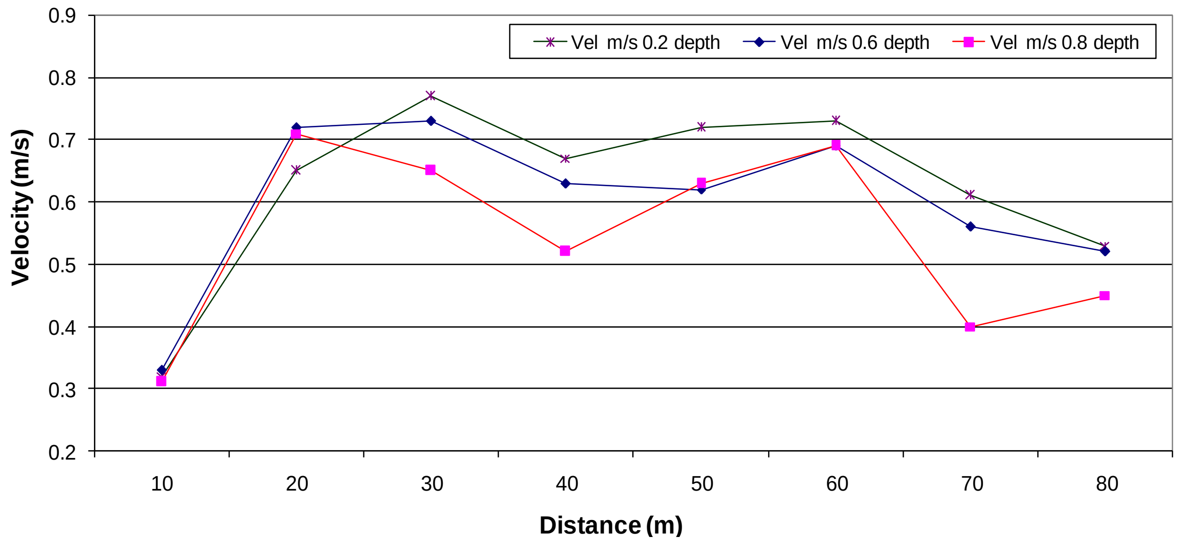

Fig. (4) Velocity distribution analysis for cross section 1

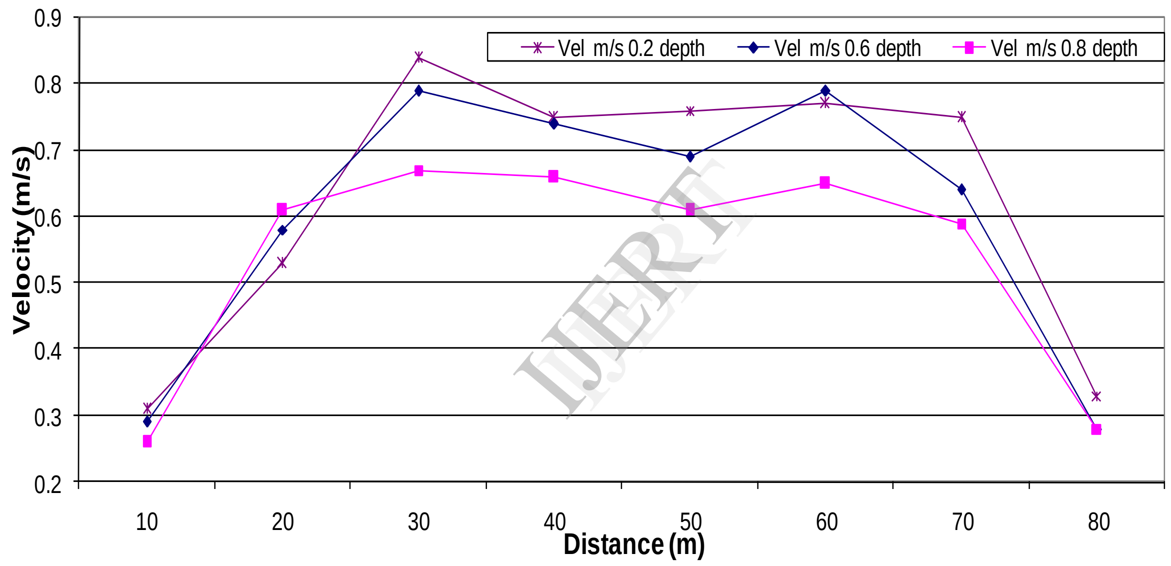

Fig. (5) Velocity distribution analysis for cross section 2

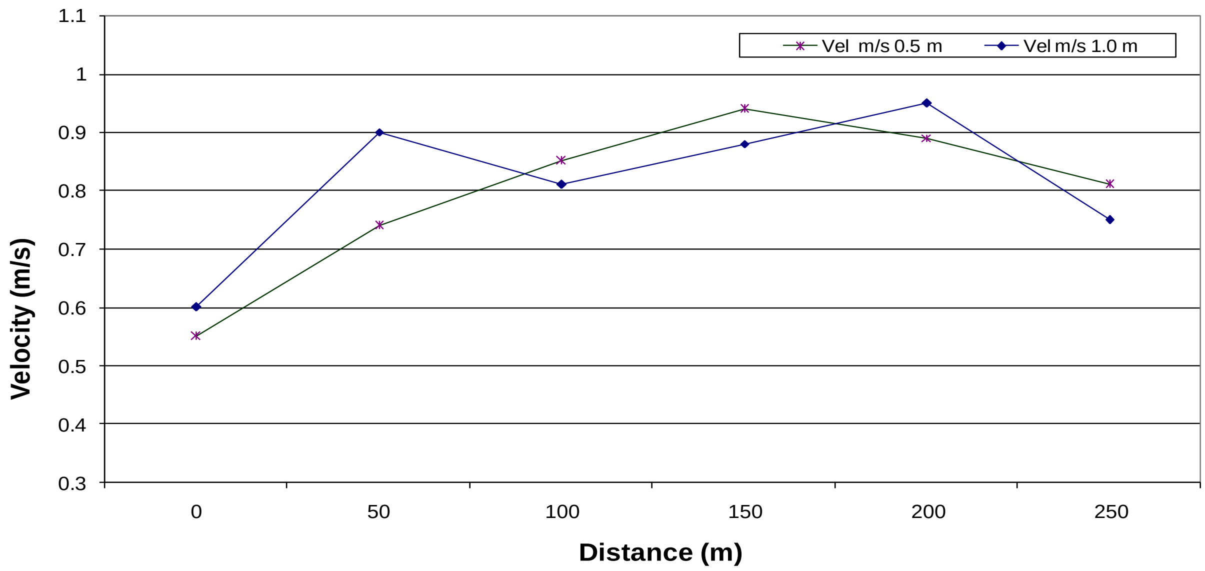

Fig. (6) Velocity distribution analysis for cross section 3

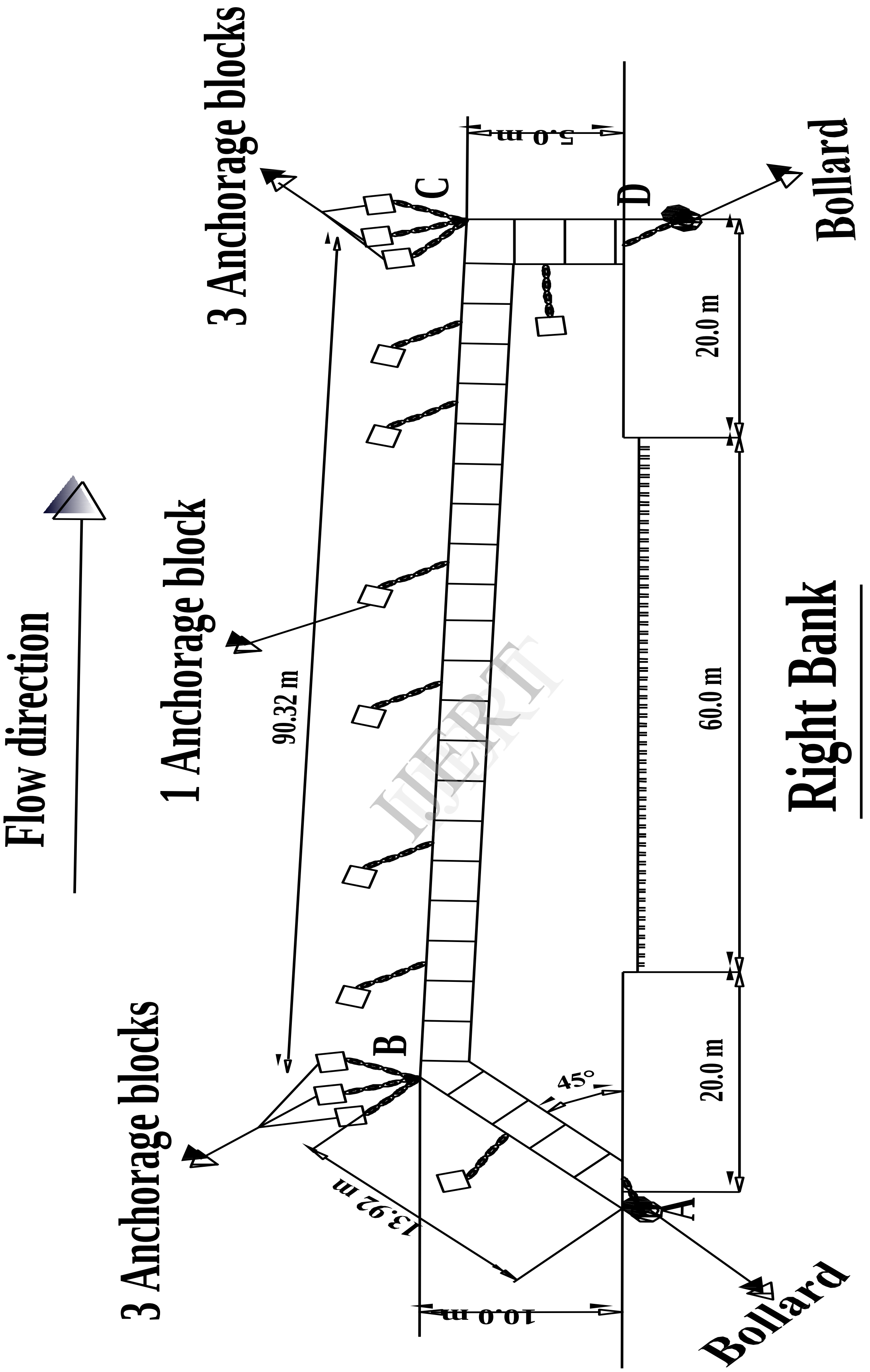

Fig.(7)The proposed barrier Location at North Giza power station

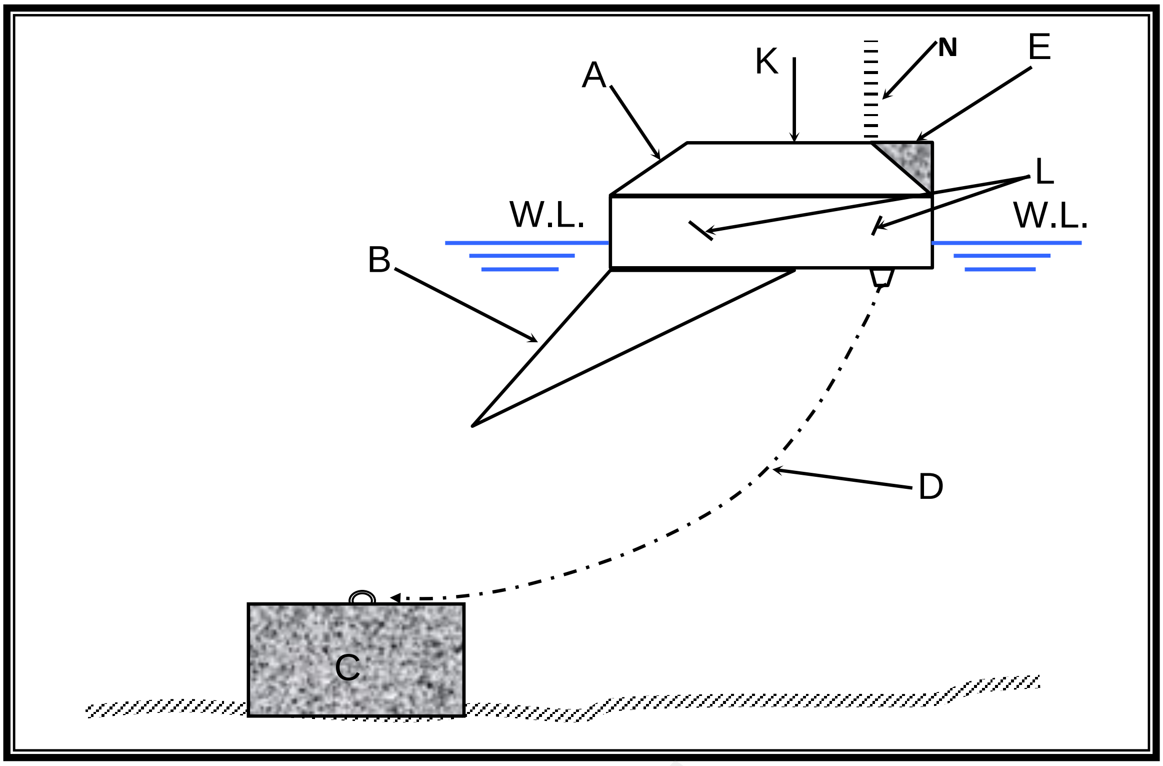

Fig. (8) The proposed barrier components

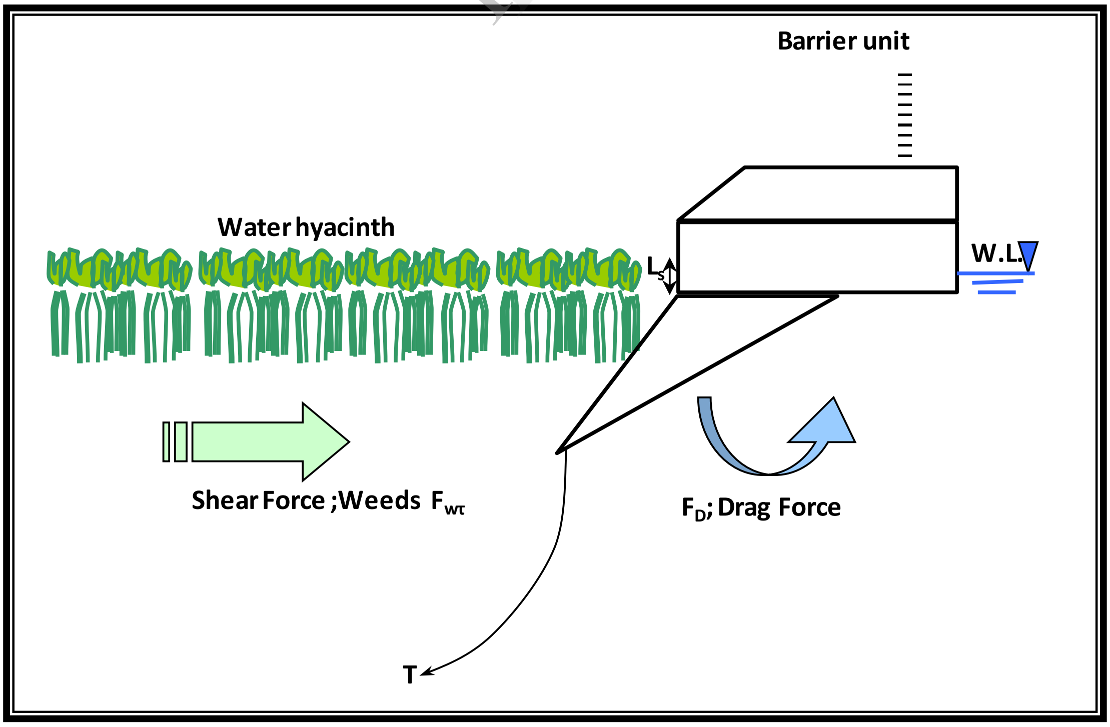

Fig. (9) The Existing forces on each buoy unit

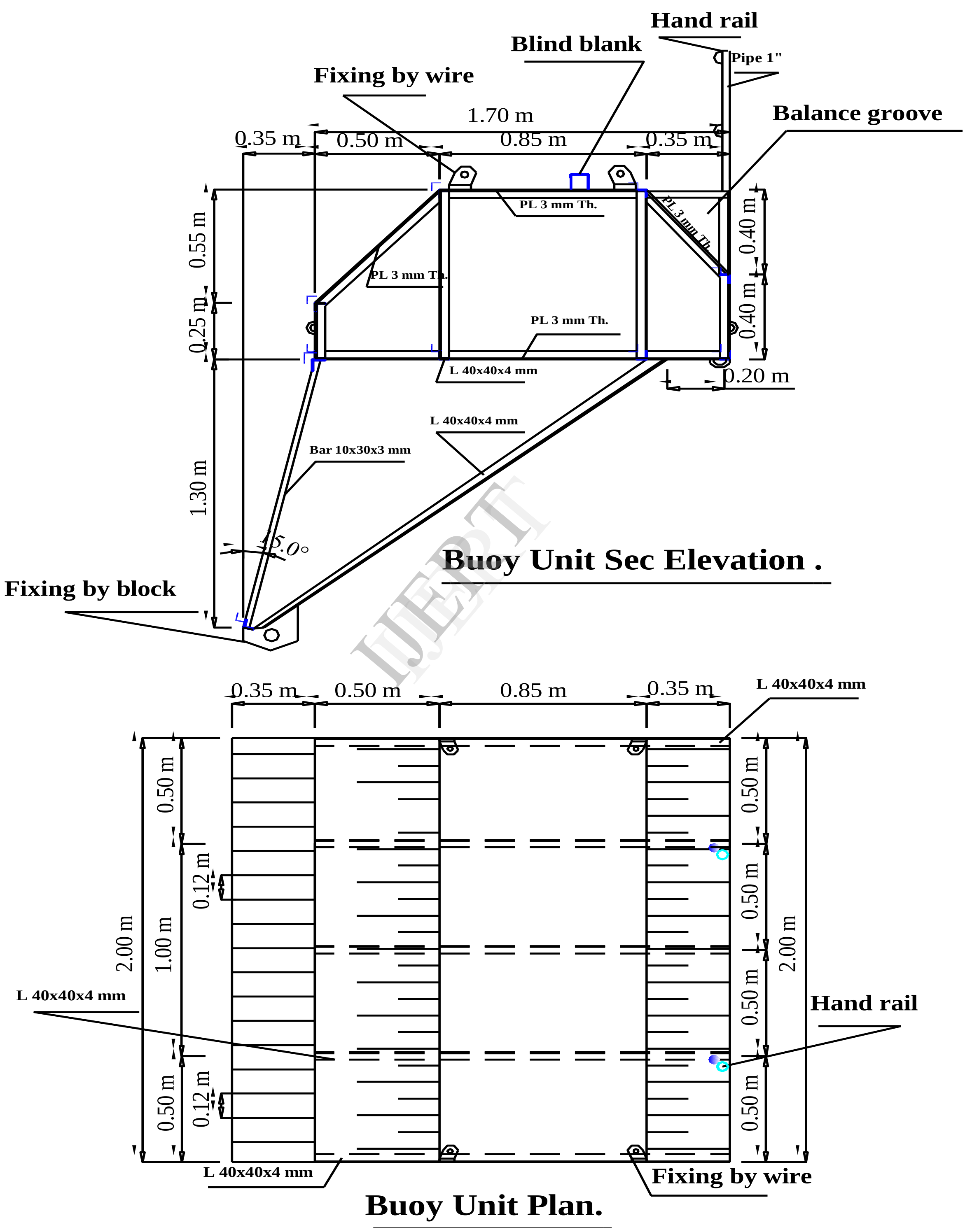

Fig.(10) Detailed design of Buoy unit , Elevation and Plan

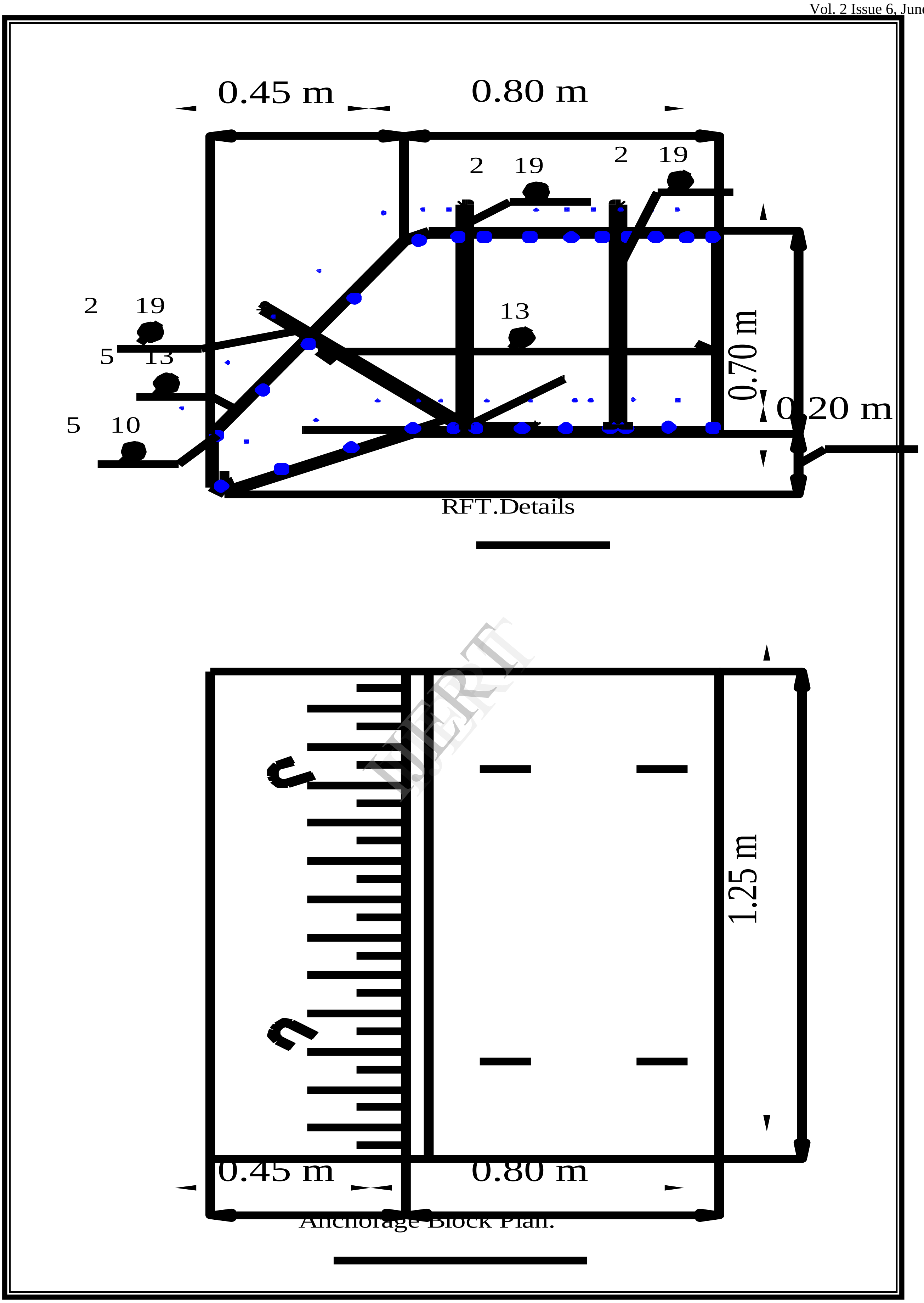

Fig.(11)Details of the Anchorage Block

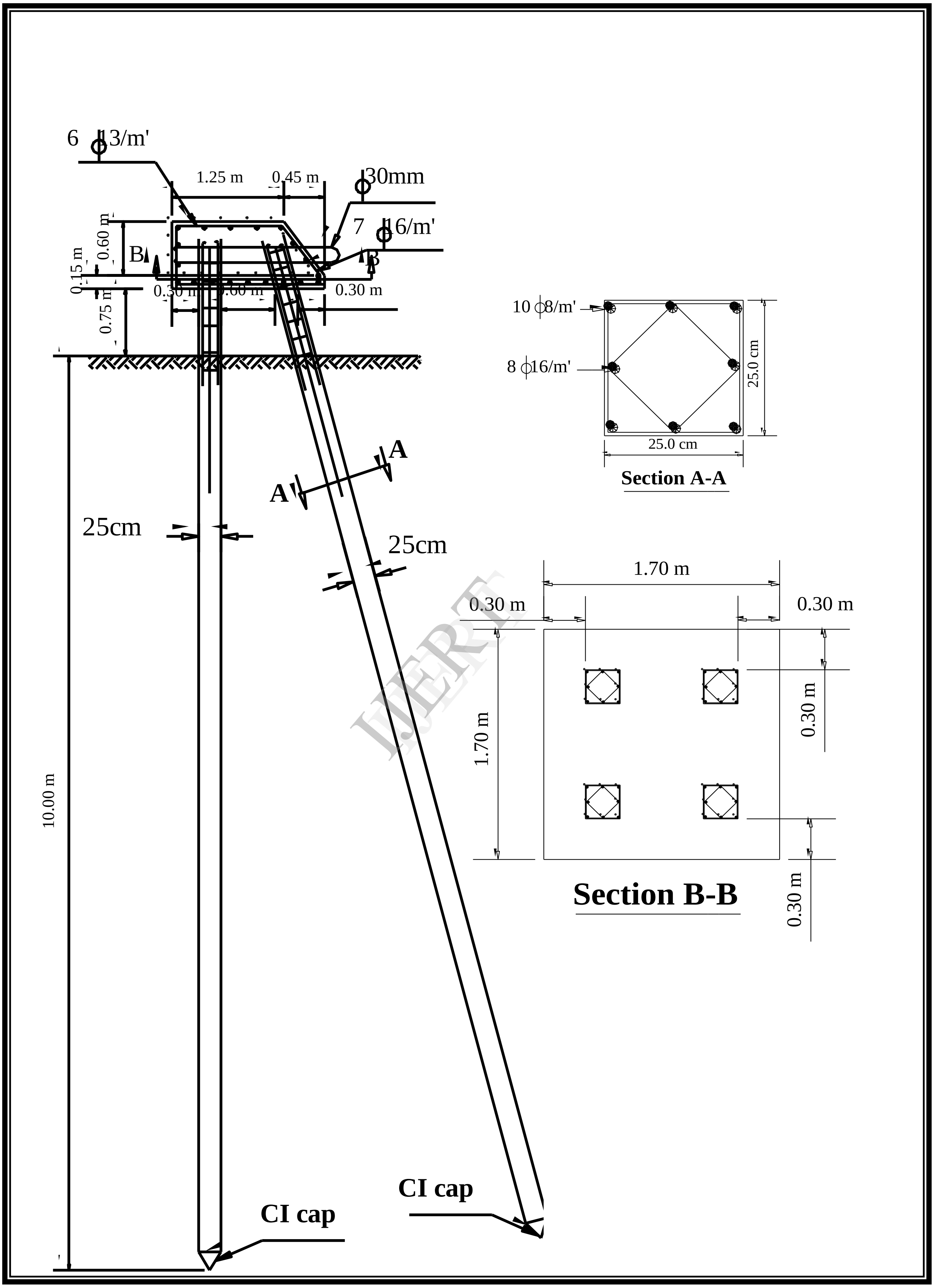

Fig.(12) Pile Anchorage Details

photo. (1) General location of North Giza power station

Photo (2) Weed sampling device

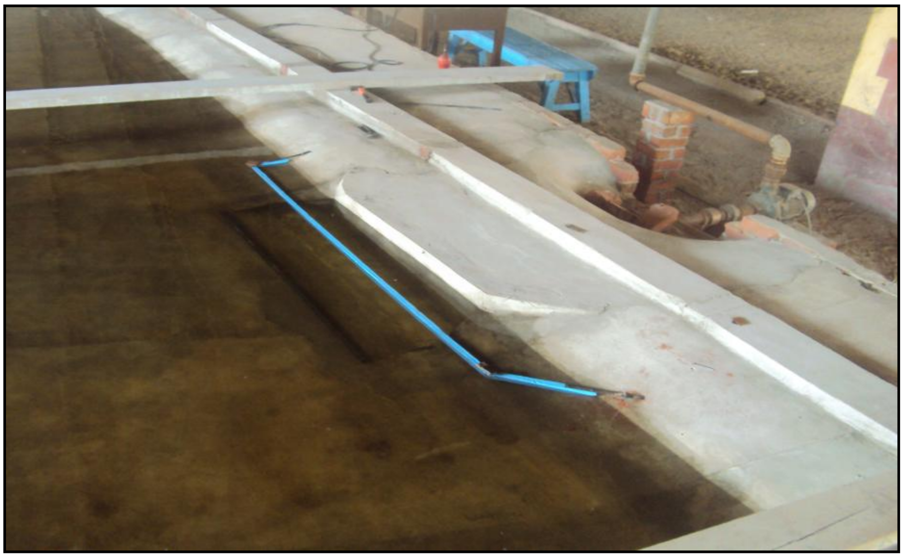

Photo (3) Physical Model Measurements

Position (m)	Distance (m)	Water Depth (m)	Velocity(m/s) at minimum discharge			
			Without barriers	0^0 inclined barrier	3^0 inclined barrier	5^0 inclined barrier
Inside barrier At 3.75 m from right bank	0	--------	---------	----------------	---------------------	---------------------
	15	5.35	0.08720984	0.17206265	0.11785113	0.099
	30	5.35	0.22391715	0.202703944	0.150849447	0.035
	45	5.35	0.17913372	0.200346921	0.197989899	0.071
	65	--------	---------	----------------	---------------------	---------------------
outside barrier At 16.25m from right bank	0	-----------	--------------	-----------------	--------------------	-----------------
	15	3.55	0.64582419	0.90509668	0.813172798	0.813172798
	30	3.55	0.16263456	0.287556758	0.292270803	0.228631193
	45	3.55	0.02592725	-0.146135401	-0.096637927	0.082495791
	65	2.20	0.48083261	0.544472222	0.476118566	0.664680374

Table (1) Velocities inside and outside barrier at minimum discharge

Position (m)	Distance (m)	Water Depth (m)	Velocity(m/s) at maximum discharge			
			Without barriers	0^0 inclined barrier	3^0 inclined barrier	5^0 inclined barrier
Inside barrier At 3.75 m from right bank	0	--------	---------	----------------	---------------------	---------------------
	15	7.85	0.23805928	0.322912097	0.292270803	0.202703944
	30	7.85	0.47611857	0.219203102	-0.096637927	0.157920514
	45	7.85	0.34883935	0.16263456	0.193275854	0.273414622
	65	--------	---------	----------------	---------------------	---------------------
outside barrier At 16.25m from right bank	--------	--------	---------	----------------	---------------------	-------------------
	5.9	5.9	0.89566859	0.898025612	0.928666906	0.966379268
	5.9	5.9	0.5939697	0.773103414	0.867384318	0.824957911
	5.9	5.9	0.40540789	0.697678691	0.768389369	0.791959595
	4.75	4.75	0.86974134	0.912167748	0.926309883	1.006448652

Table (2) Velocities inside and outside barrier at maximum discharge