Section A-Research paper

Field Application of RCC Jack Jetty For River Training

[1]Rahul Kumar, [2]Md Mustafa, [3]Md Nasir Jamil, [4]Md Rashid, [5]Mohd Irfan, [6]Md. Amir Khan, [7]Parveen Berwal

[1,2,3,4,5]Scholar, Department of Civil Engineering, Galgotias College of Engineering And Technology, Greater Noida, UP-201310,India

[6,7]Professor, Department of Civil Engineering, Galgotias College of Engineering And Technology, Greater Noida, UP-201310,India

Corresponding author: amir.khan@galgotiacollege.edu

ABSTRACT

In general, rivers meander. When the flow is high, a stream that is normally calm might become incredibly raging. Usually, the flow of the river at bends causes Both the inner and outer banks have become worse, while both have eroded. Typically, such river behaviour results in pandemonium.

A range of expensive river training often provides protection for the river banks. As a result, bank protection often only extends to key areas. Simply put Economically, For Indian states, where hundreds of kilometres of stream bankline have been damaged by erosion, the aforementioned circumstance has made traditional river training methods completely untenable. The increased need for bank protection work has brought to light the urgent necessity to build affluent river training solutions like Jack Jetty on a solid scientific foundation to address the twin burning concerns of flood and erosion as well as assist channelization in Indian rivers.

Keywords: Channelization, flood control, Jack Jetty, and River Training Structure are other related terms.

INTRODUCTION

Rivers on alluvial plains exhibit very varied behaviour and are frequently unpredictable to the typical man. A river is frequently seen leaving behind silt on the innermost bank while eroding the outer bank.However, in braided channels, rivers erode the banks and the bed at high stage and With the help of bed bars, dunes, antidunes, and other features, the eroded materials are deposited on the banks or bed at minimal stage, resulting in a variety of pathways inside the flood plain. It may take unexpected turns, tear through embankments, assault villages, and import buildings over flyover bridges. Such river action typically causes destruction. Alluvial rivers are renowned for the amount of silt they carry and for regularly shifting directions. The majority of the rivers in this category are well-known for Floods are the result of rivers overflowing and breaking their banks. Engineers have successfully employed river training to prevent such disasters. In order to preven

the river from harming the land and property next to its bank, to stable the river channel and maintain a certain alignment and cross section, river training activities are required. A river must be trained to defend its banks in order to ensure navigability, avoid excessive meandering, and achieve other goals. A river

training system directs and coerces a stream to accomplish specific goals and defend a specific region. River training activities are evolving. becoming more expensive, resulting in high labour and material costs. Therefore, it is imperative to create some low-cost measures for river conservation.

Jack Jetty

Research on the Jack Jetty, a cost-effective river training tool, has been conducted through experimental testing. H. F. Kellner created the jetty jack in the early 1920s. This sort of bank protection was permeable and cost less to implement than the non-permeable ones that were in use at the time. Three willow poles, linked at the midpoint, were used to create his first jack. He connected the willow poles with wire to keep them stretched. He then substituted steel angles for the willows.

OBJECTIVES & SCOPE

This work is straightforward yet significant. My secondary goal in sharing this history is to act as a resource for organisations, project managers, consultants, government departments, restoration biologists, and anyone else interested in a healthy riverine and riparian ecosystem—end users looking to expand their knowledge of jetty jacks in order to further their own restoration objectives. I want to add to the historical record of the ups and downs of jetty jacks in relation to the periods, introducing the past up to the present. Another goal is to draw attention to certain ongoing restoration initiatives whose outcomes will undoubtedly offer priceless knowledge and information for projects that will undoubtedly follow and require decisions about removing jetty jacks.

A final goal is to show how restoration constraints are affected by different agency missions, but also that combined effort and decision-making, or simply working together, is the best method for achieving both immediate and long-term gains in the dynamic field of restoration ecology management. Due to the fact that jetty fields have not yet been extensively removed, it is unknown how to remove them, as well as the advantages and/or downsides. Since restoration operations frequently take place in stages, with each stage producing results that may stand alone, I would hope that the removal of the jetty jack will soon be added to the pantheon of solved restoration problems. I want to advance that goal by compiling data into a single document.

This report presents a chance to advance information for further investigation and gives motivation to put in the effort to uncover workarounds for a bank protection mechanism that is no longer effective. I have restricted the focus of my study to jetty jacks alone, following the advice of Dr. Cliff Crawford, who has extensive knowledge in the restoration sector. By doing so, I have resisted the need to become mired in the tangle of problems that restoration-related issues provide. I am very appreciative of this guidance.

HISTORY

According to Grassel (2002), H.F. Kellner established the first jack jetty, known as "Kellner Jack. "compared to the non-permeable version of bank protection, which was available in 1920, Type permeable. Kellner started his investigation into a little creek close to his home in Topeka, Kansas. Kellner's first jack was made from three willow poles that were linked at the midway. He wire-laced the willow poles to keep them extended. Later, he altered the steel angles on the poles made of willow. The 4.88 m long, 0.1 m x 0.1 m x 0.006 m steel angles that make up the Jack structural unit of the system are linked at their midpoints. After that RCC Jack Jetty was utilised by Sharma (2012) at the Nakhwa location in the Ganga River.

DEVELOPMENT OF DESIGN AND PARAMETERS

The bed shear stresses were measured along various longitudinal lines behind single and multiple jacks since they directly correspond with a stream's ability to move silt. This was achieved by measuring turbulence at several points while utilising a Micro ADV to track velocity profiles. Using a micro-ADV, velocity profile data for several jetty layouts has been gathered for a micro-level investigation. Both with and without jetties in the flow, speed profiles were taken. There were just modest bed shear stresses recorded. The shear stress plots on the bed with and without jetties demonstrated that shear stress significantly decreased after jetty construction. This significant drop in shear stress clearly denotes a reduction in the channel's capacity to transport silt, which should then cause the flow to dump material in Jack's wake. To look into how the jack differs from the non-jack scenario in terms of the velocity field: As mentioned above, velocity profiles were acquired behind the jack in a grid pattern in order to assess the flow pattern. A considerable drop in velocity could be seen for several jetty layouts when the velocity reduction post-jetty installation was estimated and shown for various sections.

A jetty field is a configuration of varied tie-back and retard-line configurations of jacks for achieving various design goals. Following each experimental run, changes in bed levels (sand deposition) in the jetty field were observed. In the jetty field, berm formations have been created through these studies to maximise the deposition of silt behind the jacks.

METHODOLOGY

When appropriately positioned, a jetty jack field will trap silt and debris during flood events, effectively acting as its own levee to contain the river channel. The river's present regime is followed by a jetty system. The design favours a canal that meanders and has a concave bank. The standard design makes use of backup retard lines, often referred to as tieback lines, and diversion lines, which are variations of a parallel to the bank. They are called diversion lines because they direct the river's flow in a different direction. Depending on the current's attack angle, there may be one to three front lines (or more). There is a risk of damage to individual jacks in the line if the current angle exceeds 45 degrees. The current may be trained to follow the curve at a 20-degree angle. More diversion lines are required for acute angles. One line can effectively deposit silt, but it is susceptible to damage from floods bringing large debris. The diversion lines for the river channel are connected to the bank by the backup retard lines, which are moored at the bank line. Their distance apart varies from 75 feet to 200 feet depending on the angle of attack of the current; the more severe the angle, the closer the distance apart. As the river passes through the diversion lines, they force the river to slow down, which causes silt to settle. This is why they are called "retard lines. When the angle of attack is 20 degrees, the current should cut four lines at least, and when it is 45 degrees, it should cut six lines at least.

Jack Jetty Submeregence Index

The Jetty Field Submergence Index is defined as the proportion of the water depth above the very top of the jack height to the entire water depth, which may be written as ((H-h)/H). Lower Jetty Field values Higher values in the Submergence Index (JFSI) indicate greater submergence whereas lower values indicate greater submergence.

Jack Jetty Density Index

The indicates that the 1950s of the previous century marked the introduction of steel frame jack jetty systems. It is obvious that some initial investigation into the efficacy of modified RCC jack jetties is necessary in order to develop a rational design strategy that would permit their installation as a cost-effective, effective river training device.

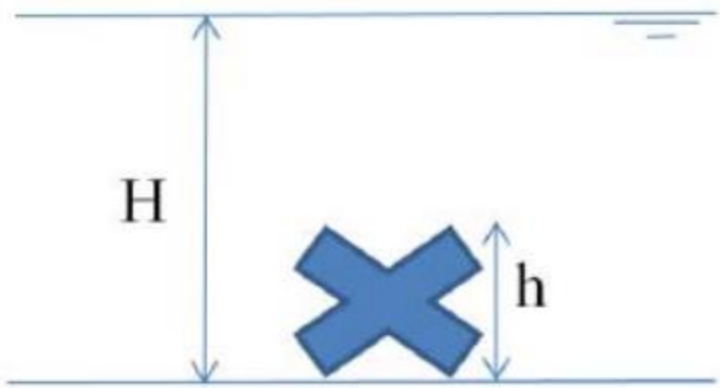

Fig. 1 represents JFSI

The experimental programme of the current study was divided into three phases to study and analyse the impact of jack jetty on the flow domain and relevant fluvial parameters for angle of diversion at 00, 200, and 300, respectively, with low jetty field density index and high jetty field density index.

. Quantification Of Velocity Reduction

The jacks of larger sizes have a more noticeable impact on the flow field than those of smaller sizes, according to the contour plots shown above. It was also indicated that submergence had an impact on the jack's performance, which varied inversely with one another. Additionally, it could be shown that many units of jacks outperform single units of jacks in terms of performance. The contour plots have provided a broad concept and a visual depiction of it. The drop in velocity caused by submerged jacks as compared to the non-jack situation has been attempted to be quantified in the study's current part using percentage terms.

The percent reduction in velocity may be calculated by comparing the velocity with and without jacks at the same locations. This comparison is carried out across a sandy region at a specific depth.The shows' percentage decline is typically 70% but can go as high as 95%.

All of these graphs exhibit the same general trend, with a bigger percentage reduction at the beginning of the plot and a progressive decline in percentage towards the conclusion. It is common knowledge that cross sections up to around 0.8 m downstream of the jack are covered at the beginning of the figure and cross sections beyond that are shown at the conclusion of the plot. In this specific figure, the highest reduction is 95%, and the average reduction is 70% up to 0.8 metres downstream of the jack, after which it drops to 60% and continues to decline.

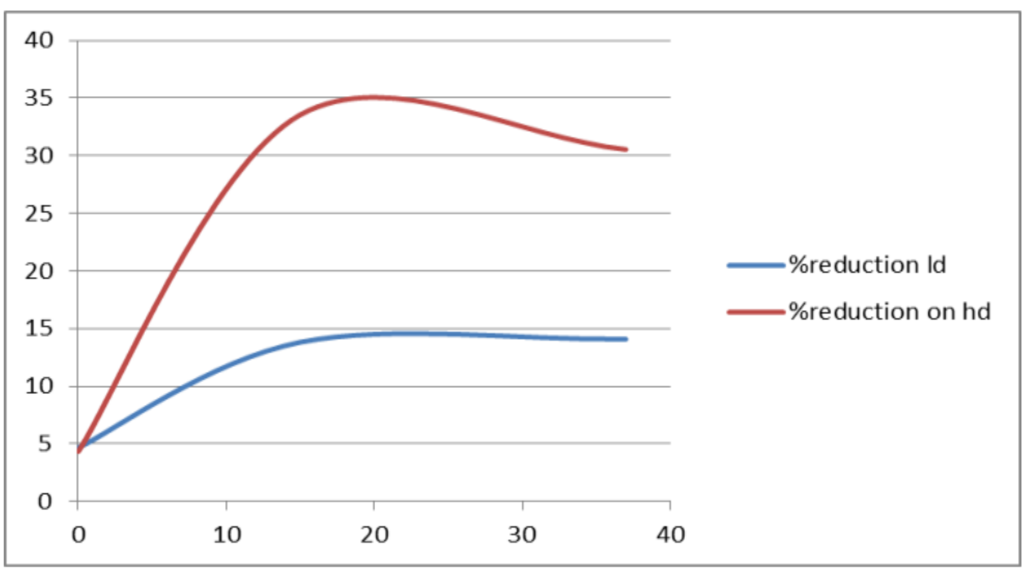

Fig.2 represents the longitudinal distance on the X axis and the percentage reduction on the Y axis, with the values for low density and high density being 1.38 and 3, respectively. 0.06 metres above the bed.

CONCLUSION

As a result of analysing experimental data, it is suggested in this chapter that the presence of submerged jacks significantly reduces flow velocity. This slowing down of the flow depends on a variety of factors, such as the fact that larger jacks cause the flow to slow down more than smaller ones. The early stretch is when the reduction in velocity is most noticeable and increases, and it subsequently tapers down to a minimum further downstream of the jack. A slight effect of submersion was visible. The experiment shows that when the arrangement is for a 20-degree angle of incidence of assault as opposed to a 30-degree angle, the impact is more apparent. The jetty field performed better when the sediment content was higher and the Jetty Field Submergence Index was lower, according to the examination of the bed profile data.

Jetty fields are positioned near one another. Design techniques might be built on a solid scientific basis with threshold values for new suitable design indices and performance measures, such as erosion control, moderate reclaim, and heavy reclaim.
This study develops new design indices and performance criteria that serve as the fundamental building blocks for designing an RCC jetty field with erosion control as the intended design aim.

REFERENCES

Adhy Kurniawan and Mustafa S. Altinakar "Velocity and Turbulence Measurements in a Scour Hole Using An Acoustic Doppler Velocity Profiler," Third International Symposium on Ultrasonic Doppler Methods for Fluid Mechanics and Fluid Engineering EPFL, Lausanne, Switzerland, September 9 – 11 (2002).

Alexander Sukhodolov, Christof Engelhardt, Angela Krüger and Heinz Bungartz. "Case Study: Turbulent Flow and Sediment Distributions in a Groyne Field," Journal of Hydraulic Engineering, ASCE, Vol. 130, No.1, January (2004)

Zende, Aijaz Ahmad, Asif Iqbal A. Momin, Rajesab B. Khadiranaikar, Abdullah H. Alsabhan, Shamshad Alam, Mohammad Amir Khan, and Mohammad Obaid Qamar. "Mechanical Properties of High-Strength Self-Compacting Concrete." *ACS Omega* (2023).

Momin, Asif Iqbal A., Aijaz Ahmad Zende, Rajesab B. Khadiranaikar, Abdullah H. Alsabhan, Shamshad Alam, Mohammad Amir Khan, and Mohammad Obaid Qamar. "Investigating the Flexural Behavior of a Two-Span High-Performance Concrete Beam Using Experimentally Derived Stress Block Parameters." *ACS Omega* (2023).

Verma, Deepak, Parveen Berwal, Mohammad Amir Khan, Raied Saad Alharbi, Faisal M. Alfaisal, and Upaka Rathnayake. "Design for the Prediction of Peak Outflow of Embankment Breaching Due to Overtopping by Regression Technique and Modelling." Water 15, no. 6 (2023): 1224.

Haribabu, A., Raviteja Surakasi, P. Thimothy, Mohammad Amir Khan, Nadeem A. Khan, and Sasan Zahmatkesh. "Study comparing the tribological behavior of propylene glycol and water dispersed with graphene nanopowder." Scientific reports 13, no. 1 (2023): 2382.

Alfaisal, Faisal M., Shamshad Alam, Raied Saad Alharbi, Kiranjeet Kaur, Mohammad Amir Khan, Mohammad Faraz Athar, and Saima Ahmed Rahin. "Application of an Optimization Model for Water Supply Chain Using Storage Reservoir Operation for Efficient Irrigation System." Discrete Dynamics in Nature and Society 2023 (2023).

Warade, Harshal, Khalid Ansari, Kul Bhaskar, Zeba Naaz, Mohammad Amir Khan, Nadeem A. Khan, Sasan Zahmatkesh, and Mostafa Hajiaghaei-Keshteli. "Optimizing the grass bio methanation in lab scale reactor utilizing response surface methodology." *Biofuels* (2023): 1-12.

Aldrees, Ali, Mohd Sayeed Ul Hasan, Abhishek Kumar Rai, Md Nashim Akhtar, Mohammad Amir Khan, Mufti Mohammad Saif, Nehal Ahmad, and Saiful Islam. "On the Precipitation Trends in Global Major Metropolitan Cities under Extreme Climatic Conditions: An Analysis of Shifting Patterns." Water 15, no. 3 (2023): 383.

Hasan, Mohd Sayeed Ul, Mufti Mohammad Saif, Nehal Ahmad, Abhishek Kumar Rai, Mohammad Amir Khan, Ali Aldrees, Wahaj Ahmad Khan, Mustafa KA Mohammed, and Zaher Mundher Yaseen. "Spatiotemporal Analysis of Future Trends in Terrestrial Water Storage Anomalies at Different Climatic Zones of India Using GRACE/GRACE-FO." *Sustainability* 15, no. 2 (2023): 1572.

Santhosh, N., B. A. Praveena, Reema Jain, Mohd Abul Hasan, Saiful Islam, Mohammad Amir Khan, Abdul Razak, and Md Daniyal. "Analysis of friction and wear of aluminium AA 5083/WC composites for building applications using advanced machine learning models." *Ain Shams Engineering Journal* (2022): 102090.

Alharbi, Raied Saad, Shaminee Nath, O. Mohammed Faizan, Mohd Sayeed Ul Hasan, Shamshad Alam, Mohammad Amir Khan, Sayantan Bakshi, Mehebub Sahana, and Mufti Mohammad Saif. "Assessment of Drought vulnerability through an integrated approach using AHP and Geoinformatics in the Kangsabati River Basin." *Journal of King Saud University-Science* 34, no. 8 (2022): 102332.

Gupta, Tripti, Khalid Ansari, Dilip Lataye, Mahendra Kadu, Mohammad Amir Khan, Nabisab Mujawar Mubarak, Rishav Garg, and Rama Rao Karri. "Adsorption of Indigo Carmine Dye by Acacia nilotica sawdust activated carbon in fixed bed column." Scientific Reports 12, no. 1 (2022): 15522.

Khan, Mohammad Amir, Nayan Sharma, Giuseppe Francesco Cesare Lama, Murtaza Hasan, Rishav Garg, Gianluigi Busico, and Raied Saad Alharbi. "Three-Dimensional Hole Size (3DHS) approach for water flow turbulence analysis over emerging sand bars: Flume-scale experiments." *Water* 14, no. 12 (2022): 1889.

Pandey, Manish, Jaan H. Pu, Hanif Pourshahbaz, and Mohammad Amir Khan. "Reduction of scour around circular piers using collars." *Journal of Flood Risk Management* 15, no. 3 (2022): e12812.

Section A-Research paper

Hasan, Mohd Sayeed Ul, Abhishek Kumar Rai, Zeesam Ahmad, Faisal M. Alfaisal, Mohammad Amir Khan, Shamshad Alam, and Mehebub Sahana. "Hydrometeorological consequences on the water balance in the ganga river system under changing climatic conditions using land surface model." Journal of King Saud University-Science 34, no. 5 (2022): 102065.

Deb, Plaban, Barnali Debnath, Murtaza Hasan, Ali S. Alqarni, Abdulaziz Alaskar, Abdullah H. Alsabhan, Mohammad Amir Khan, Shamshad Alam, and Khalid S. Hashim. "Development of eco-friendly concrete mix using recycled aggregates: Structural performance and pore feature study using image analysis." Materials 15, no. 8 (2022): 2953.

Kumar, Arun, Parveen Berwal, Abdullah I. Al-Mansour, Mohammad Amir Khan, Shamshad Alam, Seongkwan Mark Lee, Akash Malik, and Amjad Iqbal. "Impact of Crumb Rubber Concentration and Plastic Coated Aggregates on the Rheological Performance of Modified Bitumen Asphalt." *Sustainability* 14, no. 7 (2022): 3907.

Qamar, Mohd Obaid, Izharul Haq Farooqi, Faris M. Munshi, Abdullah H. Alsabhan, Mohab Amin Kamal, Mohd Amir Khan, and Aisha Saleh Alwadai. "Performance of full-scale slaughterhouse effluent treatment plant (SETP)." Journal of King Saud University-Science 34, no. 3 (2022): 101891.

Khan, Mohammad Amir, Nayan Sharma, Jaan H. Pu, Faisal M. Alfaisal, Shamshad Alam, Rishav Garg, and Mohammad Obaid Qamar. "Mid-Channel Braid-Bar-Induced Turbulent Bursts: Analysis Using Octant Events Approach." Water 14, no. 3 (2022): 450.

Hasan, Murtaza, Mehboob Anwer Khan, Abdullah H. Alsabhan, Abdullah A. Almajid, Shamshad Alam, Mohammad Amir Khan, Tinku Biswas, and Jaan Pu. "Geotechnical Behaviour of Fly Ash–Bentonite Used in Layers." Applied Sciences 12, no. 3 (2022): 1421.

Khan, Md Amir, Nayan Sharma, Jaan Pu, Faisal M. Alfaisal, Shamshad Alam, and Wahaj Ahmad Khan. "Analysis of Turbulent Flow Structure with Its Fluvial Processes around Mid-Channel Bar." Sustainability 14, no. 1 (2021): 392.

Khan, Md Amir, Nayan Sharma, and Jacob Odgaard. "Experimental and Numerical Studies of Velocity and Turbulence Intensities for Mid-Channel Bar." Water Resources 48 (2021): 746-762.

Khan, Mohammad Amir, Nayan Sharma, Jaan Pu, Mohammad Aamir, and Manish Pandey. "Two-dimensional turbulent burst examination and angle ratio utilization to detect scouring/sedimentation around mid-channel bar." Acta Geophysica 69, no. 4 (2021): 1335-1348.

Khan, Md Amir, Nayan Sharma, Jaan H. Pu, Manish Pandey, and Hazi Azamathulla. "Experimental observation of turbulent structure at region surrounding the mid-channel braid bar." Marine Georesources & Geotechnology 40, no. 4 (2022): 448-461.

Pandey, Manish, Mohammad Zakwan, Mohammad Amir Khan, and Swati Bhave. "Development of scour around a circular pier and its modelling using genetic algorithm." Water Supply 20, no. 8 (2020): 3358-3367.

Amir Khan, Md, Nayan Sharma, Manish Pandey, and Obaid Qamar. "Turbulent characteristics of flow in the vicinity of mid-channel braid bar." *Canadian Journal of Civil Engineering* 48, no. 7 (2021): 879-887.

Amir Khan, Md, and Nayan Sharma. "Study of bursting events and effect of hole-size on turbulent bursts triggered by the fluid and mid-channel bar interaction." Water Supply 20, no. 6 (2020): 2428-2439.

Khan, Mohd Amir, and Nayan Sharma. "Investigation of coherent flow turbulence in the proximity of mid-channel bar." KSCE Journal of Civil Engineering 23 (2019): 5098-5108.

Pandey, Manish, Wei Haur Lam, Yonggang Cui, Mohammad Amir Khan, Umesh Kumar Singh, and Zulfequar Ahmad. "Scour around spur dike in sand–gravel mixture bed." Water 11, no. 7 (2019): 1417.

Khan, Md Amir, and Nayan Sharma. "Turbulence study around bar in a braided river model." Water Resources 46 (2019): 353-366.

Khan, Md Amir, and Nayan Sharma. "Study of depth-wise profiles of velocity and turbulence parameters in the proximity of mid-channel bar." ISH Journal of Hydraulic Engineering 27, no. sup1 (2021): 1-10.

Khan, Md Amir, and Nayan Sharma. "Analysis of turbulent flow characteristics around bar using the conditional bursting technique for varying discharge conditions." KSCE Journal of Civil Engineering 22, no. 7 (2018): 2315-2324.

Khan, Md Amir, and Nayan Sharma. "Study of turbulent characteristics of flow around island in a braided river model using quadrant technique." ISH Journal of Hydraulic Engineering 24, no. 1 (2018): 1-8.

Khan, Md Amir, Nayan Sharma, and Gopal Das Singhal. "Experimental study on bursting events around a bar in physical model of a braided channel." *ISH Journal of Hydraulic Engineering* 23, no. 1 (2017): 63-70.

Ali Reza Keshavarzi, Ali Naghi Ziaei, Emdad Homayoun and Amin Shirvani "Fractal-Markovian scaling of turbulent bursting process in open channel flow," Chaos, Solitons and Fractals, Vol. 25, pp.307–318. (2005) http://dx.doi.org/10.1016/j.chaos.2004.12.006

Ali Talaat, Karima Attia, Gamal Elsaeed and Mohammad Ibraheem "Implementation of Spur Dikes to Reduce Bank Erosion of Temporary Diversion Channels During Barrages Construction," Australian Journal of Basic and Applied Sciences, 3(4):, pp. 3190-3205. .(2009)

A. Jacob Odgaard "River Training and Sediment Management With Submerged Vanes" (2009)

Miglio, R. Gaudio, F. Calomino, "Mobile-bed aggradation and degradation in a narrow flume: Laboratory experiments and numerical simulations" Journal of Hydro-environment Research 3, pp. 9-19(2009). http://dx.doi.org/10.1016/j.jher.2009.01.005.

Parveen Berwal , Rajesh Goel "To Study the Influence of Marble Waste on Strength Properties of Concrete" International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, Issue 1, January 2017.

Baosheng Wu M.ASCE, Guangqian Wang, Jiming Ma and Ren Zhang. "Case Study: River Training and Its Effects on Fluvial Processes in the Lower Yellow River, China," Journal of Hydraulic Engineering, ASCE, February, pp. 85-96 (2005)

Bureau of Reclamation, U.S. Department of the Interior,. Division of Research, H.M. Martin, A. J. Peterka, E. J. Carlson and R. A. Dodge "Control of Alluvial Rivers by Steel Jetties", Hydraulics Branch Report No. Hyd. 503, (1962).

Parveen Berwal, Sandeep Dalaal "Study the Strength Characteristics of Concrete using Waste Material" International Journal of Engineering, Applied and Management Sciences Paradigms, Vol. 39, Issue 01, Publishing Month: September 2016 , An Indexed and Referred Journal ISSN (Online): 2320-6608

B. Ghorbani and J.A. Kells. "Effect of submerged vanes on the scour occurring at a cylindrical pier" Journal of Hydraulic Research, Vol. 46, No. 5, pp. 610–619(2008) http://dx.doi.org/10.3826/jhr.2008.3003 International Conference on Agricultural, Environmental and Biological Sciences (AEBS-2014) April 24-25, 2014

Gupta, U.P.2003. Study on performance of submerged vanes with collar, Ph.D. Thesis, Indian Institute of Technology Roorkee, India Gupta, U.P. et al.2006. Dike formation with submerged vane, International Journal of Sediment Research, Vol.21, No3, 2006, pp.200-208

Nayak, Anupama ,2012. Experimental Study of Jack Jetty Systems for River Training, Ph.D. Thesis, Indian Institute of Technology, Roorkee India.

Odgaard, A.J. and Spoljaric, A.1986. Sediment control by submerged vanes. Journal of the Hydro.Engg., ASCE, 112(12), 1164- 1181.

Parveen Berwal, Arun Kumar et al. "A Comparative Study of Micro Silica Based Concrete Mix Design Using IS & DOE Method" Lectures notes in Civil Engineering. September 2022. pp 821-29.

Verma, D.; Berwal, P.; Khan, M.A.; Alharbi, R.S.; Alfaisal, F.M.; Rathnayake, U. Design for the Prediction of Peak Outflow of Embankment Breaching due to Overtopping by Regression Technique and Modelling. Water 2023, 15, 1224. https://doi.org/10.3390/w15061224

Odgaard, A.J. and Yallin W., 1991. Sediment management with submerged vanes. Journal of the Hydro.Engg., ASCE, 112(12), 1164- 1181.

Parveen Berwal, Arun Kumar et al. "Impact of Crumb Rubber Concentration and Plastic-Coated Aggregates on the Rheological Performances of Modified Bitumen Asphalt" March 2022, Sustainability 14(7). DOI: 10.3390/su14073907.

Isha Verma, Parveen Berwal, Saraswati Setia, Rajesh Goel, "Analysis on the Behaviour of Stiffened and Unstiffened Steel Plate Shear Walls with Enhanced Performance" International Symposium on Fusion of Science and Technology (ISFT 2020), IOP Conf. Series: Materials Science and Engineering 804 (2020) 012035, IOP Publishing doi:10.1088/1757 899X/804/1/012035.

Parveen Berwal, Praveen Aggarwal, Rajesh Goel, "Utilization of Recycled Aggregate in Wet Mix Macadam" International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-9 Issue-1, November 2019.