TO FIND THE OPTIMUM SPACING OF GROYNES THROUGH ANSYS

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE

OF

MASTER IN TECHNOLOGY IN
HYDRAULICS & WATER RESOURCES ENGINEERING

SUBMITTED BY
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I, (AMIT KUMAR, 2K16/HFE/04 STUDENT OF M. TECH (HYDRAULICS & WATER RERSOURCES ENGG.), hereby declare that the project Dissertation titled "**TO FIND THE OPTIMUM SPACING OF GROYNES THROUGH ANSYS**" which is submitted by me to the Department of civil engineering, DELHI TECHNOLOGICAL UNIVERSITY,Delhi in partial fulfillment of the requirement for the award of the DEGREE OF MASTER OF TECHNOLOGY, is original and not copied from any source without proper Citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

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CERTIFICATE

I, herby declare certify that the Project Dissertation titled "TO FIND THE OPTIMUM SPACING OF GROYNES THROUGH ANSYS" which is Submitted by AMIT KUMAR, 2k16/HFE/04, (CIVIL ENGINEERING DEPARTMENT), DELHI TECHNOLOGICAL UNIVERSITY, Delhi in partial fulfillment of the requirement for the award of Degree of MASTER OF TECHNOLOGY, is a record of the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or fulfillment for any Degree or Diploma to this University or elsewhere.

PLACE:
DATE:

DR. RAKESH KUMAR ARYA
SUPERVISIOR

ABSTRACT

Groynes are the structure used for protection of river banks from erosion caused due to meandering rivers. In this project various flow perimeters around the groynes and optimum spacing for the groynes is analysed with the help of ansys fluent. In this project various model of groynes are studied for different spacing in a compound channel having symmetrical flood plains. There are four different models in which spacing between the models is varied and then for different velocities the optimum spacing between the different groynes is found out. Variation of velocities at inlet and around the groynes is also discussed in the report. Following four models of the groynes are studied : Groynes with D=1,Groynes with D=2, Groynes with D=3, Groynes with D=4, Here "D" is the ratio of spacing between the groynes and the length of the groynes.

ACKNOWLEDGEMENT

I would like to thank Vice Chancellor of Delhi Technological University, Prof. Yogesh Singh and Prof. Nirendra Dev (Head of Department, Civil Engineering,DTU) for providing all the facilities in the college required for the completion of project work.I would like to convey my thanks, great indebtedness and gratitude to my supervisor Prof. Rakesh Kumar, Department of Civil Engineering, Delhi Technological University, for his kind supervision, remarkable comments and constant support.Professors and faculties of Department of Civil Engineering, DTU, have always extended their full co-operation and help. I would also like to thank my colleagues in the college, especially Mr. Anshuman Gupta, for their constant help and support. I would like to address my seniors for their guidance.

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M.Tech(HFE),DTU

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LIST OF SYMBOLS AND ABBREVIATIONS

v	Velocity
M	Mass
V	Volume
T	TIME
P	PRESSURE
ρ	Density
τ	Shear Stress
G	Acceleration due to gravity
D	Ratio of Length of groyne and distance b/w the groynes
b/w	Between
&	And
FIG.	Figure
Eq.	Equation

CHAPTER - 1

INTRODUCTION

Rivers have been used as a source of water, for acquiring food, for transport, as a defensive degree, as a source of hydropower to drive equipment. Riverbank erosion is one of the primary phenomena inflicting the instability of the financial institution. Predicting the purpose of riverbank erosion and stopping it is the foremost purpose of the river financial institution safety. Rainfall, soil shape, river morphology, topography of river and adjacent areas, and floods are the main factors affecting the erosion. In some areas, vegetation act as protection to the riverbanks. sometimes those flowers cowl has been destroyed with the aid of human sports which subsequently ensuing within the financial institution erosion.

Rivers are often controlled or controlled to cause them to greater beneficial, or much less disruptive, to human interest. typically used methods are through flowers, sacks and blocks, gabions ripraps, manual banks, groynes and many others. Groynes or spurs are structures constructed perpendicular to the rivers to shield the shore. Groynes might also both be impermeable or permeable. Groynes deflect the float from the shore and shield the shore. It needs to be taken care that the groynes certainly flow the erosion area to another place. via blockading the waft at a aspect the groynes tend to increase the water depth and velocities in the circulation. In the nostril of the groyne, there is also threat of turbulence which eventually motive scour within the nose.

A groyne creates and continues a wide location of seashore or sediment on its updrift aspect, and decreases erosion on the different. It is a bodily barrier to forestall sediment delivery in the direction of longshore flow (additionally known as longshore transport). This causes a construct-up, which is regularly accompanied by multiplied erosion of the downdrift beach, which receives little or no sand from longshore flow (this is regarded as terminal groyne syndrome, as it occurs after the terminal groyne in a group of groynes). Groynes upload sediment to the beach by means of shooting downward float. however, this may cause severe erosion on shores downstream from the groyne. If a groyne is successfully designed, then the quantity of fabric it is able to preserve can be restricted, and extra sediment might be free to move on via the system. but, if a groyne is just too massive it can entice an excessive amount of sediment, which could reason extreme beach erosion on the down-flow facet.

Groynes or spurs are built transverse to the river go with the flow extending from the bank into the river. This shape of river schooling works perform one or extra capabilities consisting of education the river along the favored route to reduce the concentration of flow at the point of attack, creating a slack flow for silting up the region within the region and shielding the financial institution via preserving the go with the flow away from it.

1.1 TYPE OF GROYNES

Groynes or spurs are labeled according to (i) the technique and materials of creation (ii) the peak of spur with admire to water degree (iii) characteristic to be completed and (iv) special kinds which include the following:

These are

(i) Permeable or impermeable

(ii)Submerged or non-submerged

(iii)Attracting, deflecting repelling and sedimenting and

(iv) T-formed (Denehey), hockey (or Burma) kind, kinked type, etc. The distinct styles of spurs are shown in discern:

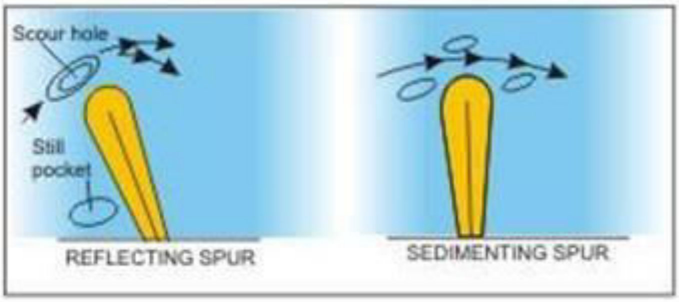


FIG. 1

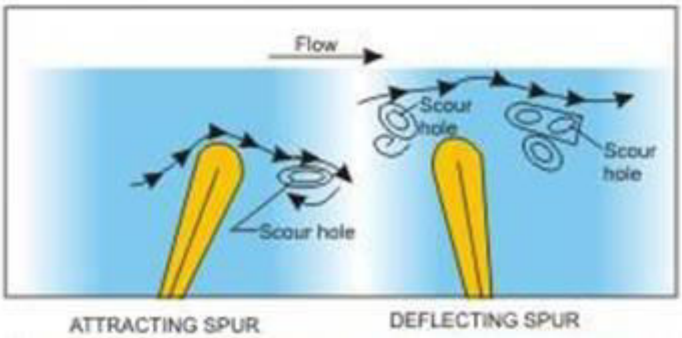


FIG. 2

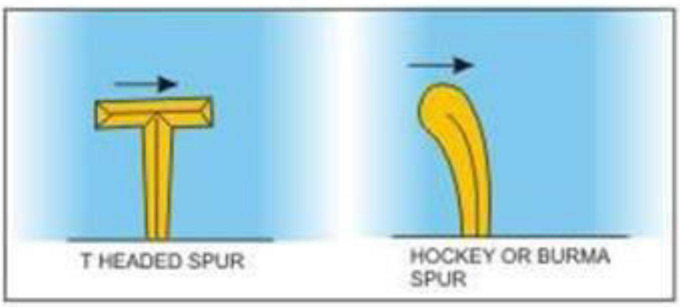


FIG. 3

FIG. 4

Impermeable spurs do not allow appreciable flow through them whereas permeable ones allow constrained waft via them. Impermeable spurs may be built of a center of sand or sand and gravel or soil as to be had within the river mattress and protected on the sides and top with the aid of a robust armour of stone pitching or concrete blocks. they are additionally built of balli crates full of stone inner a cord screen or rubble masonry.

At the same time as the phase has to be designed according to the substances used and the velocity of glide the top of the spur has to have unique safety.

Permeable spurs commonly consist of timber stakes or piles pushed for depths barely underneath the expected private scour and joined collectively to shape a framework with the aid of other wood pieces and the space in between crammed up with brush wood or branches of timber. The toe of the spur would be included by using a bed of stones or other fabric. As the permeable spurs sluggish down the current, silt deposition is caused. those spurs, being temporary in nature, are inclined to damage by way of floating debris. In bouldery or gravelly beds, the spurs might must be put up with the aid of weighing down timber beams at the base by means of stones or concrete blocks and the alternative elements of the body might then be tied to the beams at the bottom.

1.2 LAYOUT OF GROYNES OR SPURS

Groynes are a good deal more powerful while constructed in collection as they invent a pool of nearly nevertheless water between them which resists the cutting-edge and progressively accumulates silt forming a everlasting bank line in path of time. The repelling spurs are built with an inclination upstream which varies from 100 to three hundred to the road regular to the bank. inside the T-formed groynes, a greater length of the go groyne tasks upstream and a smaller portion downstream of the primary groyne.

LENGTH OF GROYNES

The length of groynes relies upon upon the role of the unique financial institution line and the designed everyday line of the skilled river channel. In easily erodible rivers, too lengthy groynes are prone to harm and failure. therefore, it could be higher to assemble shorter ones in the starting and increase them steadily as silting among them proceeds.Shorter and brief spurs built between lengthy ones are useful in inducing silt deposition.

SPACING OF GROYNES

Every groyne can defend most effective a sure duration and so the number one aspect governing the spacing between adjacent groynes is their lengths. generally, a spacing of 2 to 2.5 instances the duration of groynes at convex banks and identical to the period at concave banks is followed. tries to economise in cost via adopting wider spacings so as to insert intermediate groynes at a later date won't provide the favored results as the training of river might no longer be pleasant and maintenance may pose problems and additional expenditure. T-shaped groynes are usually located
800 m aside with the T-heads on a everyday curved or straight line.

1.3 DESIGN OF GROYNES OR SPURS

The design of groynes or spurs encompass the fixation of top width, unfastened board, side slopes, length of stone for pitching, thickness of pitching, clear out and launching apron.

TOP WIDTH OF GROYNE

The top width of the spur is saved as three to 6 m at formation stage.

FREE BOARD

The pinnacle stage of the spur is to be labored out by giving a free board of one to at least one.5 m above the highest flood degree for 1 in 500 year flood or the anticipated maximum flood degree upstream of the spur, whichever is extra.

SIDE SLOPES

The slopes of the upstream shank and nostril is usually kept no longer steeper than 2:1 the downstream slope varies from 5 : 1 to 2:1.

SIZE OF STONE FOR PITCHING

The guide strains for determining the scale of stone for pitching for guide bunds maintain true for spurs also.

THICKNESS OF PITCHING

The thickness of pitching for spurs may be decided from the method T = zero.06 Q1/three in which Q is the layout discharge in cumecs. The thickness of stone want no longer be furnished the equal thru- out the complete period of the spur. it can be step by step decreased from the nostril.

PROVISION OF FILTERS

Provision of filter gratifying the filter standards needs to be made under the pitching at nostril and on the upstream face for a period of 30 to 4 m for the subsequent 30 to 45m from the nostril. The thickness of the identical can be 20 to 30cm. The thickness of filter for the next 30 to 45m on the upstream face can be reduced to about 15 cm and beyond that, it is able to be neglected.

GROYNE AREA LAYOUT CONSIDERATIONS

Groynes are structures that make bigger from the shore into the energetic quarter of littoral flow transport and control the herbal movement of beach material and are analogous to herbal headlands. They alter the orientation of the seaside to be extra in line with incident wave crests and intercept longshore currents, lowering littoral drift delivery and promoting sediment accretion on their updrift aspect. Groynes do not directly counter erosion and recession, but offer help in growing a extra solid coastline and sand buffer, or switch the techniques to other locations. The basis of groyne discipline layout should encompass attention of littoral tactics, purposeful layout and structural layout (Balsillie and Berg, 1972).

Littoral methods are in all likelihood the single most crucial system influencing the effective operation of groynes. Littoral go with the flow delivery effects from longshore currents in (and seaward of) the surf zone brought about by way of waves that arrive obliquely to the shore and, to a lesser volume at Kingscliff seashore, via longshore wave top versions and longshore tide and wind driven currents. The bulk of littoral go with the flow transport happens inside the surf area and the cross-shore distribution of the shipping is determined with the aid of water intensity and the cross-shore distribution of sediments and wave peak. If no littoral glide bypassing of a groyne head takes place, the shoreline downdrift of a groyne will usually erode/recede. Conversely, if complete bypassing of a groyne occurs, the coastline updrift of a groyne will normally no longer maintain to accrete.

Useful groyne layout covers consists of components of duration , crest level , width , spacing , permeability, orientation, siting (place) and sediment budget. If littoral processes are nicely understood, the most critical purposeful aspects are the water depth at the head of every groyne (i.e. period) and groyne spacing.

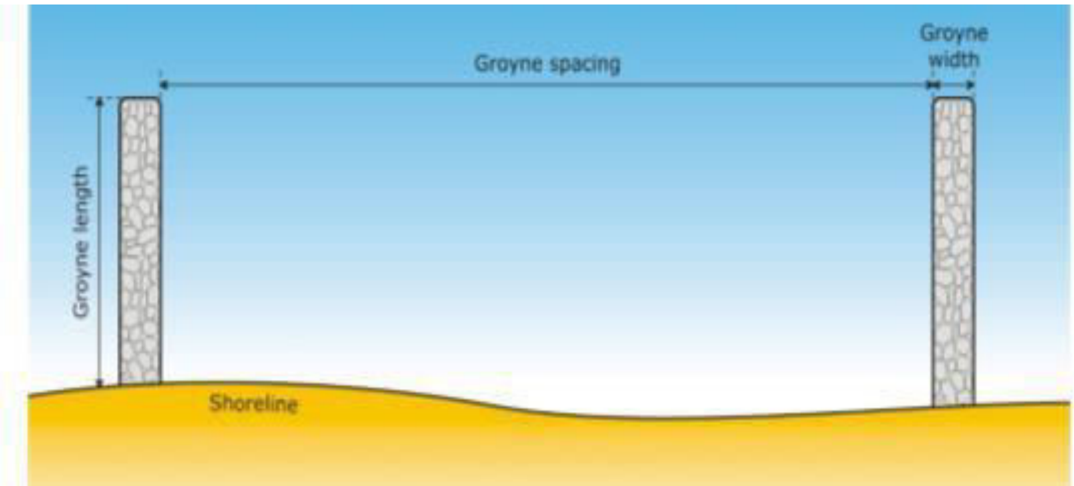


FIG. 5

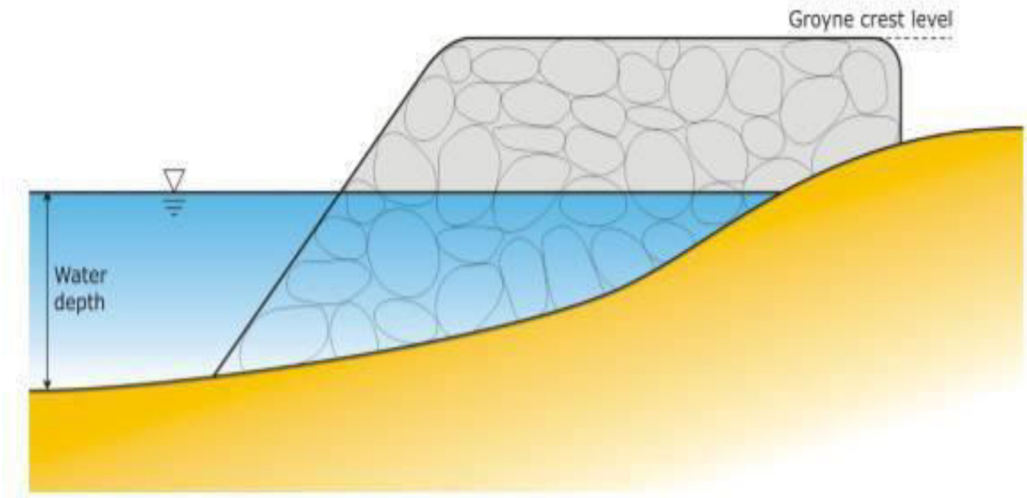


FIG.6

Structural groyne layout considers appropriate construction materials and strategies to prevent failure of the groynes as a end result of wave forces, currents forces, sediment loading and debris affects. The most vital structural decision affecting the general geometry of groynes is the selection of the predicted sand scour level on the toe which determines the most wave forces on the groynes and required armour mass.

In the development of the two groyne subject concept designs, WRL taken into consideration the performance of similar systems nearby and reviewed design steerage set out inside the literature.

CHAPTER – 2

LITERATURE REVIEW

A groyne (additionally called "groin", "retard", "spur dike", "spur dyke" etc) is a wall-like structure produced from the riverbank of a river some distance right into a river, greater or much less perpendicular to the waft course, with the objective of causing the water to float a few distance from the riverbank wherein the structures are built.A groyne roughens the bank on which it's far built and in doing so, creates a sector of decrease drift pace in which the tendency for erosion is less and deposition more. generally eddy currents shape within the pools among groynes wherein the water flows upstream alongside the financial institution. A subject of groynes is a set of structures that act collectively to govern the waft route of a river and the region of sediment deposits.

TRADOUW:

Throughout the 2006 floods, the Grootvadersbosch River on the farm Tradouw (simply east of Suurbraak) began undermining the embankment on which an irrigation dam was built. The branch turned into asked to assist arrest the erosion and guard the dam. A subject of eight groynes changed into proposed and built in early 2008 (see figure nine). A few months after construction, the groynes have been subjected to the 2008 flood which has been envisioned to be between a 1:50 and 1:a hundred year flood. unluckily get right of entry to to the farm become cut off in the course of the flood and images could not be taken of the groynes for the duration of operation. The structures had been inspected after the flood. pictures were taken at standardized positions and a detailed survey of the river was carried out to determine shifts in sediment levels. figure indicates aerial images taken of the web page before and after the 2008 flood.

FIG.7

Groyne five had a scour hole starting upstream of the structure (see darker blue area in figure) which caused the partial subsidence of the bed. If unchecked, this will in the long run lead to the subsidence of the nostril of the groyne. This is very possibly due to an over-optimistic the translation of projection length because it become measured from the original riverbank and not the landscaped riverbank. This resulted in a groyne spacing that become regionally too wide, enabling the river to meander toward the financial institution between groynes 4 and 5. The begin of the scour hole upstream of the groyne changed into 1.17 m deep and the stop simply downstream of the groyne became 1.sixteen m deep. Figure 8 indicates a frontal view of groyne 5 before and after the 2008 flood. A technically greater applicable layout for thesegroynes could have involved transferring the whole river at least 10 m eastwards. this would have accelerated the projection period and it would had been less difficult to establish a extra practical groyne spacing. The disadvantage of adopting this method could have been that creation would have been plenty more high-priced (earthworks plus longer structures), and the solution would have been less desirable from an environmental attitude (the rehabilitated riverbank could were extended beyond wherein it had been lately).

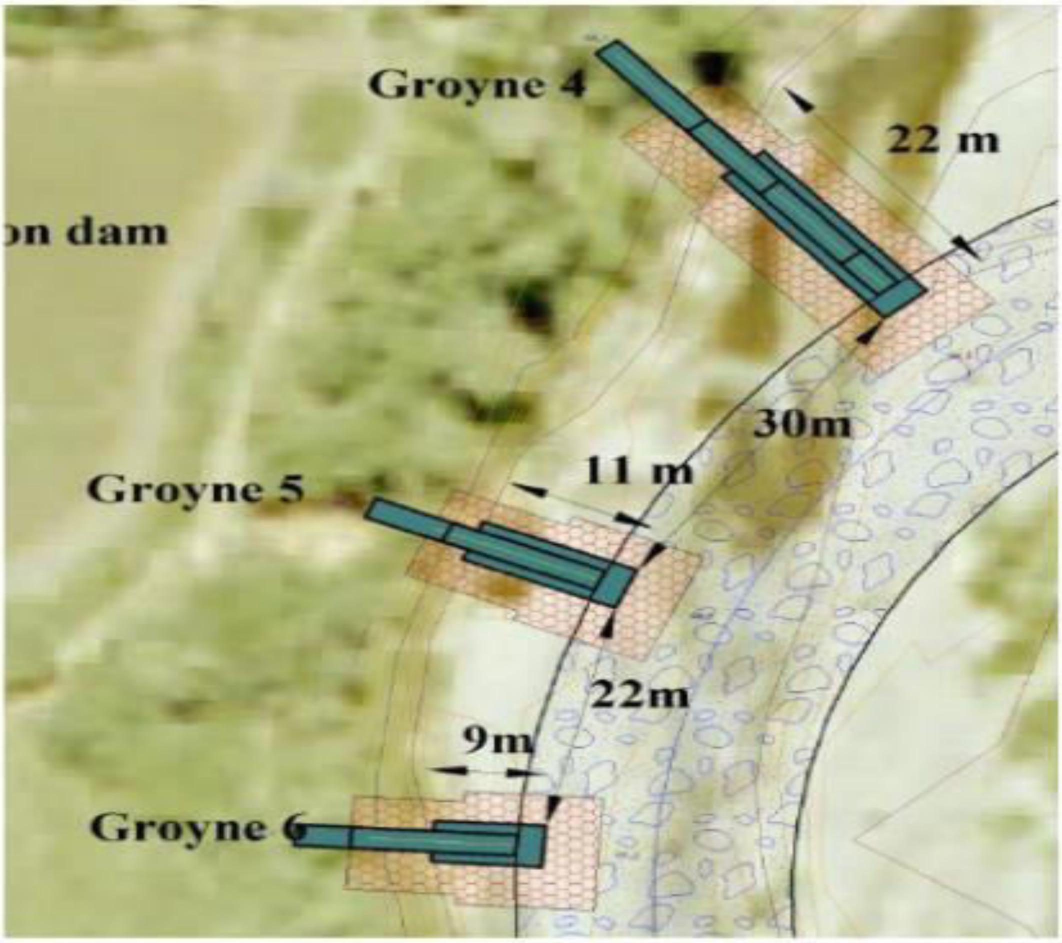


FIG.8

MULLERSRUS :

The Buffeljags River at the farms Mullersrus and Olivedale has been under commentary on the grounds that 2002. The river has for a long time made an S-bend among these farms, however recently the out of doors of the bends were eroding severely with every flood (on Olivedale the river moved some 20 meters at some point of the 2004 and once more the 2006 floods). The erosion has been made worse via the colonization of sediment on the interior of the bends with “black wattles”, and the very probably expanded sediment load inside the river because of runaway erosion of the riverbanks of different farms upstream (the farm Rotterdam misplaced approximately a 40m width of 5m high bank alongside a 300 m period over only a few years, the farm Sovereign misplaced a 30 m width of 6m excessive financial institution over a 250 m length within the 2006 flood on my own). With investment from the 2006 Flood alleviation Scheme, the department turned into asked to plot groynes for each bends in 2007 and these were constructed in early 2008. just after creation a very excessive flood become skilled in the Buffeljags River (the flood has been expected at being among a 1:50 and 1:100 year flood based totally on float measurements of the peak float on the Buffeljags Dam).

FIG.9

The observations were made:- The groynes have worked thoroughly in that there has been no similarly erosion of the riverbank in the course of the 2008 flood. Scour holes have fashioned around a number of the groynes (specially 11, 12 and thirteen). No longer a good deal deposition of sediment has taken place among the systems due to the fact the landscaping turned into to a very excessive level (to accelerate the re-flowers technique).

directly downstream of the groyne shanks, the landscaped fill has been eroded by way of turbulent drift over the shank of the groynes.

The upstream side of a few of the mattresses have been lifted up and rolled over (maximum substantially groynes 1 and 2). This turned into despite the usage of a 4m gabion basket anchor buried beneath the upstream corner of the mattress to hold it down (this became performed because the problem have been skilled earlier than). it's miles suspected that branches of floating timber hook the bed and lift it sufficient to enable the water to help carry it further. parent 16 indicates groyne 2. After the flood many large timber have been lying in the river and on the structures. numerous had trunks in excess of 500mm and some of the trees have been longer than five m. As with other web sites alongside the Buffeljags River, there was great damage to structures due to the floating timber. The pictures in figure 9 display a gabion impaled with the branch of a tree and some other groyne nose that have been ripped open (likely via a tree).

KINGSCLIFF BEACH :

Kingscliff beach, placed on the southern end of Wommin Bay on the a ways north coast of NSW (determine 1), is a segment of the Tweed shoreline with constructed property at immediately chance from coastal risks. Ongoing erosion in the previous few years has ended in widespread loss of seaside amenity and community land. hurricane erosion episodes among 2009 and 2012 significantly impacted the Kingscliff seashore vacation Park (KBHP). This phase is additionally affected with the aid of slight ongoing underlying coastline recession (WBM, 2001).

To manipulate the Kingscliff beach foreshore (parent 2) within the long term, Tweed Shire Council (TSC) is considering a mixture of numerous of the subsequent alternatives:

• Assignment numerous seaside works – dune reconstruction and vegetation, fencing, get admission to-approaches and stormwater management;

• Assignment seashore nourishment between the northern give up of Kingscliff seashore Bowls membership (KBBC) and the northern training wall of Cudgen Creek;

• Production of a terminal seawall between an present rock seawall protective KBBC to the north and an existing secant pile seawall at Cudgen Headland Surf lifestyles Saving membership (CHSLSC) to the south;

• Construction of a groyne discipline among the northern give up of KBBC and the northern schooling wall of Cudgen Creek; and/or

• deliberate retreat.

TSC became mainly requested to reconsider the closing two points by the NSW Minister for the environment following recommendation acquired from the NSW Coastal Panel in 2 December 2011 (NSW Coastal Panel, 2011). This paper considers the second one final point most effective. WRL became engaged by TSC to prepare one of a kind concept designs for a long time groyne field at Kingscliff beach. The first groyne field idea design assumed erosion protection would be supplied by means of massive scale beach nourishment at the side of the groynes. the second one design assumed erosion safety might be furnished via a terminal seawall fronting KBHP in conjunction with the groynes.

FIG.10

S. KRISHNA PRASAD

Bank erosion is the wearing away of the banks of a stream or river. Impacts of river bank erosion are multifarious: social, economic, health, education and sometimes political. Groynes are structures constructed in rivers to protect the shore. Groynes are generally made of wood, concrete, or rock piles etc. In the present study coir geotextiles in the form of cocologs are used as the groynes to make the groyne more ecofriendly. Study mainly concentrates on analysing the effects of placing groynes at different angles from 45^0 to 135^0 and to find the most effective arrangement for minimising the erosion. Results indicate that cocolog-groynes are effective in minimizing the erosion and protecting the bank. Maximum protection is observed for groyne angle of 135^0

MONA MEHMOUD MOSTAFA

The results of an experimental study and velocity analysis of flow characteristics in the vicinity of a floodplain with two rows of permeable/impermeable groynes in compound channels with one and two floodplains are presented. A 60% permeable groyne model with three different lengths relative to the floodplain width was used. The results showed that a double groyne could be considered as one groyne (one block) for aspect ratio S r < 2 (where S r is the distance between two successive groynes/groyne length). When S r > 2, each groyne started to act independently. The reduction in velocity was 45-52% of the floodplain's approach velocity, compared to 30-35% in the case of a single groyne. This significant reduction in velocity was located at a distance of 1.5-2 times the groyne length, downstream of the single or double groynes. Generally, the maximum velocities in the main channel ranged from 1.1-1.35 times the original approach velocity. The effective groyne's relative length and aspect ratio should not to be more than 0.5 and 2, respectively.

WIM S. UIJTTEWAAL

This research is aimed at finding efficient alternative designs, in the physical, economical, and ecological sense, for the standard groynes as they are found in the large rivers of Europe. In order to test the effects of various groyne shapes on the flow in a groyne field, experiments were performed in a physical model of a schematized river reach, geometrically scaled 1:40. Four different types of schematized groynes were tested, all arranged in an array of five identical groyne fields, i.e., standard reference groynes, groynes with a head having a gentle slope and extending into the main channel, permeable groynes consisting of pile rows, and hybrid groynes consisting of a lowered impermeable groyne with a pile row on top. Flow velocities were measured using particle tracking velocimetry. The design of the experiment was such that the cross-sectional area blocked by the groyne was the same in all cases. Depending on the groyne head shape and the extent of submergence variations in the intensity of vortex shedding and recirculation in the groyne field were observed. The experimental data are used to understand the physical processes like vortex formation and detachment near the groyne head. It is demonstrated that the turbulence properties near and downstream of the groyne can be manipulated by changing the permeability and slope of the groyne head. It is also observed that for submerged conditions the flow becomes complex and locally dominated by three-dimensional effects, which will make it difficult to predict by applying depth average numerical models or by three-dimensional models with a coarse resolution in the vertical direction.

MOHAMED F.M. YOSSEF AND HUIB J. DE VERIEND

Experiments have been carried out in a fixed-bed flume for a schematized straight river reach with groynes on one side to study the dynamics of the flow near groynes. The flume had a geometrical scale of 1:401:40, based on typical dimensions of the Dutch River Waal. Both emergent and submerged groynes were studied. The measurements demonstrate the differences in the nature of the turbulence between submerged and emerged groynes stages; and provide insight into the flow pattern in the vicinity of groynes, the shape and the extent of the mixing layer at different flow stages, and the dynamic behavior of the velocity along the mixing layer between the main channel and the groyne fields. A parameterization of the turbulence characteristics of the flow near groynes is presented. Large-scale velocity fluctuations are found in all test cases, with timescales that vary with the flow stage. The large-scale uu and vv velocity fluctuations are in phase in the center of the mixing layer and out of phase for the points on the boundaries of the mixing layer.

AKBAR SARFARAZDEH

Laboratory measurements were conducted to investigate the three-dimensional turbulent flow field around a single straight (SD) and two different T-shape groynes (TH and TF) under smooth flat-bed conditions. An acoustic Doppler velocimeter (ADV) was used in the measurements. Experimental results showed profound effects of the groyne shape on both the mean and turbulent flow characteristics, especially for the near bed region. The near bed velocity amplifications due to both of the local effects of groyne structure and constriction of the channel cross section in the SD is higher than T-shape groynes. The horseshoe vortex at the base of the SD has more compact and strong rotational momentum and lasts a longer distance downstream compared with T-shape groynes. By increasing the wing length of the T-shape groyne the flow structure at the upstream mini embayment changes from the vertical to the dominantly horizontal circulation, the horseshoe vortex disappears, and the wing segment acts as a scour countermeasure.

MOHAMMED VAGHEFI

In this paper, the scour hole dimensions around submerged and emerged spur dike in a 90° bend along with the mean and turbulent flowfield were investigated experimentally. Two types of re-circulating flow at the downstream of the spur dike and around the spur dike wing were observed. A direct relation between the estimated bed shear stress using TKE and the scour process prevails. More attentions is needed in estimating the bed shear stress using vertical velocity fluctuations. The scour hole dimensions increase by increasing the ratio of radius of channel bend to channel width, the Froude number of the spur dike, ratio of the length of spur dike to channel width and ratio of the approach mean flow velocity to the approach flow velocity at threshold condition. However, vice versa trends were observed by increasing ratio of the spur dike length to the median sediment size, ratio of the wing length of spur dike to the length of spur dike and the submergence ratio. A particular location of the spur dike in the sharp bend was specified beyond which the scour hole dimensions increase. The ratio of the spur dike length to the median sediment size has a secondary effect on the scour hole dimensions. New equations are proposed for prediction of the scour hole dimensions considering the submergence ratio along with other effective parameters.

PRAMOD B.F

The continuously changing course of rivers is a common feature of the rivers. This tendency poses many problems for agricultural land, the habitation, hydraulic structures etc located on the river banks. River training and anti-erosion work therefore becomes essential part of the utilization of river. River training is also required for stabilization of the river channel along the desired alignment. Spur is a river training structure widely used in anti erosion structures. Length and spacing of spurs are the two very sensitive factors that influence the satisfactory performance of river training works. The length and spacing of spurs depends basically on the purpose, river characteristics, cost of construction and maintenance, etc. As normal practice / thumb rule, α (α = Spacing of spur / Length of Spur) of 2.5 to 5.0 is adopted for bank Protection. This paper attempts to verify theses general guidelines by conducting graphical analysis and study of spurs constructed in the field. The analysis indicated that the ratio (α) is normally the same that of the thumb rule. However, safety margin to the protected bank between the spurs shows wide variations.

ANDREW McCOY

The flow hydrodynamics in a straight open channel containing a multiple-embayment groyne field on one of its sides is investigated numerically using large eddy simulation. The vertical groynes are fully emerged. The mean flow depth in the groyne region is about half that of the main channel and the length and width of the embayments are much larger than the mean depth in the embayment region. The model is validated using mean velocity and turbulent fluctuations data collected at the free surface in a previous experimental study. It is found that despite the fact that the flow inside the main recirculation eddy in the embayments can be characterized as being quasi-two dimensional, the flow inside the mixing layer region between the embayments and the channel is strongly nonuniform over the depth. As this region controls the mass exchange processes between the groyne field and the main channel, a three-dimensional description of the flow in this area is essential. The large-scale eddies that populate the mixing layer can penetrate the embayment region over lateral distances of the order of the channel depth. These eddies advect with them channel fluid inside the embayment. Eventually, the channel fluid is mixed with the embayment fluid by the small scales. The other main mixing mechanism is due to the injection of patches of high-vorticity mixing-layer fluid near the tip of the downstream groyne and their subsequent convection in the form of a wall-attached jet-like flow into the embayment, first parallel to the downstream groyne face and then to the sidewall. It is shown that on average, most of the fluid leaves the embayment region via the top layer of the embayment-channel interface (upstream half) and enters the embayment region at levels situated around the middepth (practically over the whole length of the embayment) of the interface surface. This explains why the mass exchange coefficients are overestimated when predicted using methods that employ floating particles as a tracer. The instantaneous bed shear stress inside the cavity is found to peak close to the downstream groyne face of each embayment and to show a high variability around the mean values due to the interaction of the mixing layer eddies with the tip of the groynes and the formation of the jet-like flow parallel to the groyne face.

CHAPTER -3

INTRODUCTION TO CFD

3.1 WHAT IS CFD?

• Computational fluid dynamics (CFD) is the science of predicting fluid waft, heat switch, mass switch, chemical reactions, and related phenomena through solving the mathematical equations which govern these approaches the use of a numerical process.we're interested in the forces (strain, viscous strain and so on.) performing on surfaces (example: In an plane, we're interested in the raise,drag, electricity, pressure distribution etc).We would love to determine the velocity field (example:In a race car, we are interested by the nearby drift streamlines, so that we are able to layout for much less drag).we're interested in knowing the temperature distribution (example: warmness transfer within the place of a computer chip)

3.2 IMPORTANCE OF COMPUTATIONAL FLUID DYNAMICS

There are three strategies in study of Fluid: concept analysis, experiment and simulation (CFD). As a new approach, CFD has many benefits in comparison to experiments.

	SIMULATION (CFD)	EXPERIMENT
COST	CHEAP	EXPENSIVE
TIME	SHORT	LONG
SCALE	ANY	SMALL/MEDIUM

INFORMATION	ALL	MEASURED POINT
REPEATABLE	YES	SOME
SAFETY	YES	SOME DANGEROUS

3.3 PHYSICS OF FLUID

Fluid is liquid and fuel for example, water and air. Fluid has many essential properties, which includes flow, strain, temperature, density and viscosity. The density of a fluid is its mass according to unit volume. If the density of fluid is constant (or the change could be very small), we name the fluid is incompressible fluid. If the density of fluid isn't steady, we call the fluid is compressible fluid. commonly, we can treat water and air as incompressible fluid. If the fluid is incompressible, we can simplify the equations for this type of fluid.

$$\rho = \frac{M}{V}\left[\frac{kg}{m^3}\right] \qquad \text{eq.(i)}$$

The viscosity is internal assets of fluid which offers resistance to the float. for instance to stir the answer of sugar and water is simpler than to stir honey due to the fact viscosity of honey is extra.

CONSERVATION LAW

Navier-Stokes equations are the governing equations of Computational Fluid Dynamics. it's miles based totally at the conservation law of bodily houses of fluid. The principle of conservational law is the alternate of homes, as an example mass, power, and momentum, in an object is determined by means of the enter and output. for example, the change of mass in the object is as follows

$$\frac{dM}{dt} = m_{in} - m_{out} \qquad \text{eq.(ii)}$$

If $m_{in} - m_{out} = 0$, we have

$$\frac{dM}{dt} = 0 \qquad \text{eq.(iii)}$$

Which means , M = Constant

NAVIER-STOKES EQUATION

Applying the mass, momentum and power conservation, we will derive the continuity equation,momentum equation and electricity equation as follows

MOMENTUM EQUATION

$$\underset{I}{\rho\frac{\partial U_j}{\partial t}} + \underset{II}{\rho U_i\frac{\partial U_j}{\partial x_i}} = \underset{III}{-\frac{\partial P}{\partial x_j}} \underset{IV}{-\frac{\partial \tau_{ij}}{\partial x_i}} + \underset{V}{\rho g_j} \qquad \text{eq.(iv)}$$

Where

$$\tau_{ij} = -\mu\left\{\frac{\partial U_j}{\partial x_i} + \frac{\partial U_j}{\partial x_j}\right\} + \frac{2}{3}\delta_{ij}\mu\frac{\partial U_k}{\partial x_k} \qquad \text{eq.(v)}$$

Where

I: Local change with time
II: Momentum convection
III: Surface force
IV: Molecular-dependent momentum exchange (diffusion)
V: Mass force

ENERGY EQUATION

$$\underset{I}{\rho c_u\frac{\partial T}{\partial t}} + \underset{II}{\rho c_\mu U_i\frac{\partial T}{\partial x_i}} = \underset{III}{-P\frac{\partial U_i}{\partial x_i}} + \underset{IV}{\lambda\frac{\partial^2 T}{\partial {x_i}^2}} \underset{V}{- \tau_{ij}\frac{\partial U_j}{\partial x_i}} \qquad \text{eq.(vi)}$$

I : Local energy change with time
II: Convective term
III: Pressure work
IV: Heat flux (diffusion)
V: Irreversible transfer of mechanical energy into heat

If the fluid id compressible, we can simplify the continuity equation and momentum equation as follows ;

CONTINUITY EQUATION

$$\frac{\partial U_i}{\partial x_i} = 0 \qquad \textit{eq.(vii)}$$

GENERAL FORM OF NAVIER-STOKES EQUATION

To simplify the Navier-Stokes equations, we are able to rewrite them as the overall form.

$$\frac{\partial(\rho\Phi)}{\partial t}+\frac{\partial}{\partial x_i}\left(\rho U_i\Phi-\Gamma_\Phi\frac{\partial\Phi}{\partial x_i}\right)=q_\Phi$$

..eq.viii

When Φ=1, Uj,T, we can respectively get continuity equation, momentum equation and energy equation.

FINITE VOLUME TECHNIQUE

The Navier-Stokes equations are analytical equations. Human can recognize and resolve them,however if we want to solve them by means of computer, we should transfer them into discretized form. This procedure is discretization. the typical discretization strategies are finite distinction, finite detail 25 and finite extent methods. here we introduce finite extent method.

THE APPROACH OF FINITE VOLUME METHOD

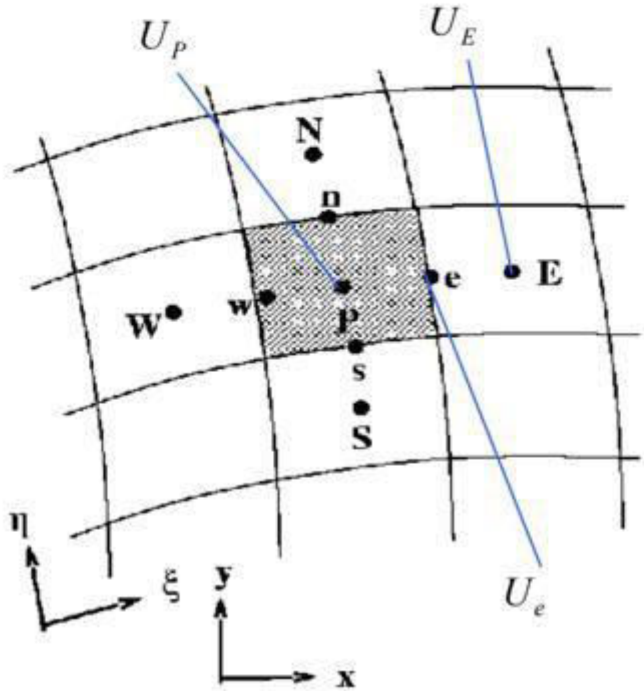
$$\int_v \phi dV = \int_s \phi . n_i dS \qquad \text{eq.(ix)}$$

We will get the integral form of Navier-Stoke equation
To approximate the surface crucial, as an example strain pressure, we've got

$$\oint_{S_i} PdS \approx \sum_k P_k S_k \qquad \text{eq.(x)}$$

$$k = n,s,e,w$$

normally we store our variables at the center of control volume, so we want to interpolate them to get P_k, that are positioned on the surface of control extent.commonly, we have two kinds of interpolations, one is upwind interpolation,and the alternative one is



imperative interpolation.

Upwind interpolation

$$U_e = f(x) = \begin{cases} U_P, & (\vec{U}.\overrightarrow{n})_e > 0 \\ U_E, & (\vec{U}.\vec{n})_e < 0 \end{cases} \qquad \text{eq.(xi)}$$

Center interpolation

$$U_e = U_E\lambda_e + U_P(1 - \lambda_e) \qquad \text{eq.(xii)}$$

CONSERVATION OF FINITE EXTENT APPROACH

If we use finite distinction and finite detail technique to discretized Navier-Stokes equation, we've got to manually manipulate the conservation of mass, momentum and electricity. but with finite extent method, we will without problems find out that, if the Navier-Stokes equation is happy in each manipulate extent, it will automatically be happy for the whole domain. In some other words, if the conservation is happy in each manage quantity, it will be automatically happy in complete domain. that is the reason why finite volume is favored in computational fluid dynamics.

FLUID DYNAMICS

•Fluid dynamics is the science of fluid motion.

•Fluid drift is generally studied in one in every of 3 ways:

- Experimental fluid dynamics.
- Theoretical fluid dynamics.
- Numerically: computational fluid dynamics (CFD).

•At some point of this direction we can attention on acquiring the understanding required which will solve realistic fluid drift issues the use of CFD.

•Subjects blanketed these days encompass:

- A brief overview of thehistory of fluid dynamics.
- An introductory assessment of CFD.

3.4 ANTIQUITY

•Attention on waterworks: aqueducts, canals, harbors, bathhouses. •One key discern become Archimedes Greece (287-212 BC). He initiated the fields of static mechanics, hydrostatics, and pycnometry(how to degree densities and volumes of gadgets) considered one of Archimedes'innovations is the water screw, which can be used to raise and transport water and granular substances**.**

18TH AND NINETEENTH CENTURY

- For the duration of this era, big paintings became achieved seeking to mathematically describe the motion of fluids.
- Daniel Bernoulli (1700-1782) derived Bernoulli's equation. •Leonhard Euler (1707-1783)proposed the Euler equations, which describe conservation of momentum for an inviscid fluid,and conservation of mass. He also proposed the speed capacity idea.
- Claude Louis Marie Henry Navier (1785-1836) and George Gabriel Stokes (1819-1903) delivered viscous delivery into the Euler equations, which resulted within the Navier-Stokes equation**.** This bureaucracy the basis of contemporary day CFD.
- Other key figures were Jean Le Rondd'Alembert, Siméon-Denis Poisson, Joseph LouisLagrange, Jean Louis Marie Poiseuille, John William Rayleigh, M. Maurice Couette, and Pierre Simon de Laplace.

OSBORNE REYNOLDS -ENGLAND (1842-1912)

Reynolds become a prolific creator who posted nearly 70 papers during his lifetime on a extensive kind of technological know-how and engineering associated topics. he's maximum well-known for the Reynolds quantity, which is the ratio between inertial and viscous forces in a fluid. This governs the transition from laminar to turbulent float.Reynolds'apparatus consisted of a long glass pipe through which water could flow at exceptional costs, controlled with the aid of a valve at the pipe exit. The country of the float become visualized by a streak of dye injected at the entrance to the pipe. The go with the flow charge become monitored through measuring the fee at which the unfastened floor of the tank fell at some stage in draining.The immersion of the pipe within the tank provided temperature manipulate due to the large thermal massof the fluid.

First a part of the 20th century tons paintings become achieved on refining theories of boundary layers and turbulence.

- Ludwig Prandtl (1875-1953): boundary layer theory, the combination length idea, compressible flows, the Prandtl wide variety, and extra.
- Theodore von Karman (1881-1963) analyzed what's now referred to as the von Karman vortex road.
- Geoffrey Ingram Taylor (1886-1975): statistical concept of turbulence and the Taylor
- Andrey Nikolaevich Kolmogorov (1903-1987): the Kolmogorov scales and the prevalent power spectrum.
- George Keith Batchelor (1920-2000): contributions to the concept of homogeneous turbulence.
- Lewis Fry Richardson (1881-1953) :In 1922, Lewis Fry Richardson developed the primary numerical weather prediction device.–division of space into grid cells and the finite distinction approximations of Bjerknes's"primitive differential equations.” –His very own try and calculate climate for a unmarried 8-hour length took six weeks and resulted in failure.

CHAPTER - 4

NUMERICAL MODELLING AND SIMULATION STUDIES

Ansys fluent is the software used in modelling and simulation of the fluid flow around the groynes. Geometry was created in design modular in ansys fluent. Ansys allows geometry to be imported from different softwares. The major problem faced during the creation of geometry was overlapping surfaces as ansys does not allow the creation of overlapping surfaces in the geometry construction. So to get the model created different planes were created and then the geometry was created. The geometry consisted of a symmetrical channel with flood plains with different arrangement of groynes.

4.1 GEOMETRY

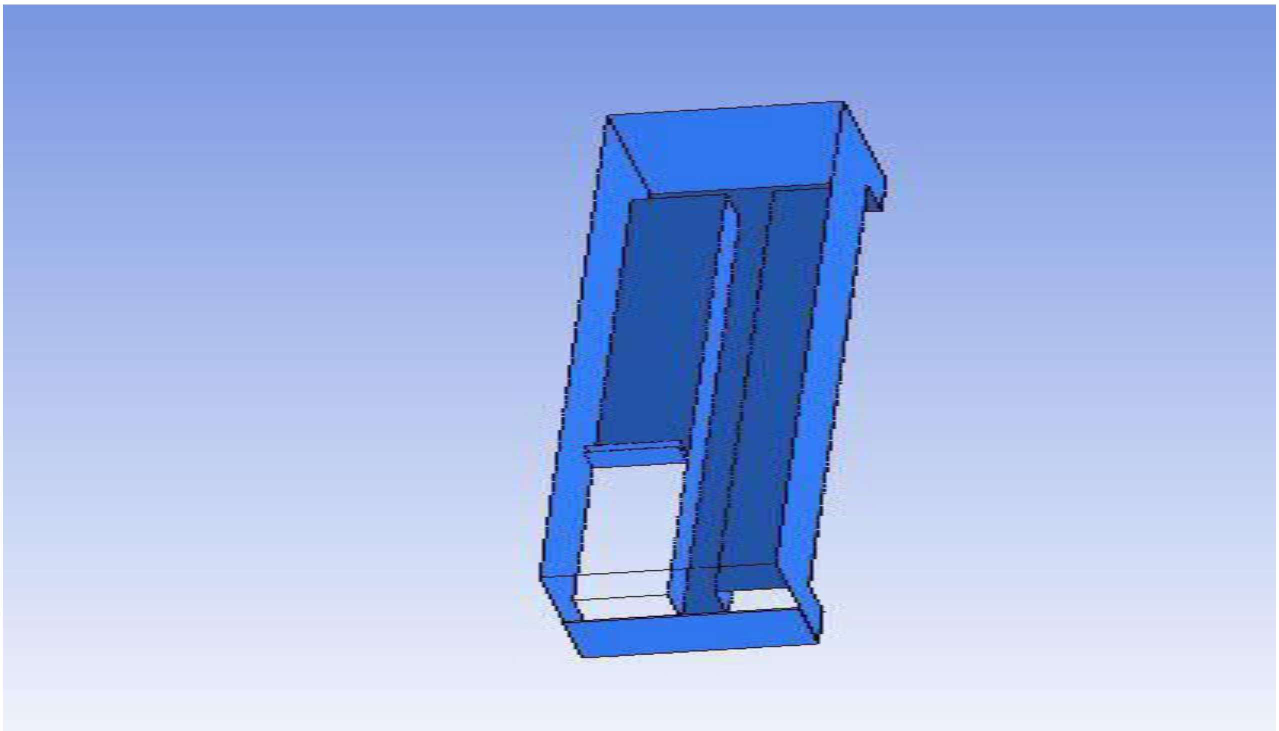


FIG.11

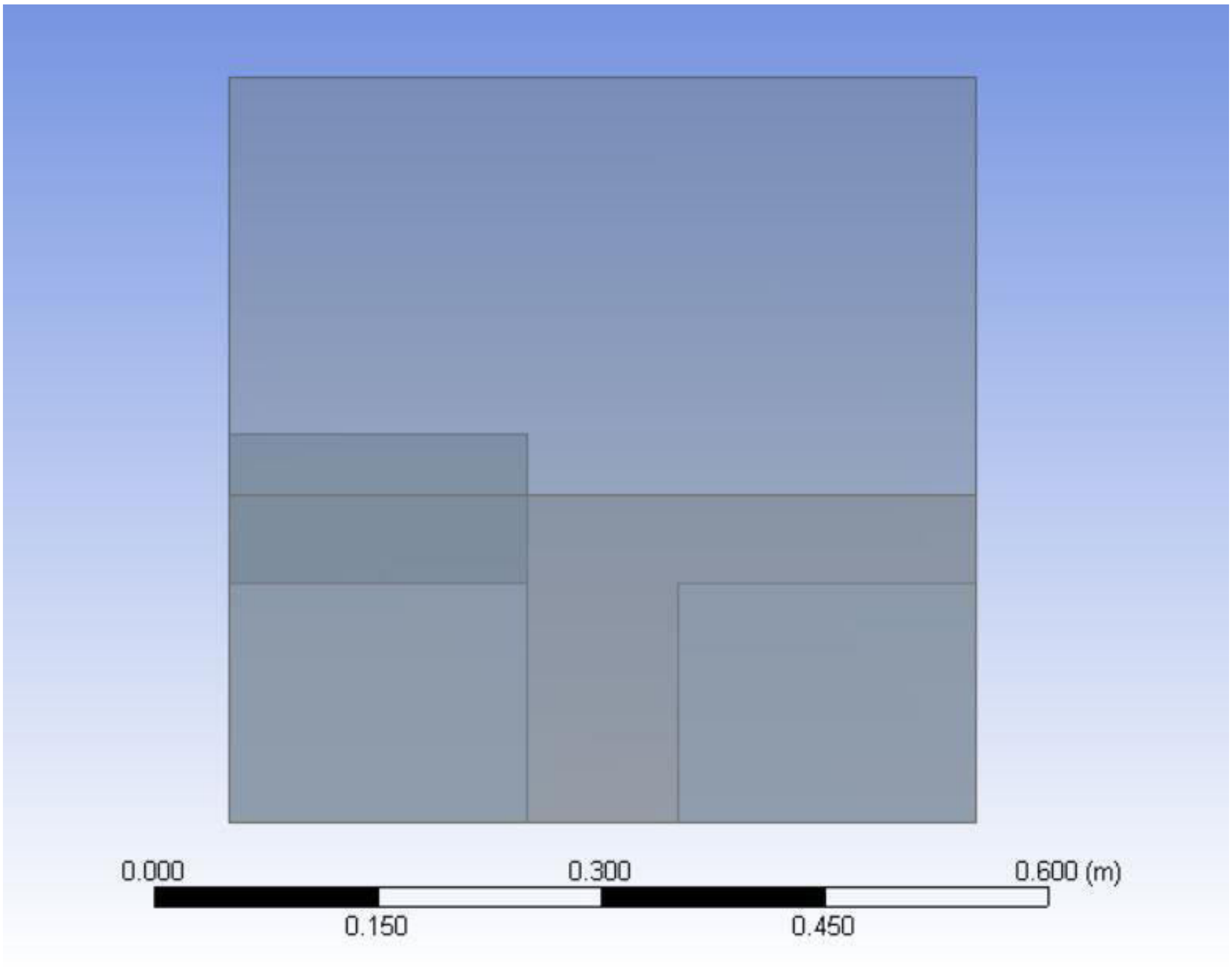


FIG.12

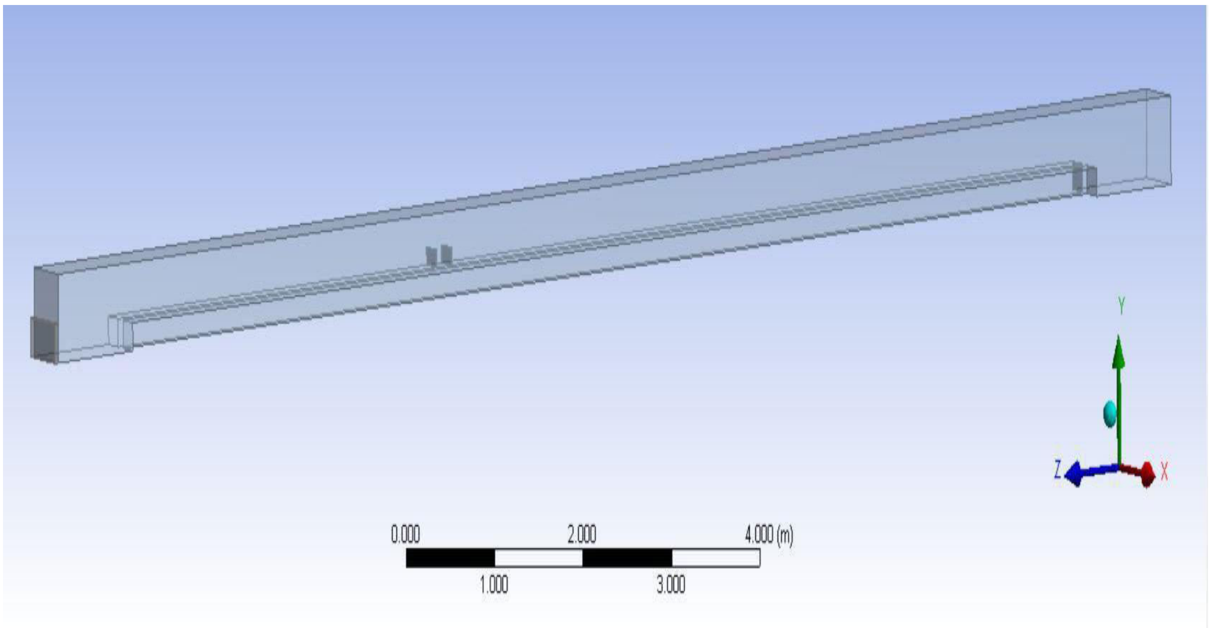


FIG.13

4.2 MESHING

ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient multiphysics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation. creating the maximum appropriate mesh is the muse of engineering simulations. ANSYS Meshing is aware of the type of answers so that it will be used in the venture and has the best criteria to create the fine appropriate mesh. ANSYS Meshing is robotically integrated with each solver inside the ANSYS Workbench surroundings. for a quick analysis or for the brand new and rare consumer, a usable mesh can be created with one click on of the mouse. ANSYS Meshing chooses the most suitable alternatives based totally at the analysis kind and the geometry of the version. specifically handy is the capacity of ANSYS Meshing to robotically take advantage of the available cores inside the laptop to apply parallel processing and as a consequence drastically reduce the time to create a mesh. Parallel meshing is to be had without any extra cost or license necessities.

The maximum primary shape of mesh category is based upon the connectivity of the mesh: dependent or unstructured.

based Meshes

STRUCTURED MESH

A structured mesh is characterized by way of ordinary connectivity that can be expressed as a two or three dimensional array. This restricts the element choices to quadrilaterals in second or hexahedra in 3-D. The above instance mesh is a established mesh, as we could save the mesh connectivity in a 40 by using 12 array. The regularity of the connectivity permits us to conserve area for the reason that neighborhood relationships are described through the garage association. extra category may be made upon whether or not the mesh is conformal or not.

UNSTRUCTURED MESHES

An unstructured mesh is characterised by abnormal connectivity isn't effectively expressed as a or 3 dimensional array in computer reminiscence. This permits for any feasible detail that a solver might be capable of use. compared to established meshes, the garage necessities for an unstructured mesh can be drastically large since the community connectivity must be explicitly saved.

HYBRID MESHES

A hybrid mesh is a mesh that carries structured quantities and unstructured quantities. note that this definition calls for information of how the mesh is saved (and used). there's confrontation as to the correct utility of the terms "hybrid" and "combined." The time period "combined" is typically implemented to meshes that incorporate factors associated with dependent meshes and elements related to unstructured meshes (possibly stored in an unstructured style).

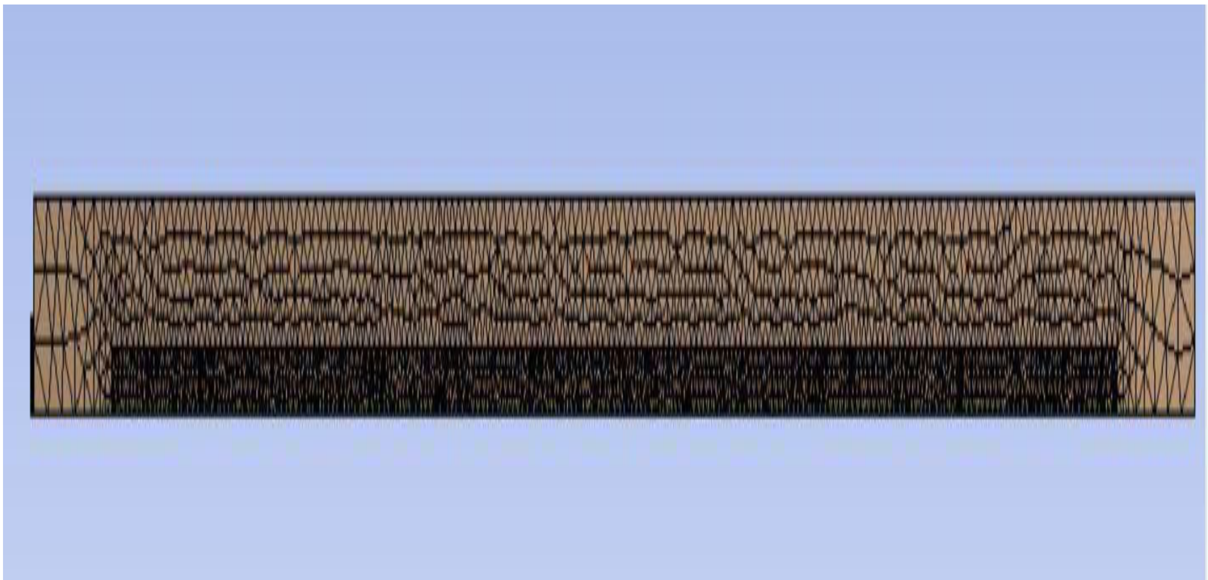


FIG.14

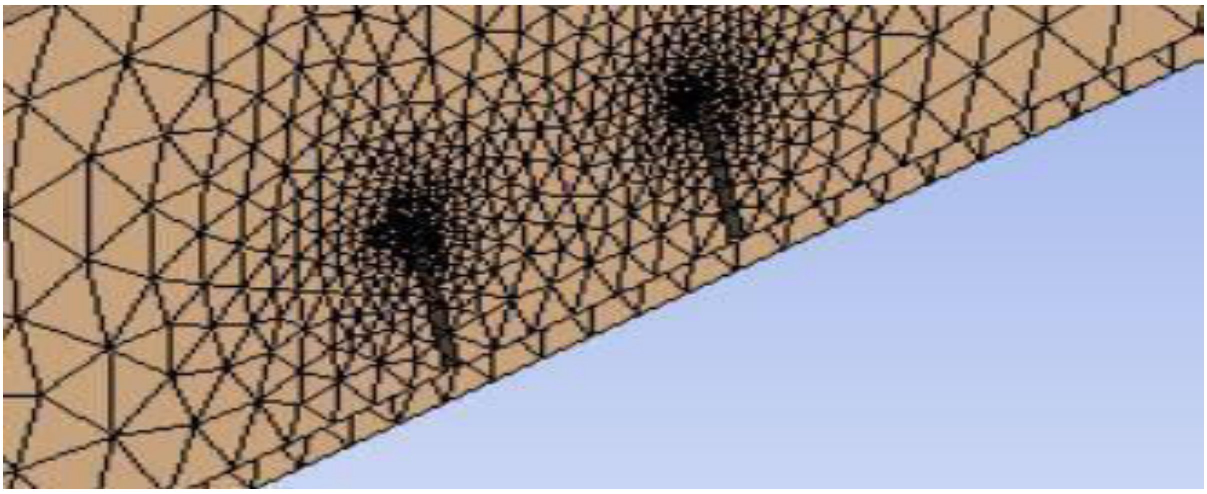


FIG.15

Meshing report

Project

First Saved	Tuesday, May 15, 2018
Last Saved	Saturday, June 2, 2018
Product Version	18.2 Release
Save Project Before Solution	No
Save Project After Solution	No

Mechanical_Report_Files/Figure0001.png

Contents

Units

Model (A3)
Geometry
Parts
Coordinate Systems
Connections
Contacts
Contact Region
Mesh
Mesh Controls
Named Selections

Units

TABLE 1

Unit System	Metric (m, kg, N, s, V, A) Degrees rad/s Celsius
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

Model (A3)

Geometry

TABLE 2
Model (A3) > Geometry

Object Name	Geometry
State	Fully Defined
Definition	
Source	C:\Users\amit\Desktop\AMIT MAJOR ANSYS\groyne 1_files\dp0\FFF\DM\FFF.agdb
Type	DesignModeler

Length Unit	Meters
Bounding Box	
Length X	0.5 m
Length Y	0.5 m
Length Z	15.05 m
Properties	
Volume	2.9231 m^3
Scale Factor Value	
Statistics	
Bodies	
Active Bodies	
Nodes	
Elements	
Mesh Metric	None
Basic Geometry Options	
Parameters	Independent
Parameter Key	
Attributes	Yes
Attribute Key	
Named Selections	Yes
Named Selection Key	
Material Properties	Yes
Advanced Geometry Options	
Use Associativity	Yes
Coordinate Systems	Yes
Coordinate System Key	
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	Yes
Compare Parts On Update	No
Analysis Type	3-D
Decompose Disjoint Geometry	Yes
Enclosure and Symmetry Processing	No

TABLE 3
Model (A3) > Geometry > Parts

Object Name	Solid
State	Meshed
Graphics Properties	
Visible	Yes
Transparency	
Definition	
Suppressed	No
Coordinate System	Default Coordinate System
Behavior	None
Reference Frame	Lagrangian
Material	

Assignment	
Fluid/Solid	Defined By Geometry (Solid)
Bounding Box	
Length X	0.5 m
Length Y	0.22 m
Length Z	5.e-002 m
Properties	
Volume	5.5e-003 m³
Centroid X	0.25 m
Centroid Y	0.11 m
Centroid Z	7.525 m
Statistics	
Nodes	
Elements	
Mesh Metric	None

Coordinate Systems

TABLE 4
Model (A3) > Coordinate Systems > Coordinate System

Object Name	Global Coordinate System
State	Fully Defined
Definition	
Type	Cartesian
Coordinate System ID	
Origin	
Origin X	0. m
Origin Y	0. m
Origin Z	0. m
Directional Vectors	
X Axis Data	[1. 0. 0.]
Y Axis Data	[0. 1. 0.]
Z Axis Data	[0. 0. 1.]

Connections

TABLE 5
Model (A3) > Connections

Object Name	Connections
State	Fully Defined
Auto Detection	
Generate Automatic Connection On Refresh	Yes
Transparency	
Enabled	Yes

TABLE 6
Model (A3) > Connections > Contacts

Object Name	Contacts
State	Fully Defined
Definition	
Connection Type	Contact
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Auto Detection	
Tolerance Type	Slider
Tolerance Slider	
Tolerance Value	3.7667e-002 m
Use Range	No
Face/Face	Yes
Face Overlap Tolerance	Off
Cylindrical Faces	Include
Face/Edge	No
Edge/Edge	No
Priority	Include All
Group By	Bodies
Search Across	Bodies
Statistics	
Connections	
Active Connections	

TABLE 7
Model (A3) > Connections > Contacts > Contact Regions

Object Name	Contact Region
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Contact	1 Face
Target	1 Face
Contact Bodies	Solid
Target Bodies	Solid
Advanced	
Small Sliding	Program Controlled

Mesh

TABLE 8
Model (A3) > Mesh

Object Name	Mesh

State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
Relevance	
Export Format	Standard
Element Order	Linear
Sizing	
Size Function	Proximity and Curvature
Relevance Center	Fine
Max Face Size	0.20 m
Mesh Defeaturing	Yes
Defeature Size	Default (1.e-003 m)
Transition	Slow
Growth Rate	Default (1.20)
Span Angle Center	Fine
Min Size	Default (2.e-003 m)
Max Tet Size	0.20 m
Curvature Normal Angle	Default (18.0 °)
Proximity Min Size	Default (2.e-003 m)
Num Cells Across Gap	Default (3)
Proximity Size Function Sources	Faces and Edges
Bounding Box Diagonal	15.0670 m
Minimum Edge Length	1.e-002 m
Quality	
Check Mesh Quality	Yes, Errors
Target Skewness	
Smoothing	High
Mesh Metric	None
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
Transition Ratio	
Maximum Layers	
Growth Rate	
Inflation Algorithm	Pre
View Advanced Options	No
Assembly Meshing	
Method	None
Advanced	
Number of CPUs for Parallel Part Meshing	Program Controlled
Straight Sided Elements	
Number of Retries	
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Triangle Surface Mesher	Program Controlled

Topology Checking	No
Pinch Tolerance	Default (1.8e-003 m)
Generate Pinch on Refresh	No
Statistics	
Nodes	
Elements	

TABLE 9
Model (A3) > Mesh > Mesh Controls

Object Name	Face Sizing
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	4 Faces
Definition	
Suppressed	No
Type	Element Size
Element Size	0.1 m
Advanced	
Defeature Size	Default (1.e-003 m)
Size Function	Uniform
Behavior	Soft
Growth Rate	Default (1.2)

Named Selections

TABLE 10
Model (A3) > Named Selections > Named Selections

Object Name	INLET
State	Fully Defined
Scope	
Scoping Method	Geometry Selection
Geometry	1 Face
Definition	
Send to Solver	Yes
Visible	Yes
Program Controlled Inflation	Exclude
Statistics	
Type	Manual
Total Selection	1 Face
Surface Area	0.11 m^2
Suppressed	

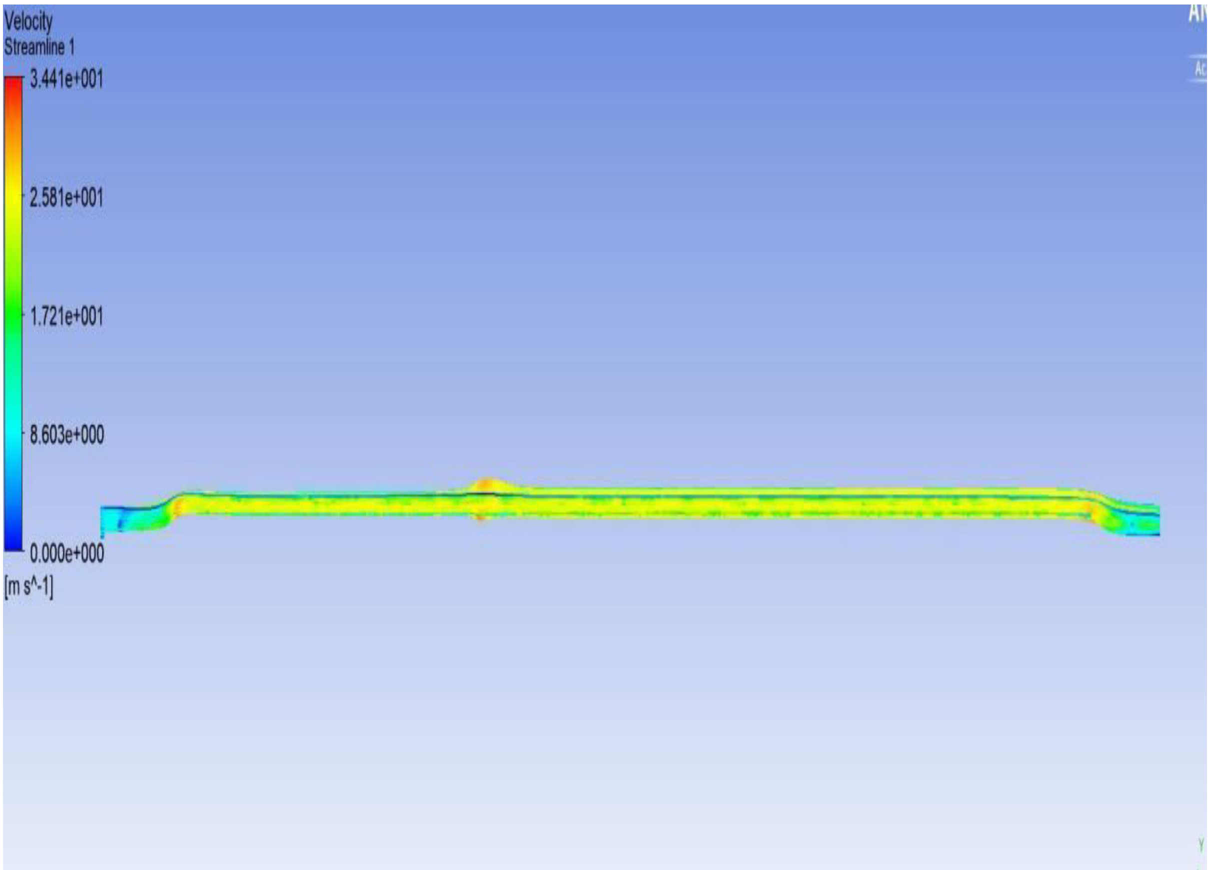

Velocity
Streamline 1
3.441e+001
2.581e+001
1.721e+001
8.603e+000
0.000e+000
[m s^-1]

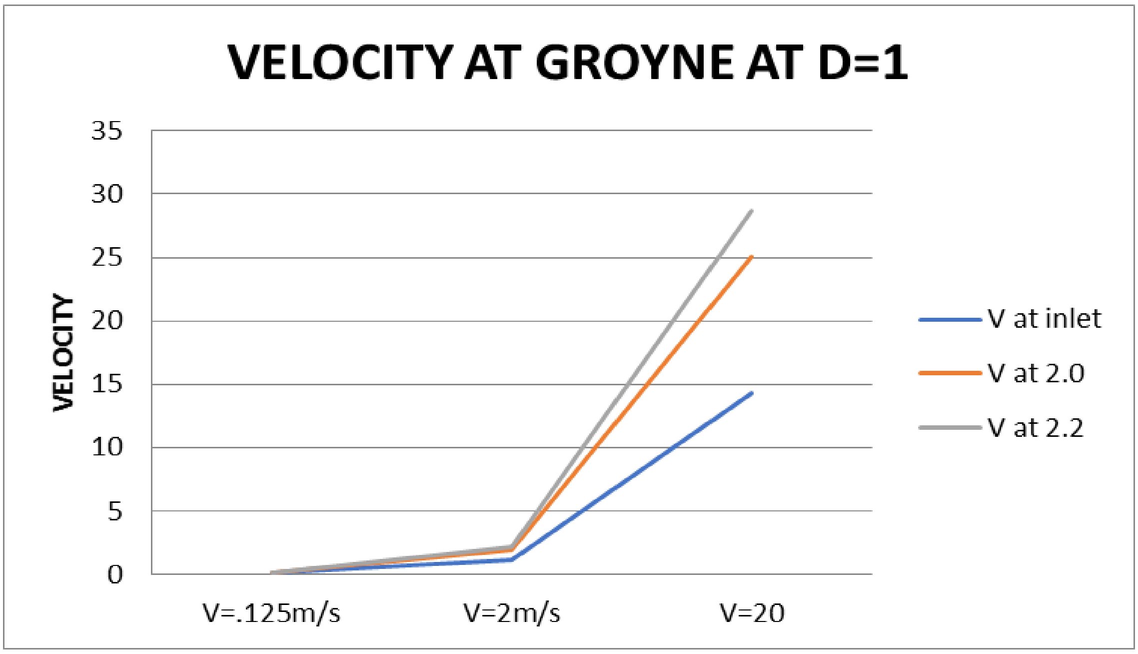
FIG.16

CHAPTER - 5

RESULTS AND CONCLUSION

VELOCITY AT GROYNE AT D=1			
	V=.125m/s	V=2m/s	V=20
V at inlet	0.0632	1.1135	14.3266
V at 2.0	0.1348	1.958	25.11495
V at 2.2	0.1383	2.2027	28.707

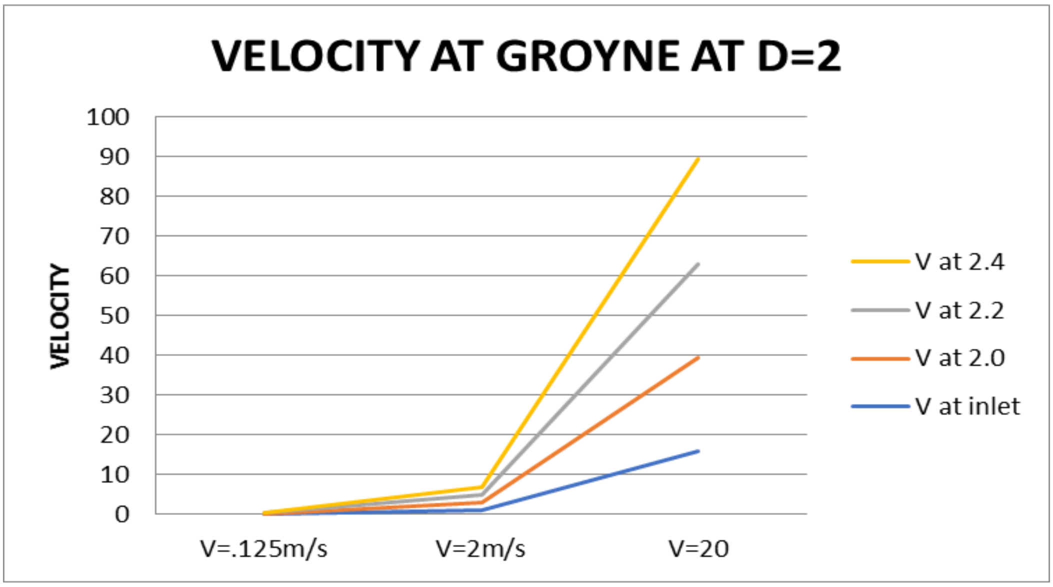
TABLE-1



In the above table it can be seen that velocity b/w the groynes is increasing so it can be observed that at D=1 both the groynes behaves as a single groyne.

VELOCITY AT GROYNE AT D=2			
	V=.125m/s	V=2m/s	V=20
V at inlet	0.06925	1.16	15.925
V at 2.0	0.133	1.86	23.41755
V at 2.2	0.1249	1.874	23.534
V at 2.4	0.1317	2.09	26.55

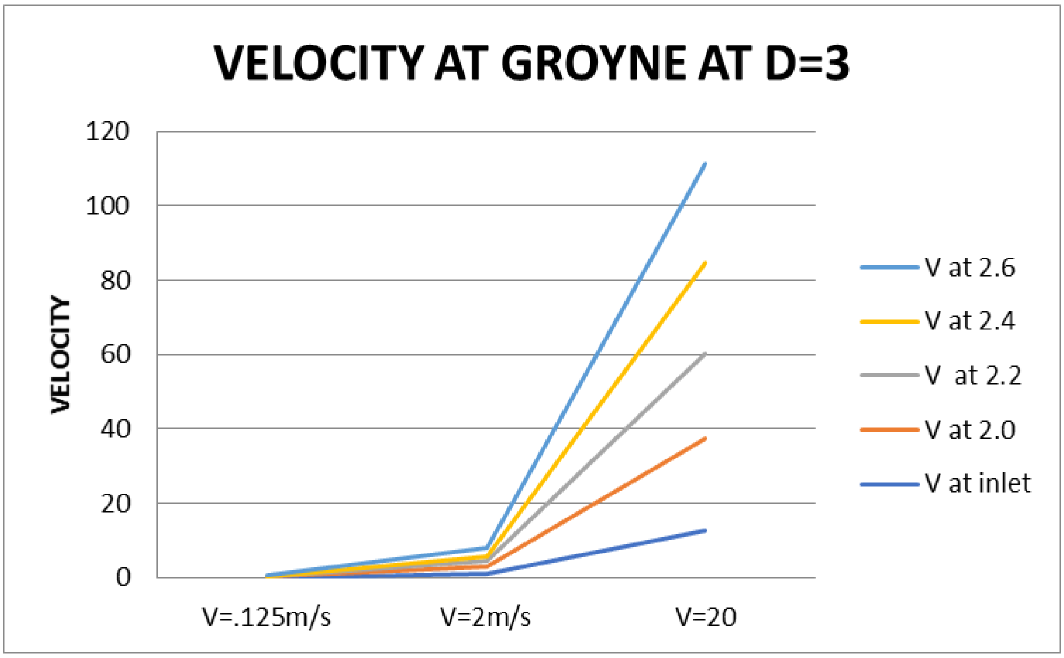
TABLE-2



From the table no.2 we can it is observed that for v=0125 velocity first increases and then decreases b/w the groynes but for v=2m/s and v=20 m/s velocity only increases b/w the groynes.

VELOCITY AT GROYNE AT D=3			
	V=.125m/s	V=2m/s	V=20
V at inlet	0.05375	0.9217	12.505
V at 2.0	0.132	1.974	24.9317
V at 2.2	0.116	1.78	22.83
V at 2.4	0.1169	1.1886	24.365
V at 2.6	0.1312	2.095	26.91

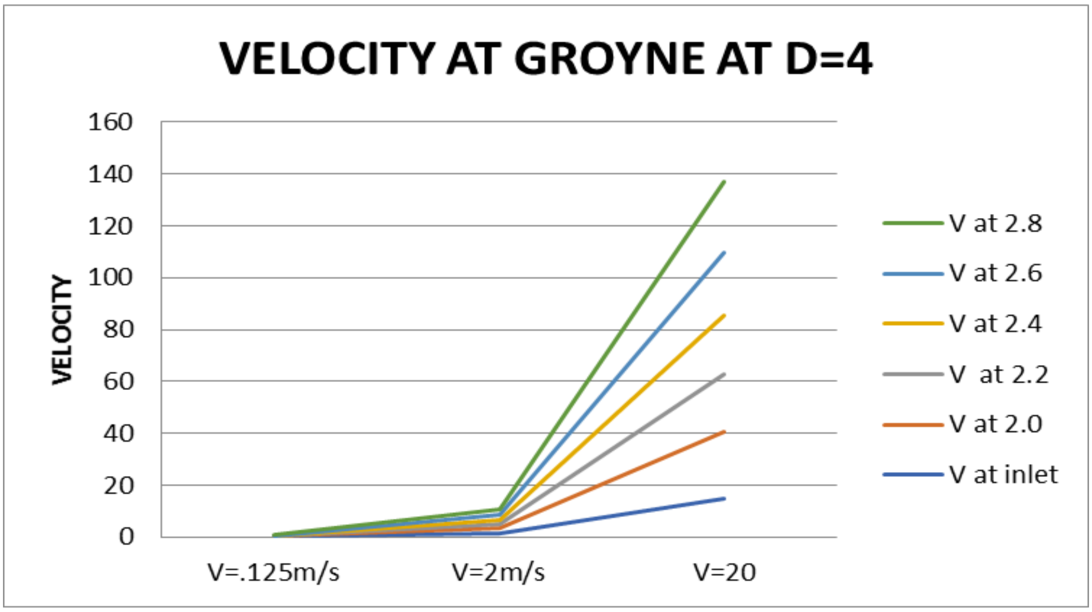
TABLE-3



From table no. 3 we can see that velocity b/w the two serially placed groynes first increases in front of the first groyne and then decreases b/w the groynes and then increases around the second groyne.

VELOCITY AT GROYNE AT D=4			
	V=.125m/s	V=2m/s	V=20
V at inlet	0.0688	1.1458	14.646
V at 2.0	0.13453	2.0503	25.756
V at 2.2	0.118	1.77	22.53
V at 2.4	0.1178	1.797	22.61
V at 2.6	0.1181	1.9225	24.332
V at 2.8	0.133	2.136	26.94

TABLE-4



From table no. 4 we can see that velocity b/w the two serially placed groynes first increases in front of the first groyne and then decreases b/w the groynes and then increases around the second groyne.

SCOPE AND IMPORTANCE

- The analysis is important in the study of flow around impermeable groynes.The above analysis is for impermeable groynes for further improvement in future work the groynes could be made permeable. The analysis will be really helpful in placement of groynes in the rivers for the protection of the banks as optimum spacing is found out in the above analysis with a fair amount of precision. So the work could be helpful in the field problems relating to the flow around the groynes in a river or a channel.

- The analysis has further scope as the problem is a very simple problem related to the flow around groynes in a symmetrical channel. The groynes are straight and impermeable so for future considerations permeability of groynes can be varied and then the efficiency could be compared with those of impermeable groynes.

- Further the angle of the groynes can be varied and then the flow can be analysed for various purposes such as to obtain and compare optimum spacing of groynes with that of straight groynes and it could be discussed which of the groynes would be economical in preventing banks.

CONCLUSION

- When the spacing b/w the groynes is equal to their length then both groynes behave as a single groyne.
- When the spacing b/w the groynes is equal to 3 to 4 times then that spacing results in optimum spacing.

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