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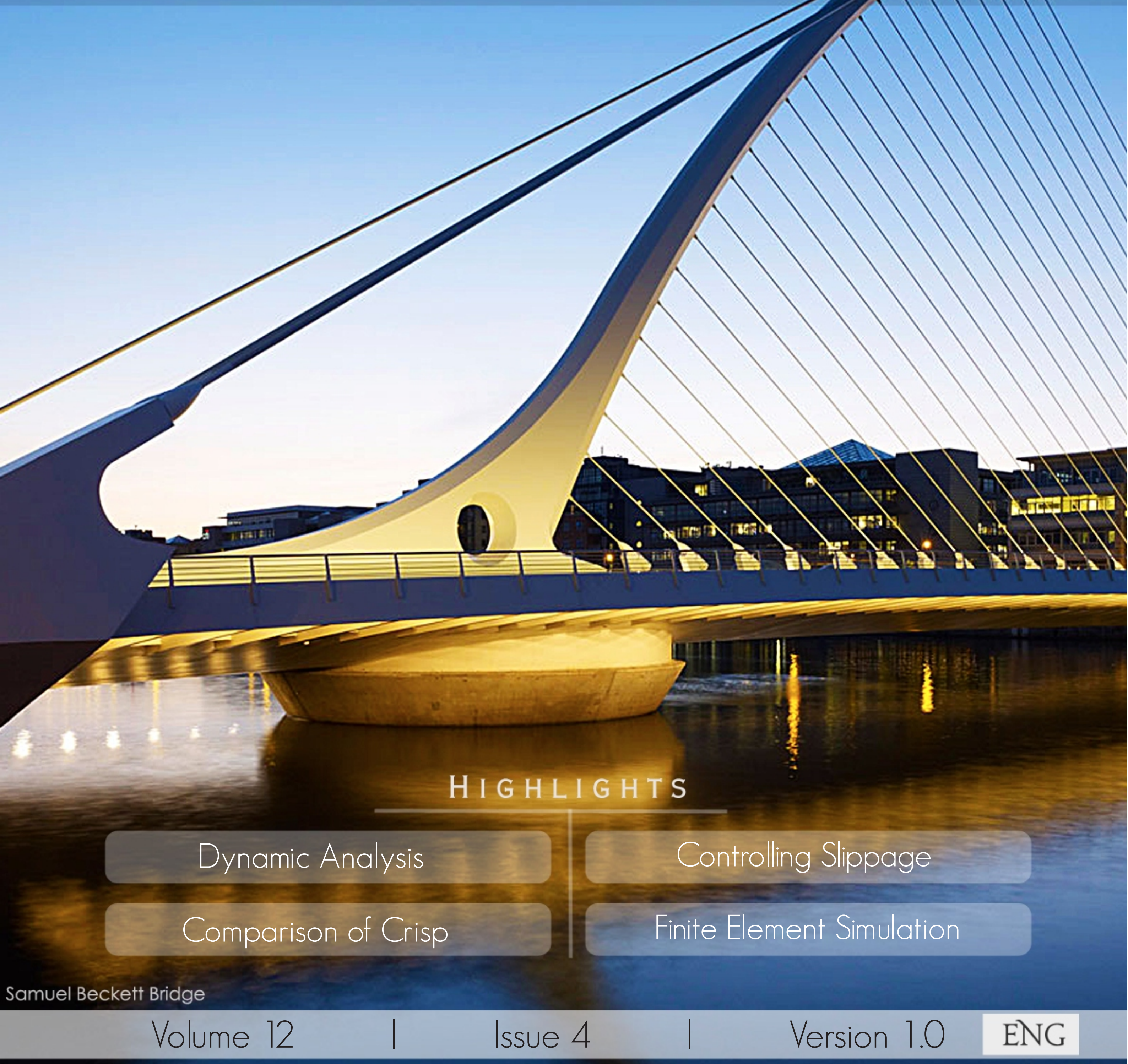

Highlights

- Dynamic Analysis
- Controlling Slippage
- Comparison of Crisp
- Finite Element Simulation

Samuel Beckett Bridge

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Finite Element Simulation of the Reverse Bending and Straightening of Steel Bars Used For Civil Engineering Applications

By Kazeem K, Adewole
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Keywords : steel bars, FE simulation, Reverse bending and straightening test, Static roller, Tensile armour wire.

I. Introduction

Carbon steel bars are steel elements/materials with sizes from 10mm to 32mm [1]. They are used as pre-stressing steel bars and as flexible pipe tensile armour bars which provides longitudinal and hoop (circumferential) tensile stress resistances for flexible pipes used for offshore oil and gas transportation. Carbon steel bars are subjected to routine reverse bending and straightening test which involves bending the bars over a rotating left hand roller, reverse bending the bars over the middle roller and finally straightening of the bars over the right hand roller as shown in Figure 1 to detect laminations in bars. Laminations (particularly the type that may be present in carbon steel bars used for civil engineering application) are line type defects or long cracks which are normally invisible at the surface, are generally parallel to the rolling or drawing direction and are usually revealed through reverse bending of the bars [2]. Crack-like laminations (longitudinal cracks) have been found to be instrumental to the fractures of the pre-stressing wires (carbon steel elements/materials smaller than bars with sizes from 2.5mm to 8mm) of ruptured pre-stressed concrete pipe [3].

Most of the published literature on bending and reverse bending of metal products such as the work of [4-7], among others, relates to the processing of sheet metal during sheet metal forming operations. The few literature that deals with the bending and reverse bending of wires includes the experimental work conducted by [8] on reverse bending for descaling of wire rods and the experimental and FE simulation works conducted by [9, 10] on the effect of excessive bending, which Aluminium Conductor Composite Core (ACCC) experiences due to the reeling of the wires on mandrels on the axial compressive stress and the residual tensile strength of the wires. To date, neither the FE simulation of the reverse bending, nor the FE simulation of the reverse bending and straightening of carbon steel bars used for civil engineering application has been published.

Burks et al [9, 10] conducted a FE simulation of the bending of the ACCC wire round a mandrel by

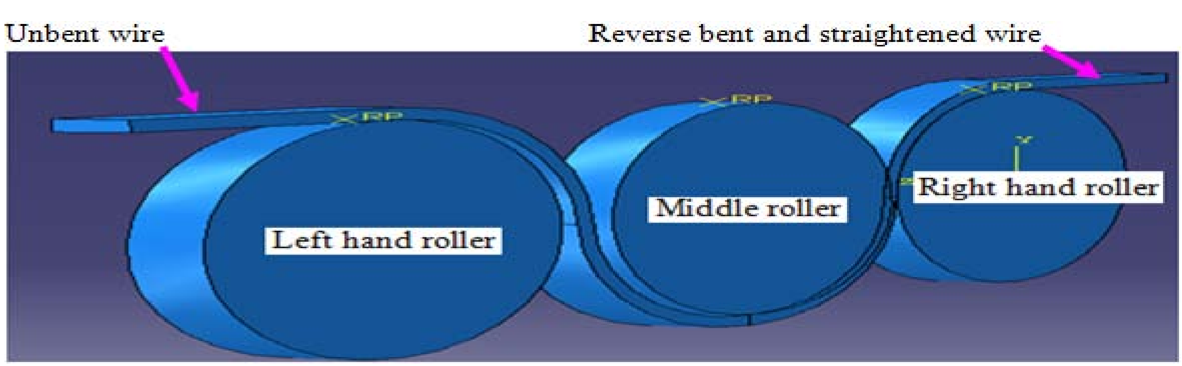

Figure 1 : Industrial reverse bending equipment with three rollers

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pinning the nodes on the end of the ACCC wire that are in contact with a static mandrel at the beginning of the simulation and applied a concentrated load to the free end of the wire to bend the wire round the mandrel. Although this methodology may produce the desired bending effects in the wire, it does not simulate the actual bending process in practice. In practice, the mandrel is rotated and the wire is bent and wrapped round the rotating mandrel. Also this modelling approach of bending the wire round a static mandrel instead of the rotating mandrel bending the wire round it could not be used to simulate the reverse bending of wires over the second roller without having to unwind the bent wire from the first roller, thereby introducing the unwinding process which is not part of the reverse bending process in practice. Consequently, this modelling approach could not be used to simulate the reverse bending and straightening of bars used for civil engineering applications.

This paper presents three dimensional FE simulation of the reverse bending and straightening of steel bars used for civil engineering application which was conducted as a part of the research to numerically predict the effects of the combination of reverse bending and straightening process and defects such as laminations and scratches on the tensile properties of the bars. Numerical prediction methodology was employed in the research because it was not possible to machine the longitudinal line-type or crack-like laminations that are parallel to the bar's length (rolling direction) and cut across the width of the wire experimentally. The reverse bent and straightened (RBS) specimen and the unbent bar specimen were subjected to a tensile testing simulation to determine the effect of the reverse bending and straightening process on the bar in terms of the force-displacement response. The force-displacement curves from the FE simulation of the tensile testing of the RBS and unbent bar specimens were then validated with the force-displacement curves from the laboratory tensile testing of unbent and experimentally RBS bar specimens. The FE simulation was conducted using the combined hardening plasticity models combined with the phenomenological shear failure model in-built in the Abaqus v 6.9.3 material library which has been identified by [11] as an appropriate fracture model for the prediction of the fracture behaviour of the bar considered in this work. The calibrated shear damage and fracture modelling parameters used for the FE simulations are fracture strain of 0.3451, Shear stress ratio of 12.5, Strain rate of $0.000125s^{-1}$ and a material parameter Ks of 0.3. Interested readers are referred to Adewole, et al [11] for the details of the shear damage and fracture model and the phenomenological fitting procedure employed to obtain the calibrated shear failure modelling parameter values. The details of the combined hardening plasticity model are presented in section 1.1.

a) Combined Hardening Plasticity Model

The combined hardening plasticity model used for this simulation is a combination of the nonlinear kinematic and isotropic hardening models. The isotropic cyclic hardening component is based on the exponential law given in equation (1) obtained from [12]. The kinematic hardening component is based on the evolution of the backstress (a nonlinear evolution of the centre of the yield surface) $\dot{\alpha}$ given in equation (2) obtained from [12].

$$\sigma^0 = Y_i + Q_\infty (1 - e^{-b\varepsilon^{pl}}) \quad (1)$$

$$\dot{\alpha} = C\frac{1}{\sigma^0}(\sigma - \alpha)\bar{\varepsilon}^{pl} - \gamma\alpha\bar{\varepsilon}^{pl} \quad (2)$$

Here σ^0 is the size or magnitude of the yield surface (the limit of the elastic range), Y_i is the initial yield stress, Q_∞ is the maximum stress increase in the elastic range, ε^{pl} is the plastic strain, and b is a material parameter that defines the rate at which the maximum size is reached as plastic straining develops. α is the overall backstress, C and γ are kinematic hardening parameters, which are material parameters that define the initial hardening modulus and the rate at which the hardening modulus decreases with increasing plastic strain respectively [12].

II. Experimental And Fe Analysis Procedures

The details of the experimental and FE simulations are presented in this section.

a) Laboratory Reverse Bending, Straightening and Tensile Testing of Bars

The reverse bending, straightening and tensile testing of RBS bar specimen was simulated experimentally in the laboratory by winding a length of the flat bar with 12mmx5mm cross-sectional dimension round a 100mm roller as shown in Figure 2. The bent bar length was then reverse bent in the opposite direction over the same 100mm roller. The reverse bent bar length was finally straightened and cut into tensile test specimens. The RBS specimen and the unbent specimen were then subjected to tensile testing using an Instron universal testing machine (IX 4505) fitted with an Instron 2518 series load cell with a maximum static capacity of ±100 kN. The displacement was measured using an Instron 2630-112 clip-on strain gauge extensometer with a 50 mm gauge length.

Figure 2 : Experimental simulation of reverse bending of tensile armour bar

b) Reverse Bending and Straightening Simulation procedures

The FE simulation of the bending, reverse bending, straightening and tensile testing of the flat bar was conducted in four simulation steps. Figure 3 shows the arrangement used for the simulation which consists of a 305mm long tensile armour bar strip between the left roller (Roller 1) and the right roller (Roller 2), and a guide plate. The guide plate was introduced to prevent Roller 2 from lifting vertically upward during the bending simulation. The 305mm long bar consist of a 50mm long central tensile testing specimen and two 127.5mm long left and right attachments. The attachments were introduced to prevent localised deformation of the ends of the tensile testing specimen, which occurred when the specimen was bonded to the rollers directly. The whole model was meshed with C3D8R elements (8-node hexahedral linear brick reduced integration elements with hourglass control). The rollers and the guide plate were meshed with 3mmx3mmx3mm elements while the attachments and the specimen were meshed with elements having 3mmx3mmx0.5mm and 3mmx1mmx0.5mm dimensions respectively. The 1mm dimension is along the specimen length and the 0.5mm dimension is along the specimen thickness, which translates to 10 elements along the bar thickness. The specimen was meshed with the finest mesh in order to obtain accurate results as the tensile testing simulation was carried out on the 50mm long specimen alone. The rollers, the guide plate and the attachments (which were only introduced to prevent localised deformation of the ends of the specimen) were meshed with a coarse mesh to reduce the output file size and computation time.

The bending simulation was conducted by rotating Roller 1 in an anticlockwise direction to wind the bar round Roller 1. The reverse bending simulation was conducted by rotating Roller 1 in a clockwise direction to unwind the bar whilst simultaneously rotating Roller 2 in an anticlockwise direction to reverse bend and wind the bar round Roller 2. The straightening simulation was conducted by rotating Roller 2 in a clockwise direction to unwind the tensile armour bar and pulling Roller 1 longitudinally and vertically simultaneously, until the attachments and test specimen were straightened.

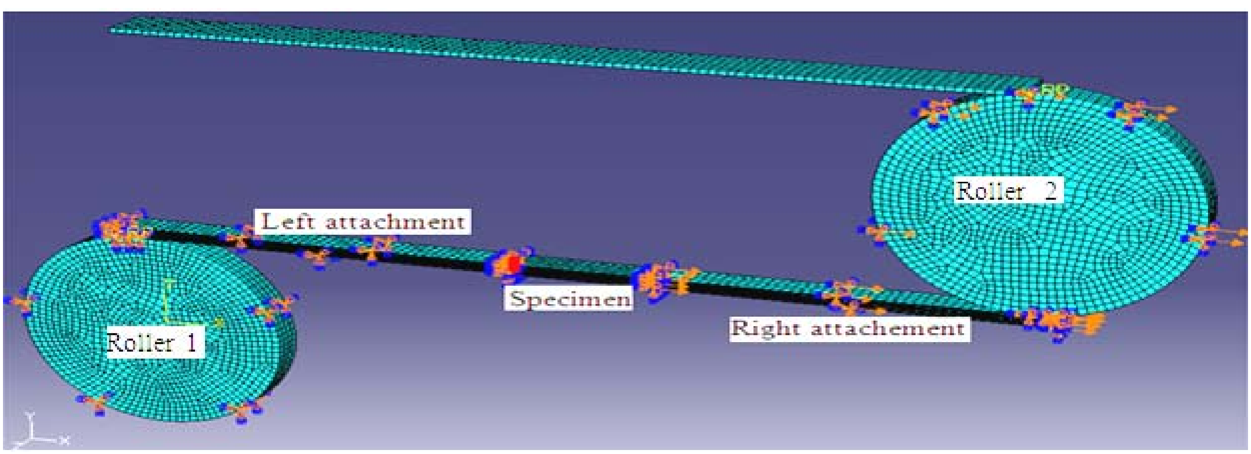

Figure 3 : Assembly of specimen, attachments, rollers and guide plate showing the boundary condition during tensile testing simulation.

c) Tensile Testing Simulation Procedures

The simulation of the tensile testing of the RBS bar specimen model was conducted on the model of the bar specimen within the rollers-attachments-specimen assembly. In order to establish the appropriate boundary conditions to be used for the simulation of the tensile testing of the RBS bar specimen within the rollers-attachments-specimen assembly, tensile testing simulations were conducted on the model of an unbent bar within the rollers-attachments-specimen assembly. The left hand end of the specimen, the left roller and the left attachment were fixed, while the right hand end of the specimen, the right roller and the right attachment, which were free to move only in the tensile load direction were subjected to a longitudinal axial tensile displacement in the tensile load direction. The results in terms of the force-displacement response and the fractured shape were then compared with the result of the tensile testing simulation conducted on an unbent bar specimen alone. The left hand end of the specimen alone was fixed, whiles the right hand end of the specimen alone, which was free to move only in the tensile load direction, was subjected to a longitudinal axial tensile displacement in the tensile load direction as shown in Figure 4. A good agreement between the results of the tensile testing simulation conducted with the unbent bar specimen within the rollers-attachments-specimen assembly and the unbent bar specimen alone was then established as presented later in sections 3.2 and 4. The same simulation boundary conditions applied to the tensile testing of the unbent bar specimen within the rollers-attachments-specimen assembly was then applied to the tensile testing simulation of the RBS bar specimens within the rollers-attachments-specimen assembly.

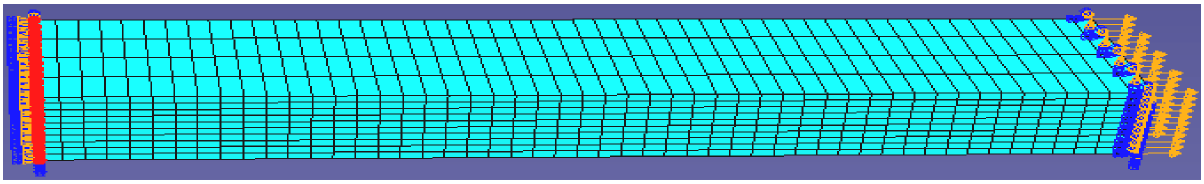

Figure 4 : Boundary condition during the simulation of the tensile testing simulation of the unbent bar specimen.

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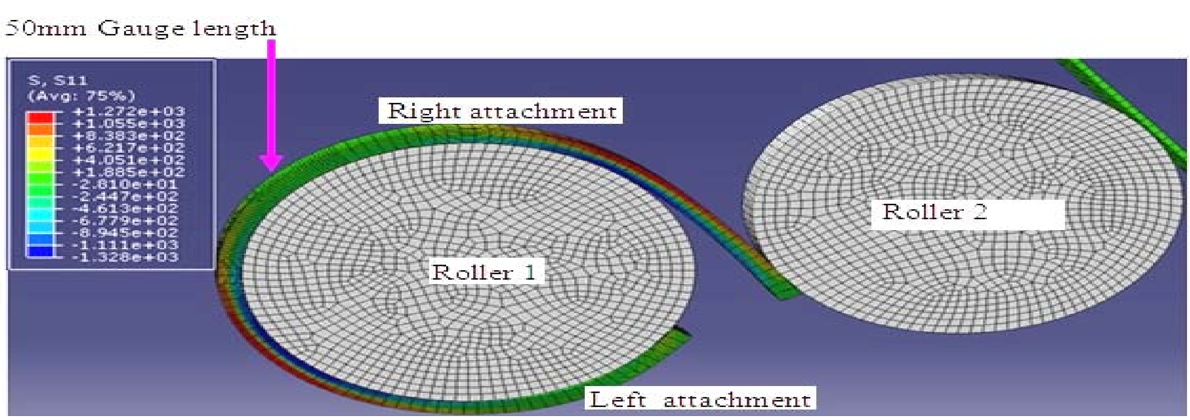
III. Results

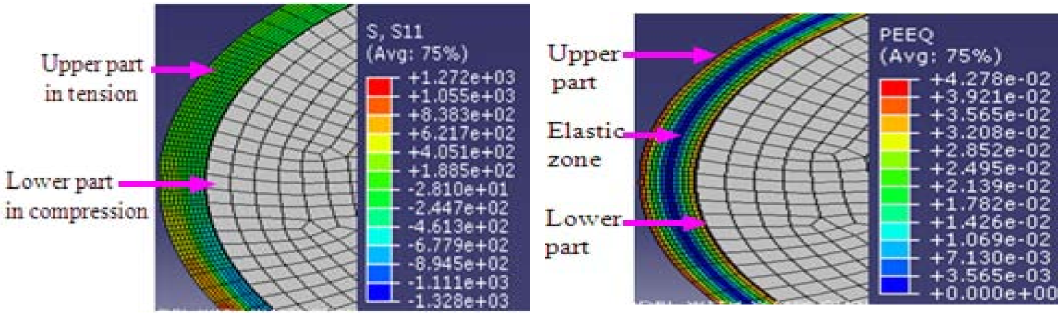
The results in terms of the deformed shapes showing the stress and strain distributions at the various stages of the bending, reverse bending, straightening and tensile testing process simulations are presented in this section. All the force-displacement curves in this paper are normalised with experimental ultimate load and displacement at fracture.

a) Bending, Reverse bending and straightening simulation results

The deformed shape of the entire 305mm long bar strip showing the longitudinal axial stress (designated as S11 in the contour plot) distribution in the bar and the position of the 50mm gauge length tensile test specimen after the bending simulation, during the reverse bending simulation, after the reverse bending simulation and after the straightening process simulations are shown in Figures 5(a), 6(a), 7(a) and 8(a) respectively. The through thickness longitudinal axial stress distribution in the tensile test specimen after the bending, reverse bending and straightening processes simulations is shown in Figures 5(b), 7(b) and 8(b) respectively. Positive axial stresses in the S_{11}contour plot represent tensile axial stresses, while negative axial stresses represent compressive axial stresses. The highest tensile stress is indicated at the top of the contour plot with the deepest red colour while the highest compressive stress is indicated at the bottom of the contour plot with the deepest blue colour. The through thickness equivalent plastic strain (designated as PEEQ in the contour plot) distribution in the tensile test specimen after the bending, reverse bending and straightening process simulations are shown in Figures 5(c), 7(c) and 8(c) respectively.



(a) Deformed shape showing longitudinal axial stress distribution



b) Specimen longitudinal axial stress distribution (c) Equivalent plastic strain

Figure 5 : Deformed shape showing longitudinal axial stress (MPa) and equivalent plastic strain distributions in bar after bending process simulation.

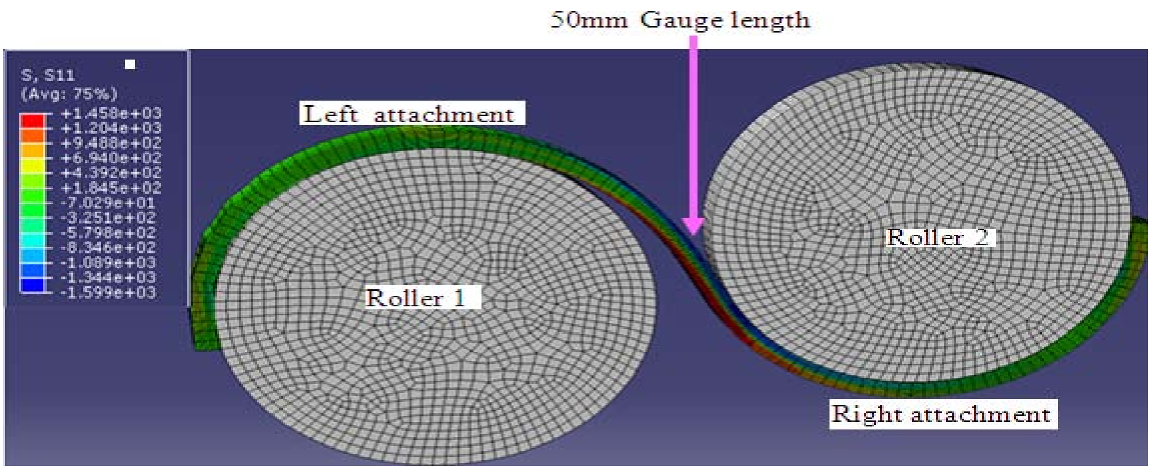
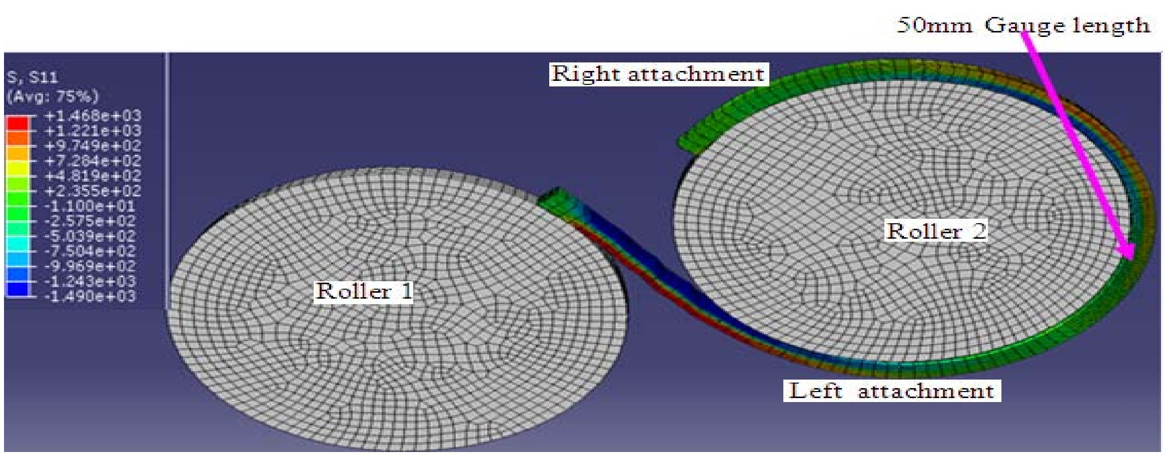


Figure 6 : Deformed shape showing longitudinal axial stress (MPa) distribution in specimen during reverse bending process simulation.



(a) Deformed shape and longitudinal axial stress distribution in whole bar length

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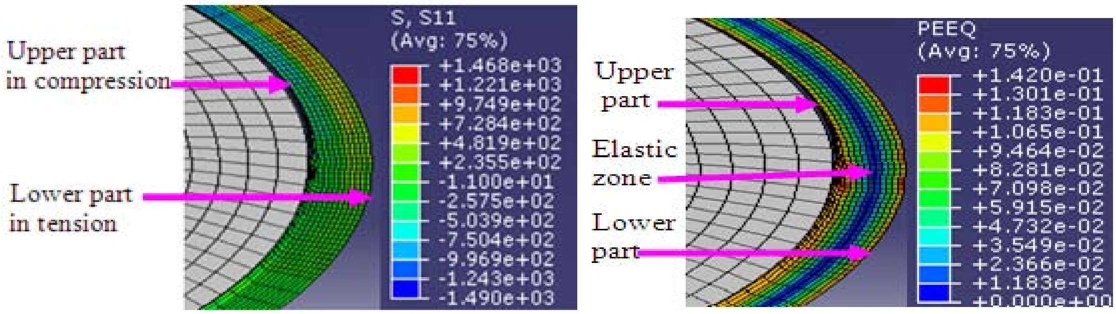
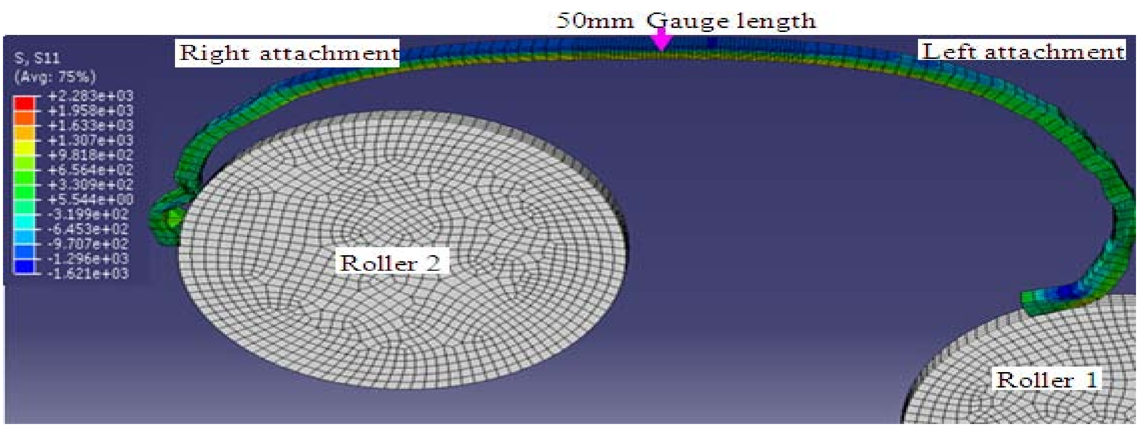
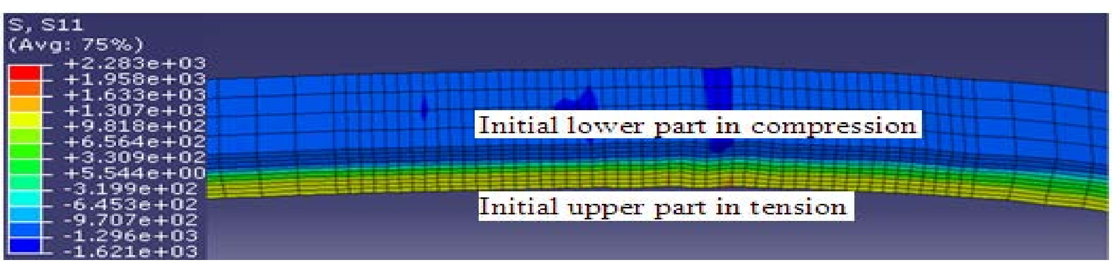


(b) Longitudinal axial stress distribution (c) Equivalent plastic strain distribution

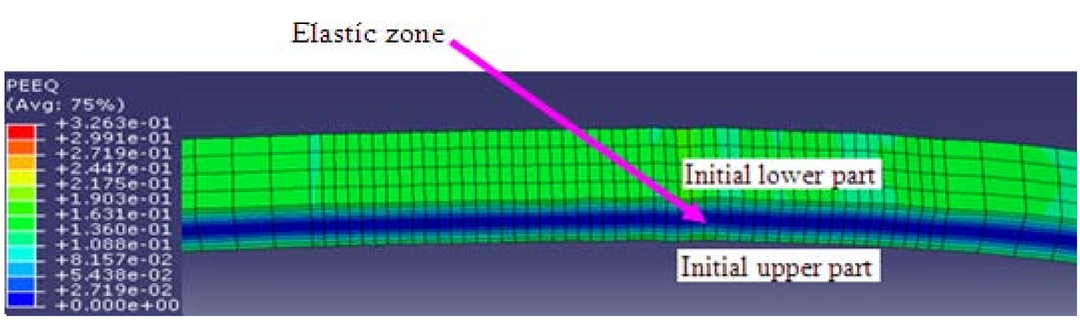
Figure 7 : Deformed shape showing longitudinal axial stress (MPa) and equivalent plastic strain distributions in bar after reverse bending process simulation.



(a) Deformed shape and stress distribution in whole bar length



(b) Longitudinal axial (MPa) stress distribution



(c) Equivalent plastic strain distribution

Figure 8 : Deformed shape showing longitudinal axial stress (MPa) and equivalent plastic strain distributions in bar after straightening process simulation.

b) Tensile testing simulation results

The fracture shapes predicted by the simulations conducted with the unbent bar specimen within the rollers-attachments-specimen assembly and with the unbent bar specimen alone are shown in Figures 9 and 10 respectively. The deformed shape of the entire 305mm long bar showing the longitudinal axial stress distribution in the bar and the fractured RBS tensile test specimen within the rollers-attachments-specimen assembly after the tensile testing simulation is shown in Figure 11. The fractured shape of the numerically simulated RBS specimen subjected to tensile testing simulation is shown in Figure 12(a) and the fractured experimentally RBS tensile specimen subjected to laboratory tensile testing is shown in Figure 12(b).

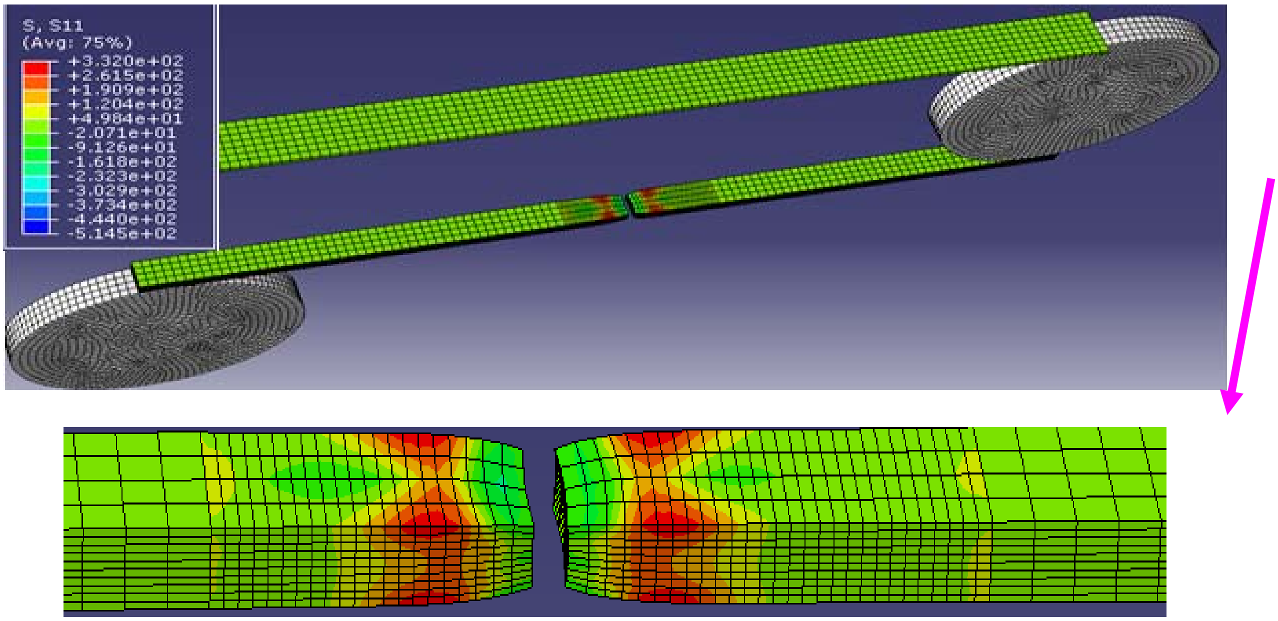


Figure 9 : Fractured unbent specimen from simulation conducted with bar specimen within the rollers-attachments-specimen assembly.

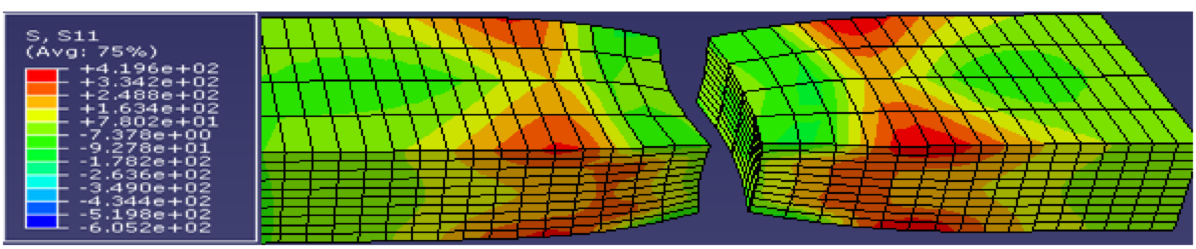


Figure 10 : Fractured unbent specimen from simulation conducted with bar specimen alone.

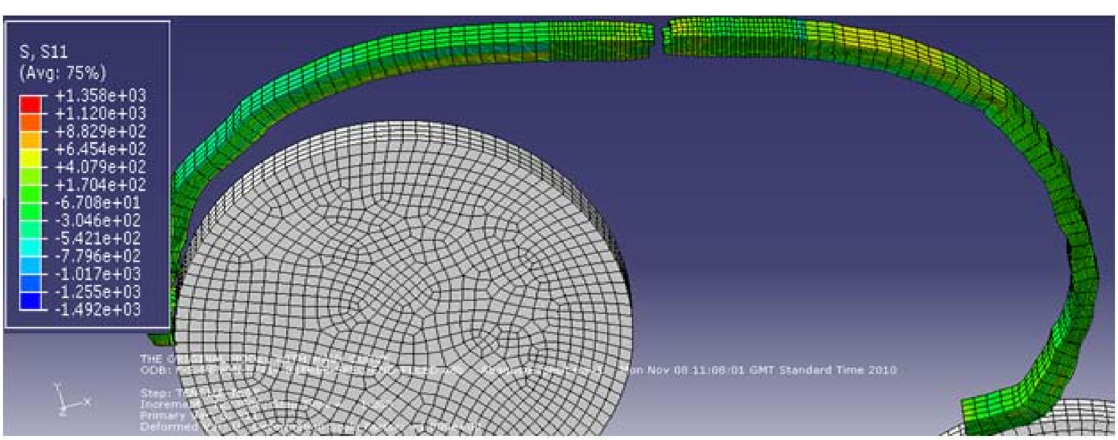
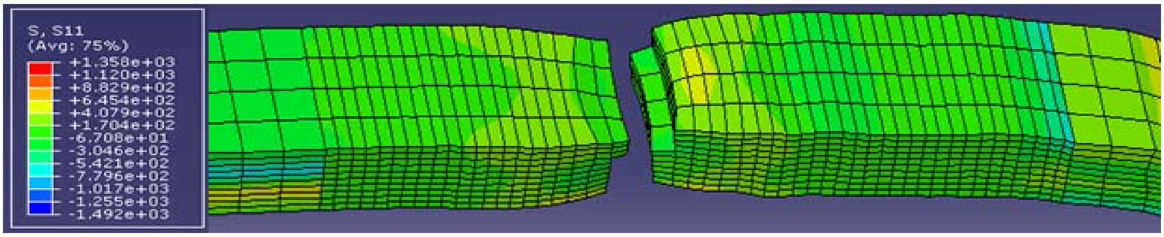


Figure 11 : Deformed shape of the whole bar length showing the longitudinal axial stress (MPa) distribution in the bar and the fractured RBS specimen



(a) Fractured numerically RBS specimen.

(b) Fractured experimentally RBS specimen.

Figure 12 : Fractured numerically and experimentally RBS specimens after tensile testing.

The normalised force-displacement curves obtained from the simulations of the tensile testing of the unbent bar specimen alone and the unbent bar specimen within the rollers-attachments-specimen assembly are shown in Figure 13. The normalised force-displacement curves obtained from the simulation of the tensile testing of the numerically simulated RBS specimen and the laboratory tensile testing of the experimentally RBS tensile specimen are shown in Figure 14.

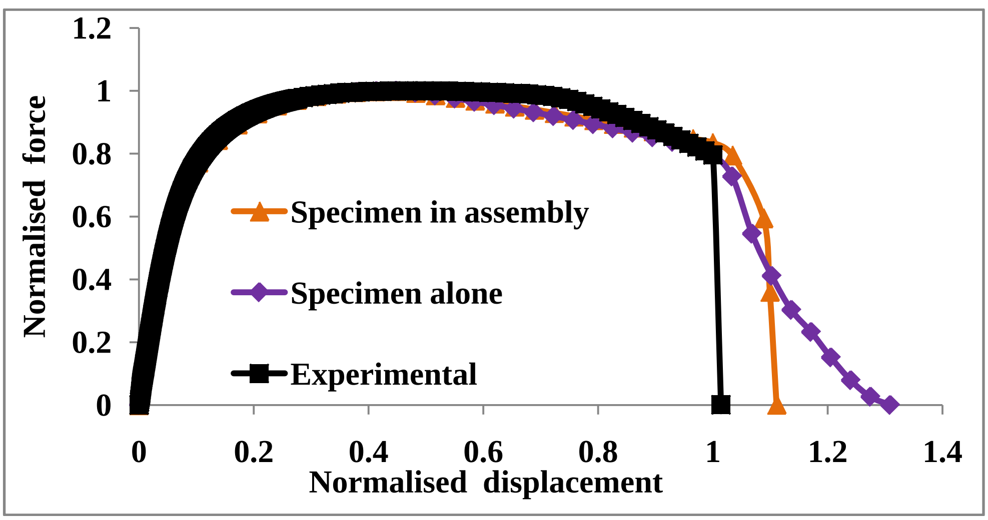


Figure 13 : FE force-displacement curves from tensile testing of unbent bar specimen alone and bar specimen within rollers-attachments-specimen assembly

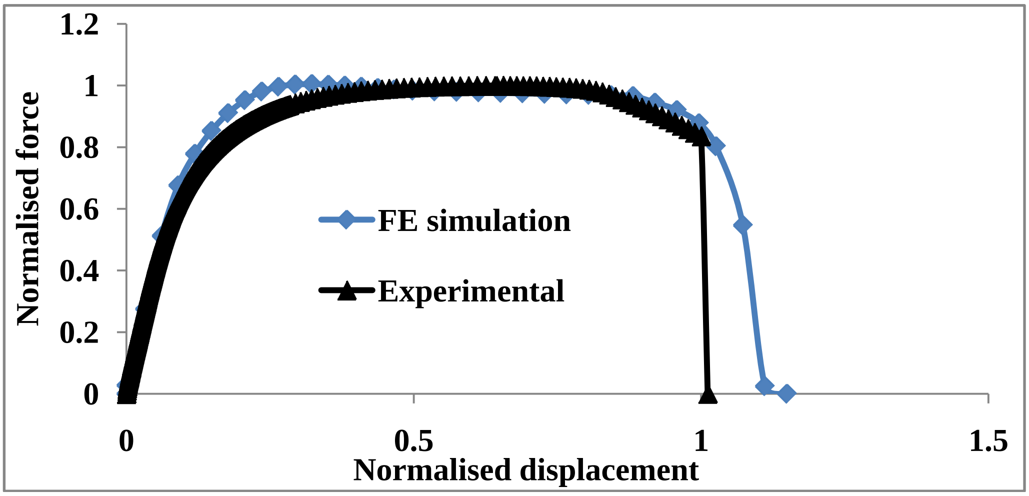


Figure 14 : Experimental and FE force-displacement curves from tensile testing of RBS bar specimen.

IV. Discussion

As shown in Figure 5(b), after the bending simulation, the upper and the lower parts of the bar specimen are subjected to tensile and compressive axial stresses respectively, which agrees with the stress pattern in a bent bars stated by [8]. The tensile and compressive axial stresses caused plastic deformations of the upper and the lower parts of the bar specimen as shown by the equivalent plastic strains in the specimen in Figure 5(c). The middle 20% (approximately two element layers) of the bar specimen's thickness, where the neutral axis lies remains elastic with zero equivalent plastic strain as shown in Figure 5(c). The peak stress and strain occurred at the surfaces of the bar specimen, which agrees with what is reported by [13] and further shows the accuracy of the bending simulation. The peak stress and strain occurred at the surfaces of the bar because the elements at the surfaces of the bar experienced the highest stress and strain.

Substituting the bar thickness, T, of 5mm and the roller diameter, D_r, of 100mm in equation (3) obtained from [8] as shown in equation 4 gives a maximum strain, e, of 0.048. The maximum strain of 0.043 predicted by the bending simulation as shown in the equivalent strain contour plot in Figure 5(c) agrees well with the maximum strain value of 0.048 calculated with the analytical expression. This further demonstrates the accuracy of the bending simulation.

$$e = \frac{T}{T + D_r} \qquad (3)$$

$$e = \frac{T}{T + D_r} = \frac{5}{5 + 100} = 0.048 \qquad (4)$$

As shown in Figures 6, 7(a) and 7(b), the initial upper part of the bar is now subjected to compressive stress and the initial lower half is now subjected to tensile stress during and after the reverse bending simulation as a result of strain/stress reversal associated with the reverse bending operation. The through thickness deformation pattern of the bar specimen after the reverse bending simulation is similar to that predicted by the bending simulation as the upper and the lower parts of the bar specimen were plastically deformed, while the middle 20% of the bar specimen thickness, within which the neutral axis lies remains elastic with zero equivalent plastic strain as shown in Figure 7(c).

The initial upper part and the initial lower part of the bar specimen at the beginning of the simulation is now the lower part and the upper part of the bar specimen that has undergone bending, reverse bending and straightening (RBS) and are in tension and compression respectively as shown in Figures 8(b) and (c). From Figure 8(c), approximately the middle 20% of the bar specimen thickness also remains elastic after the straightening simulation, while the remaining outer portions of the bar specimen have been plastically deformed. The stress and the strain in the RBS specimen at the end of the straightening simulation represent the residual stress and the accumulated plastic strain in the tensile test specimen at the beginning of the tensile testing simulation. Thus, the upper and lower parts of the RBS bar specimen that was subjected to tensile testing simulation had undergone cyclic tensile and compressive plastic deformations, with residual compressive and tensile stresses respectively, while the middle 20% of the thickness of the bar remained elastic. This leaves the RBS bar specimen with an unbalanced residual stress distribution and a non-uniform through thickness deformation.

The fracture shapes shown in Figures 9 and 10, and the force-displacement curves shown in Figures 13 predicted by the simulations conducted with the unbent

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bar specimen in the rollers-attachments-specimen assembly and the unbent bar specimen alone are in a good agreement. This indicates that the boundary conditions applied to the reels, attachments and specimen during the tensile testing simulation are appropriate as they have negligible impact on the fracture shape and the tensile response of the specimen with a maximum of 0.19% difference between the tensile properties (occurring in the displacement at fracture) predicted by the two simulations. The good agreements in the fracture shapes shown in Figure 12 and in the force-displacement curves shown in Figure 14 predicted by the simulation of the tensile testing of the numerically simulated RBS bar specimen and the curves from the laboratory tensile testing of the experimentally RBS bar specimen shows the accuracy of the bending, reverse bending, straightening and tensile testing simulations.

V. Conclusion

In this paper, the details of the simulation procedures employed for the simulation of the bending and reverse bending of a flat carbon bar used for civil engineering applications as it is conducted in practice, and the straightening and tensile testing simulation processes are presented. It is demonstrated that the bending simulation procedure employed is able to predict a maximum bending strain that agrees with an existing analytical expression. It is also demonstrated that the bending, reverse bending and straightening simulation methodologies employed are appropriate to predict the behaviour of carbon steel wires for civil engineering application subjected to bending, reverse bending and straightening processes. This is evidenced in the good agreement in the fracture shapes and the tensile responses of the experimentally and numerically RBS bar tensile specimens. This paper thus presents a FE simulation procedure which is essential to the research on the numerical prediction of the effect of the combination of reverse bending and straightening process and laminations on the tensile properties of bars used for civil engineering applications.

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Controlling Slippage in Water Resources and Infrastructure Projects

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Synopsis- Slippage of projects particularly in the water and infrastructure sector is a common occurrence. The activity networking techniques initiated in the USA in the 1950s gained large popularity. This was followed by introduction of computer and numerous software on network analysis aiming at effective project control. While these techniques are helpful the real problem of controlling the project slippage still remains largely unsolved. The author is involved in further research in this area. It is felt that arresting project slippage would be largely possible with improvisation and innovation of the techniques already in use. The shortcomings are not so much on the available methods but on their effective application to derive the desired result. An effective control comes from the management process – the individuals, the team and the implementation of proper controls and procedures.

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CONTROLLING SLIPPAGE IN WATER RESOURCES AND INFRASTRUCTURE PROJECTS

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I. Project Planning And Implementation

Planning and implementation of water resources and infrastructure projects have been considered under major groups like, surface water projects, ground water projects, projects on storm water drainage, sewage and effluent treatment and projects on protection of the environment and preservation of the ecological system. In addition, other projects on infrastructure development have been considered.

a) Surface Water Projects

Surface water projects involve dams and hydroelectric projects, multipurpose river valley projects; barrage, canals and head works, water intake, treatment and water supply network, dredging, embankment protection and river training, sea water desalination and distribution etc. Planning of these projects involve locating the source and the possible yield and its reliability and sustainability, choosing the process and the route, assessing the availability of required land, land acquisition keeping in view existing farm land, existing villages and other human habitation, existing flora and fauna, effect on the environment etc.

While care should be taken to avoid farm land, exiting villages, etc. it may not be possible in many situations. Relief and rehabilitation to the project affected people including providing alternative employment to them is a priority. Implementation should be suitably phases out to meet the construction schedule causing least inconvenience to the general public, at the same time, safeguarding the environment.

b) Ground Water Projects

Groundwater constitutes an integral part of the overall hydrological system. Water, the earth's most precious natural resources, is the most exploited and grossly misused resource. To mitigate the ever increasing demand for clean water people largely depend on groundwater which is being pumped out at an alarming rate causing lowering of sub-soil water table. The recharging of the aquifer by rainfall and natural infiltration does not compensate for the excessive withdrawal. In addition this drop in water table results in intrusion of arsenic, other harmful minerals salts and saline water in coastal areas. In addition this causes large scale subsidence of the ground. The solution lies in controlling the withdrawal of groundwater and ensuring adequate recharging of the aquifer with fresh water.

The planning of a groundwater project must be done considering the overall water scenario of the surrounding taking into account the draw down of the water table and the circle of influence. One consideration should be on the topography of the surface, density of population, prevailing plant and vegetation, existing structures, nature of surface and sub-surface soil strata, with particular reference to its porosity, permeability, prevalence of clay, sand and silt, rock and other impervious strata with corresponding degree of weathering.

These projects may be grouped under : Groundwater exploration and conservation; rain water harvesting; recharging of aquifer to raise the sub-soil water table; prevention of groundwater contamination and protection against groundwater pollution; protection against arsenic and saline water intrusion; prevention of water table lowering; and preventing the possibility to large scale land subsidence.

c) Sewage Treatment and Environment Protection

These projects introduce faecal sewage treatment plants, effluent treatment plants, recycling of treated sewage/effluent and storm water drainage systems. Projects on protection of the environment include solid waste disposal, disposal of hospital and medical waste, disposal of radio active waste and used isotopes.

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Storm water drainage projects should ensure that the water flows by gravity and self cleansing velocity of flow is maintained to minimise additional cleaning efforts. Similar consideration holds good for sewage and effluent treatment plants so that installation of additional booster pumps may not be necessary.

d) Other Infrastructure Projects

Some of the broad items in infrastructure may be – Building and housing; Highways, Roads, Railways, Bridges, Tunnels; Power Generation and Distribution; Hospitals and Health Centres; Universities and Educational Institutions; Hotels and Hospitality Centres; Markets and Shopping Malls; Entertainment Centres and Multiplexes; IT and Digital Communication. In general infrastructure covers all facilities and services for the use and benefit of the people in general which supports public life but are outside the scope of the main manufacturing process. Planning and implementation of these facilities have to be done keeping in mind the ultimate beneficiary, i.e., the general public.

II. Causes Of Project Slippage

There are many possible causes of project slippage some of which are common in most projects. Some causes are special in case of projects relating to development of water resources and infrastructure. Project slippage is also frequent in developing countries as compared to the developed world. In most real life project situations multiple causes occur simultaneously. Some researchers call this concurrent delay syndrome. Many of these causes are intervention and inter-dependent and may be in engineering and/or in management. The major causes may be summarized as follows :

- Planning : Many projects on water and infrastructure are taken up without enough home work or in depth planning.
- Change : As a result of lack of sufficient detailed planning in advance the water and infrastructure projects are subjected to frequent and substantial change in the course of implementation.
- Poor Management : Many of such projects suffer delay due to lapses in management.
- Scheduling : Initial schedule sometimes is very tight with a view to promise early completion. Such schedules do not take into account the ground realities and are unrealistic.
- Management Support : Efficient management and timely completion is possible only with the full cooperation and support from the top management.
- Funding : Regular and smooth cash flow is a must and is an essential requirement to make the project progressing in conformity with the schedule.
- Cost Contaminant : Cost overrun is a frequent cause of slippage in water and infrastructure projects.
- Resources : For the project success and its completion on schedule optimum resources – men, material, machinery and money must be made available at all stages.
- Information Management : Lack of accurate and timely feed back and poor coordination and communication are causes of project failure in the water and infrastructure sector.
- Incentives : Project success depends largely on effective deployment of the human resources and getting the best output to benefit the project. Workers motivation through incentives is a major aspect in achieving project success.
- Risk Analysis : Many projects in water and infrastructure sector are taken up without a prior in-depth assessment of the consequent risk involved.
- Total Involvement : Involvement of the Government, the community and all the stakeholders are significant factors in achieve project success. The legal support and the political will to make it happen is no less important.

The delaying factors may be put under two main categories, i.e., internal and external.

Internal Factors : These are causes which are somewhat within the control of the project authorities.

- Non-acquisition of project site and access to site
- Clearance to start work from local authorities
- Project funding and mobilisation of resources
- Improper contracting due to strict compliance with rules
- Consultants' lapses in providing drawings and documents in time
- Contractors' lapses in delaying the start and shortcomings on mobilisation of materials, equipment, workforce at site.
- Lapses in identifying key problem areas.
- Delayed decision on corrective action and its timely implementation.
- Lapses in issues relating to health, safety and environment.
- Contractors' low productivity and poor performance.
- External Factors: These are causes which are by and large beyond the control of the project authorities :
- Act of God, Force Majeure
- Natural calamities like heavy rain, cloud burst, unprecedented storm, flood, high intensity earthquake, tsunami and other natural calamities.
- New legislation enacted by the Central or State Government.
- Power and Water Supply Failure.

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- Famine and outbreak of epidemic.
- Labour unrest, strike, lockout, etc.
- Local festival causing large scale absenteeism

Although the external factors, are beyond the control of the project authorities, the consequent impact may be minimised by re-sequencing of project phases and re-arranging the order of priorities in implementation.

The engineering aspects leading to project delay may include design lapses, improper detailing, interference of facilities and services, emergence of unforeseen obstruction at site, etc.

III. Methodology For Arresting Project Slippage

Slippage is causes by delays at various stages causes by one or more problems. Hence, the root cause is the problem which has to be identified in advance and pro-active action taken to eliminate it. The suggested approach is identifying the problems, analysing the causes, quantifying the slippages, evaluating the overall impact on the project and taking appropriate remedial measures. The project response to the corrective action applied has to be measured on a continuous basis. In case of unsatisfactory project response, revised strategy has to be evolved and applied to achieve best result. Proven time tested techniques are suggested including application of proven project management software. Effective result can be achieved by improvisation and innovation at all stages. Reliable and accurate feedback information and total involvement of all concerned is important. Shortening the time for data processing and transmittal is equality important. This can be achieved through the optimum utilisation of state-of-the-art IT and telecommunication technology, advanced mechanised construction and application of automation and robotics in construction wherever applicable.

a) Critical Path Method (CPM)

CPM is the most widely used scheduling technique. Both CPM and the Programme Evaluation and Review Technique (PERT) were initiated in the USA about fifty years back and are in use all over the world. Computer programmes and algorithms for CPM and PERT are widely available. There are two forms of presentation namely, Activity on Arrow (AOA), Activity Oriented Network and Activity On Node (AON), Event Oriented Network.

b) Precedence Diagramming Method (PDM)

The precedence diagram is a modified form of event oriented network (AON) where the events are in rectangular boxes and the logical sequence of occurrence is represented in the following four basic relationships between the predecessor and successor activities :

- Finish to Start (FS) – The successor activity (S) cannot start unless the predecessor activity (P) is completed P → S.
- Start to Start (SS) – The success activity P S cannot start until the predecessor activity has been started.
- Finish to Finish (FF) – The successor activity P S cannot finish until the predecessor activity has been finished.
- Start to Finish (SF) – The successor activity P S cannot finish until the predecessor activity has been started.

Eight separate categories of precedence constraints can be defined, representing greater than (Lead) or less than (Lag) time constraints. These relationships are: FS Lead, FS Lag, SS Lead, SS Lag; FF Lead, FF Lag, SF Lead, SF Lag.

c) Time Estimate

In estimating the activity duration there are normally two approaches – deterministic and probabilistic. CPM takes into account single time estimate based on past experience and historical record on similar projects. PERT was developed on research projects where the activity durations could not be estimated with certainty. Hence, a statistical method based on probability was adopted. The pattern of distribution considered was 'β' distribution which has been simplified for practical application as the three time estimate. Hence, for all practical purposes the time estimate are – Single Time Estimate for CPM and Three Time Estimate for PERT.

The algorithm for the probabilistic time estimate for an activity (i, j) is, Optimistic time estimate $= a$; Most likely time estimate $= m$ and Pessimistic time estimate $= b$ Activity duration $\mu\ (i,\ j)$ based on β distribution would be, $\mu(i, j) = \dfrac{a + 4m + b}{6}$ while there are more complex statistical formulae for probabilistic time estimate the three time estimate based on β distribution is widely used.

d) Data Collection, Assembly and Feed-Back

The reliability of the basic project planning, scheduling and the monitoring and control depends a lot on the data fed into the system and the subsequent feedback information. The data must be realistic based on spot investigation, official record from concerned authorities and historical record on past projects.

e) Work Breakdown Structure (WBS)

The WBS is a basic technique of breaking down the total scope of the project into manageable work packages and further detailed activities to facilitate detailed planning. The logical sequence of activities need not be considered at this stage however, responsibilities are to be assigned to help evaluate the possible number of work packages and develop a proper Organization Breakdown Structure (OBS). It should be an essential first step in developing the activity network. WBS can be organised into a logical sequence to develop a network schedule. It is desirable to develop a flexible WBS that can be modified with changing project situation.

f) Network Formulation, Stabilisation and Updating

The flow charts in Fig.1 shows the steps involved in formulation and stabilisation of the network and issuing the initial report for follow-up. Fig.2 shows by a flow chart the project updating cycle. This is a repetitive operation during project monitoring and evaluation. The updating interval has to be decided carefully to effect adequate project control.

g) Project Risk Analysis

The economic viability of the project must be assessed in the beginning with reasonable degree of certainly. The following questions should be asked and satisfactory answers obtained:

Why take the risk on this project? What will be gained by implementing this project? What could be lost by taking up this project? What are the chances of success or failure on this project? What can be done if the desired result is not achieved? Is the potential reward from this project worth the risk being taken?

Every project has a risk. The degree of risk and the corresponding possibility of success should be assessed. Most water and infrastructure projects are justified from the consideration of long term social benefit rather than aspects of immediate commercial profitability.

h) Project Slippage Control

The flow chart in Fig.3 shows the Major Steps in Delay Management and Outlines the overall control system. The main action points to be specially attended to are:

- Delay Identification : Determining which delays are likely to affect the project and documenting the characteristics of each.
- Delay Quantification : Evaluating the effect of each delay and assessing its overall influence on the project.
- Delay Analysis : Identifying the problems causing the delays and breaking down the delays caused by each problem.
- Problem Analysis : Analysing the delay causing problems and ascertaining possible corrective actions to assess the impact of the delay on the project.
- Corrective Action : Application of remedial measures, evaluating how the project is responding to the corrective actions; deciding and applying revised actions in due time.

IV. Quality Assurance And Quality Control (QA/QC)

Quality Assurance (QA) and Quality Control (QC) are synonymous in nature. QA signifies all activities implemented within the quality system and demonstrated as needed, to provide confidence that services rendered will fulfil the requirements of quality. QC includes all activities and operational techniques that are used to fulfil the requirements for quality. Strict adherence to QA/QC is essential for achieving success in all construction projects.

In the recent past International Standards Organization (ISO), a worldwide federation of national standards bodies have issued ISO 9000 series of standards which are accepted internationally. In conformity with ISO 9000 international standards the Bureau of Indian Standards (BIS) have issued corresponding Indian Standards under series IS 14,000 which are applicable to construction and other activities in India.

V. Environment, Health And Safety

Execution of a construction project with due care of the environment, and health and free of accidents should be a clear objective for all concerned. Even in developed countries like the UK and USA construction is the most hazardous industry. The situation is much worse in developing countries. In India a number of codes on safety in construction have been brought out by the Bureau of Indian Standards (BIS) and other authorities. Unfortunately, a large part of the construction particularly in the water and infrastructure sector is carried out by the unorganised sector securing orders primarily on price consideration. In many projects the contractor's technical capability and past record on environment, health and safety is not a prime consideration for placement of order. Environment, health and safety should be the composite responsibility of all agencies involved in the construction project – the planner, the designer, the consultants, the project authority, the contractor and above all the workmen themselves.

VI. Human Aspects And Public Awareness

All projects on water resources and infrastructure are primarily to serve the people in general. So, the common people must be taken into full confidence right from day one and the work executed in full transparency. In countries like India with high density of population any project will involve acquisition of substantial privately owned land. It is natural that many people will be displaced from their age old homes, many farm land will be occupied, many wild animals will need to be re-located. Apart from a large scale social problem execution of large water and infrastructure projects create associated environmental problems as well. Political and legal involvement is a natural consequence in these projects.

Largely hydroelectric project is a good option to sold India's chronic power shortage. It is non-polluting and the energy source is renewable. But this involves construction of large dams leading to creation of large reservoirs inundating villages, towns, forests, etc. Because of the social, environmental, political and legal problems construction of large dams has virtually stopped in India. Considering large scale irrigation canal systems, inter-linking of rivers, large inter-state highways and railways which are cross-country and at times cross-border involving several neighbouring countries. Interaction with the project affected people and political negotia-tion and advance agreement is essential before signalling the go-ahead. The problem is complex in all countries but in densely populated India the problem has a special dimension. Development has a price which must be paid by way of temporary hardship and inconvenience to the project affected people for the long term social benefit to the nation.

VII. Case Studies

The research shows that the proposed model should be within the broad framework of the time tested network analysis technique. Attempts should be made to reach perfection in the basic inputs to the project on planning. The authors have substantiated the proposed innovative methodology on the following projects.

a) Water, Infrastructure and Services for SIDOR Steel Plant, Venezuela (1975-1980)

The project relates to PLAN IV Expansion of Venezuela's only state owned integrated steelworks at Matanzas with an investment of US$ 5 Billion involving large scale water resource and infrastructure development. The planning methodology adopted was activity networks (PDM) for data processing using IBM370 mainframe computer with IBM-PROJACS Control System. This construction was completed in about four years as planned without any significant time overrun and within approved budget. A photograph of the SIDOR Project-Water and Infrastructure facilities is shown in Fig.4.

b) Water, Power and Outdoor Facilities for Misurata Steel Complex, Libya (1983-1988)

The plant with an investment of US$ 5.5 Billion is situated on the Mediterranean coast close to Misurata City. Desalinated sea water was used for plant construction and operation. A central water station was provided for circulating the cooling and emergency water. Extensive yard facilities were also provided – project monitoring was done through activity networking in three categories. Computerised data processing was done through packages like IBM PROJACS, K&H and ARTEMIS. Commissioning of water and other infrastructures were completed on schedule. A photograph of the Misurata Steel Complex underground yard piping is shown in Fig.5.

c) Infrastructure, Water and Services for Salem Steel Plant – Phase II Expansion (1989-1991)

This project is Tamil Nadu, India was completed well ahead of schedule. The morale boosting achievement was a lesson useful for implementation of future projects. Slippages were arrested by timely corrective action and minimising consequential delays. Computerised CPM monitoring technique was adopted. The factors contributing to this achievement are:

Excellent Performance by all agencies : Meticulous planning and timely action in advance; vigorous project monitoring and follow-up; timely management intervention; excellent cooperation and team spirit.

d) Water Supply Project for Vikram Ispat Sponge Iron Plant, Raygad, Maharashtra, India (1991-1992)

The project involved supplying water from River Kundlika to the plant through a 500 mm dia, 40 km long pipeline. The pipes were of pre cast pre-stressed concrete in most parts and of MS in some parts. The project was planned in great details using the activity networking technique and rigorously followed up with close interaction with all agencies. The project was completed within the targeted schedule and within approved budget.

e) Water, Utilities and Services for Whirlpool Refrigerator Plant, Pune, India (1997-98)

The project infrastructure involved, Roads and Pavements, Storm Water Drainage, Raw Water Storage, Treated Water Storage, implementation was closely followed up through computerised network scheduling and close monitoring and follow-up. The key to success was a dedicated project team, total involvement and commitment of all concerned, excellent top management support, total focus on timely completion and fast decision, coordination and communication. All infrastructure and services were made ready in good time.

f) Orissa Water Resource Consolidation Project, India [OWRCP] (1998-2001)

OWRCP was a World Bank funded project to establish multi sectoral water planning, enhance the efficiency of public expenditures and, provide more efficient and effective irrigation services. The work was carried out by DOWR with technical assistance of a group of international and national consultants. Monitoring plan for the project components were developed with application of standard management software. A special software MEMIS (Monitoring and Evaluation Management Information System) was also developed. The project components on which the computerised monitoring plan was adopted successfully included Naraj Barrage Projects, Sakkhigopal Branch Canal System and Baghua Stage II Earth Dam Project.

VIII. Conclusion

The conclusion of this research work may be outlined as follows :

- Project slippage is a common occurrence. The projects relating to water resource and infrastructure sector in particular gives rise to some special problems.
- Delay in planning and implementation of projects may be caused due to several internal or external reasons. Introducing a system of recording delays on a day to day basis through a Delay Log Book is very effective.
- The methodology proposed in this paper for arresting project slippage is based on sufficient improvement and improvisation of the techniques which are already being used globally.
- The suggested approach is identifying the problem, analysing the causes, quantifying the slippages, evaluating the overall impact, and taking appropriate remedial measures.
- Due care should be taken for QA/QC, environment, health and safety, human aspects and public awareness.
- The proposed method reported herein was applied in SIX real life projects in water resource and infrastructure sector and adequate success was observed in controlling the slippage.

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Comparison of Crisp and Fuzzy Logics on the Location of a Gauging Station

By Mônica de Aquino Galeano Massera da Hora, Olga Kelman Brocki Calhman & Michely Libos

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Abstract - The traditional logic (crisp) is based on the dichotomy of true and false, what is not true is false and what is not false is true. Half term does not exist. However, the real world presents some situations where the answers true and false are not enough to represent the reality. Using this idea, it was applied, in this paper, the logics crisp and fuzzy to a problem of choose of place for the implantation of a gauge station in a watershed. COPPETEC-COSENZA model for crisp logic and operation with triangular numbers in electronic spread sheet (fuzzy) were adopted. The same results had been presented with regard to the adequateness to the implantation of the gauge station.

Keywords : fuzzy logic, crisp logic, gauging station, hydrology.

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COMPARISON OF CRISP AND FUZZY LOGICS ON THE LOCATION OF A GAUGING STATION

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Comparison of Crisp and Fuzzy Logics on the Location of a Gauging Station

Mônica de Aquino Galeano Massera da Hora [α], Olga Kelman Brocki Calhman [α] & Michely Libos [σ]

Abstract - The traditional logic (crisp) is based on the dichotomy of true and false, what is not true is false and what is not false is true. Half term does not exist. However, the real world presents some situations where the answers true and false are not enough to represent the reality. Using this idea, it was applied, in this paper, the logics crisp and fuzzy to a problem of choose of place for the implantation of a gauge station in a watershed. COPPETEC-COSENZA model for crisp logic and operation with triangular numbers in electronic spread sheet (fuzzy) were adopted. The same results had been presented with regard to the adequateness to the implantation of the gauge station.

Keywords : fuzzy logic, crisp logic, gauging station, hydrology.

I. Introduction

The traditional logic, called Aristotelian logic or Boolean, assumes a reality there only exists true and false, yes and no, [1]. However, humans function in a vague manner, using as often as possible words such as: warm, not so much, perhaps, more or less, and other words that belong to the infinite universe located among true and false, yes and no, [2]. To this logic, which treats the cloudiness present in many of the processes of daily life, it is given the name of fuzzy logic. With that in mind, we tried to address in this paper the application of crisp and fuzzy logic to a problem of locating a gauging site in a given river basin. Regarding the application of the crisp logic it was applied the COPPETEC-COSENZA model, [3]. Regarding the fuzzy logic, it was applied the operation with triangular numbers in an electronic worksheet.

II. How it Works

The human operators control very complex processes, based on inaccurate or approximate information or about what is being regarded. The manner how the human brain works in processing this information is also of imprecise nature and, in general, is able to be expressed in linguistic terms. The fuzzy logic, as its sets and its theories, can be used to translate imprecise information into mathematical terms expressed by a set of linguistic rules, [4].

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The fuzzy logic, as its sets and its theories, can be used to translate imprecise information into mathematical terms expressed by a set of linguistic rules, [4].

In this case, the variable is a linguistic variable. In order to illustrate, the values of the fuzzy temperature variable could be expressed as high, not high, quite high, very high, not very high, high but not too high. In this context, the temperature variable is a linguistic variable.

The main function of the linguistic variables is to provide a systematic manner to an approximate characterization of complex phenomena or badly defined. In essence, the use of the type of linguistic description taken on by humans, and not quantified variables, allows the treatment of very complex systems to be analyzed through conventional mathematical terms, [2].

III. Application to a Gauging Site

The implementation of a gauging site consists on the installation of a stage gauge or a water-level recorder that enables the knowledge of the water levels. Figure 1 presents a photo of a stage gauge installed on the Guandu river bank, located in Rio de Janeiro State, Brazil.

Fig. 1 : Gauging site on Guandu river

It is necessary to know the water levels and flow rates associated to support the management of water resources, highlighting the activities of planning, uses, reservoirs operation, navigation, recreation, flood risks, land use and occupation, erosion and environmental protection. Data on water levels, combined with the results of measurements of flow, allow the establishment of a relation called rating curve. Thus, the rating curve is a graphic representation of this relation, which involves geometric and hydraulic characteristics of the measuring sections and the considered section of the river.

For the present paper, a hypothetical basin was defined, as shown in Figure 2, where three river sections were selected with the following characteristics:

Section 1

- Section with waterfalls and no hydraulic control;
- Stable cross section;
- Difficult access;
- No interference on the upstream reach;
- No spatial scope;
- Existence of a bench-mark;
- Existence of an observer, however, far from the station.

Section 2

- Straight section with no hydraulic control;
- Stable cross section;
- Easy access;
- Interference on the upstream reach;
- Relative spatial scope;
- Absence of close bench-mark;
- Existence of an observer, nearby the site.

Section 3

- Straight section with hydraulic control;
- Stable cross section, subject to eventual flooding;
- Access is not permanent;
- No interference on the upstream reach;
- Spatial scope;
- Existence of a bench-mark;
- Existence of an observer, nearby the site.

It was assumed the same hydrometric team responsible for gauging site.

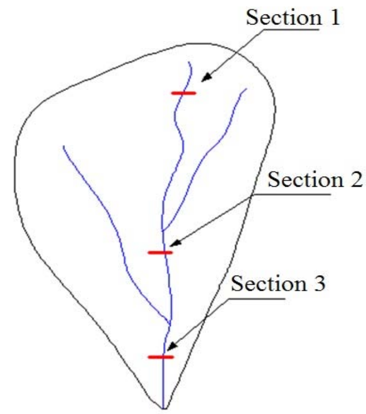

Fig. 2 : Gauging site on Guandu River

The general and specific factors of demand and offer, as well as its framework on a scale of linguistic terms were ranked based on information from experts in water resources. Thus, the factors to consider when locating a gauging site are:

General factors

- Access (A): should be permanent;
- Local observer (LO): the station should have an observer;
- Maintenance (M): the equipment and the site should be maintained by the hydrometric team;
- Bench-mark (BM): existence of references, in order to verify the position of the stage gauge.

Specific factors

- Hydraulic control (HC): the river section should be straight and, if possible, have a downstream hydraulic control;
- Stable cross section (CS): the river margins must be stable and high enough to prevent river overflows;
- Absence of interference in the upstream river reach (AI): it is recommended to avoid reaches where existing river sand mining, derivations or effluent discharges, which may interfere and / or modify the hydraulic section;
- Spatial scope (SS): it is recommended that the station is representative of the drainage area to the gauging site.

The demand factors were classified by the following attributes:

- Critical (Cr): strongly demanded;
- Conditioning (C): demanded;
- Little conditioning (PC): little demanded;
- Irrelevant (I): no effect on demand.

The offer factors were classified by the following attributes:

- Great (Gt): offered in excess;
- Good (G): offered;
- Regular (R): little offered;
- Weak (W): not offered.

IV. Simulation Through Electronic Worksheet

The triangular fuzzy numbers representing each attribute of demand and offer are presented in Tables 1 and 2 and their graphical representations in Figures 3 and 4.

Table 1 : Triangular fuzzy numbers of demand attributes

Attribute	Demand		
	L	M	R
Cr	2	3	3
C	1	2	3
PC	0	1	2
I	0	0	1

Table 2 : Triangular fuzzy numbers of offer attributes

Attribute	Demand		
	L	M	R
Gt	2	3	3
G	1	2	3
R	0	1	2
W	0	0	1

Note that the letters L, M and R represent the left, medium and right values of the fuzzy triangle.

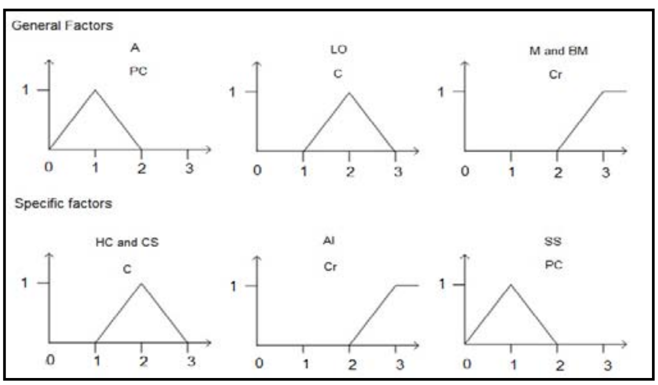

Fig. 3 : Graphic representation of the linguistic variables of demand

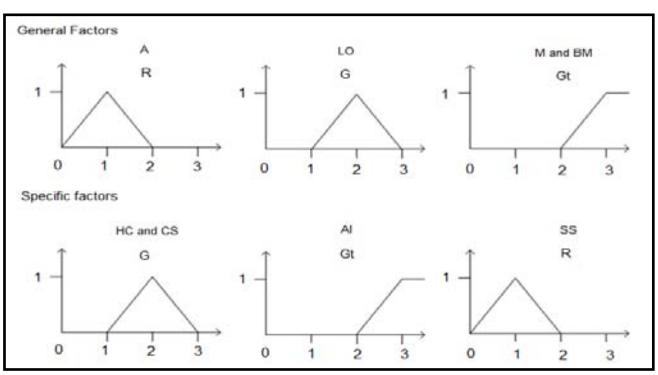

Fig. 4 : Graphic representation of the linguistic variables of offer

The resulting matrix was obtained by considering two calculation criteria. The first, called Crisp-Fuzzy (CF) admits that the matrix of demand is represented by a crisp number equal to the sum of the medium value of the triangular fuzzy number. The second criterion, named Fuzzy-Fuzzy (FF) admits that the matrix of demand is represented by the triangular fuzzy numbers.

The weighed equation adopted is given by:

$$i_K = \frac{\sum a_i \cdot b_i}{\sum a_i} \qquad (1)$$

Where i_k is the support value; a_i the demand matrix and b_i the offer matrix.

The calculation worksheets by the two criteria are shown in Tables 3 and 4, and the graphic representation of the fuzzy numbers in Figure 5.

Table 3 : Matrix resulting from weighing between the demand and offer CF solution

Factors	Demand			Weighted Offer								
				Section 1			Section 2			Section 3		
	L	M	R	L	M	R	L	M	R	L	M	R
A	0	1	2	0	0	1	2	3	3	0	0	1
LO	1	2	3	0	2	4	4	6	6	4	6	6
M	2	3	3	6	9	9	6	9	9	6	9	9
BM	2	3	3	6	9	9	0	0	3	6	9	9
HC	1	2	3	0	0	2	2	4	6	4	6	6
CS	1	2	3	4	6	6	4	6	6	0	2	4
AI	2	3	3	6	9	9	0	0	3	6	9	9
SS	0	1	2	0	0	1	0	1	2	2	3	3
Sum		17		22	35	41	18	29	38	28	44	47
Support Value				1,3	2,1	2,4	1,1	1,7	2,2	1,6	2,6	2,8

Table 4 : Matrix resulting from weighing between the demand and offer FF solution

Factors	Demand			Weighted Offer								
				Section 1			Section 2			Section 3		
	L	M	R	L	M	R	L	M	R	L	M	R
A	0	1	2	0	0	2	0	3	6	0	0	2
LO	1	2	3	0	2	6	2	6	9	2	6	9
M	2	3	3	4	9	9	4	9	9	4	9	9
BM	2	3	3	4	9	9	0	0	3	4	9	9
HC	1	2	3	0	0	3	1	4	9	2	6	9
CS	1	2	3	2	6	9	2	6	9	0	2	6
AI	2	3	3	4	9	9	0	0	3	4	9	9
SS	0	1	2	0	0	2	0	1	4	0	3	6
Sum	9	17	22	14	35	49	9	29	52	16	44	59
Support Value				0,6	2,1	5,4	0,4	1,7	5,8	0,7	2,6	6,6

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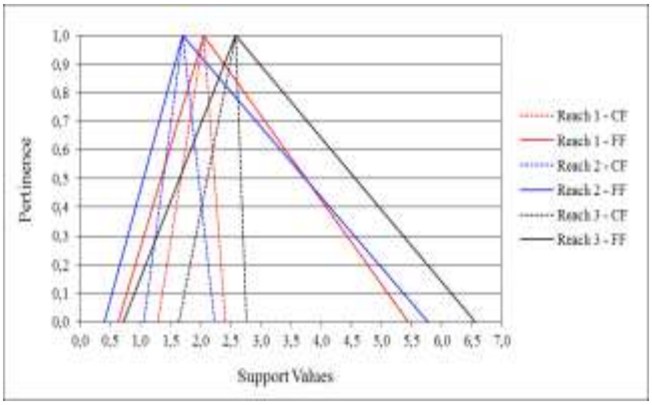


Fig. 5 : Representation of fuzzy numbers resulting from CF and FF simulations

V. Simulation Through Coppetec-Cosenza Location Model

The success expected with respect to the COPPETEC COSENZA location model concerns: (a) careful conceptualization of the attributes that will be considered in each case of study, and (b) mechanisms to evaluate the level in each attribute will be offered or demanded [5]. According to the model, the specific factors are those essential to the establishment of an industry: the absence of any of these factors implies the impracticability of this industry on the evaluated site.

They are classified into:

– Present in satisfactory amounts to meet industrial demand = 1;
– Missing or unsatisfactory amounts = 0.

The general factors are those common to many types of industries, usually infrastructure. They are classified, both for offer and demand in:

– Critical (Cr)
– Conditioning (C)
– Little conditioning (PC)
– Lrrelevant (I)

The values to be considered in the matrices of offer and demand are:

– Offer matrix: present = 1; absent = 0
– Demand matrix: critical (Cr) = 1; conditioning (C) = 1; little conditioning (PC) = 0; irrelevant (I) = 0

Being n the number of general and specific factors:

a) $n \cdot C > n \cdot PC + n \cdot I$
b) $n \cdot PC > n \cdot I$
c) If there is a critical factor or an insufficient amount, the region should be disregarded in the process of decision making.

From the classifications made, offer matrices are constructed of specific and general factors of each elementary area to be analyzed and demand ones for these same factors of industries to be evaluated.

Matrices of Demand and Offer of General Factors

Demand Matrix: $A = \lfloor a_{ij} \rfloor_{mxs}$

Where m is the number of industries and s is the number of general factors.

Offer Matrix: $B = \lfloor b_{jk} \rfloor_{sxr}$

Where r is the number of elementary regions.

Priority Matrix in Relation to General Factors

Being matrix $C = [c_{ik}]_{mxr} = A\Theta C$, where the operation of multiplication is given by the matrix below:

b_{jk} / a_{ij}	0	1
0	1/n!	1/n
1	0	1

So that n is the amount of general location factors. This comparison is made to determine the location advantages with respect to these factors.

Matrices of Demand and Offer of Specific Factors

Demand Matrix: $A^* = \lfloor a^*_{ij} \rfloor_{mxs'}$

Where s' is the number of specific factors.

Offer Matrix: $B^* = \lfloor b^*_{jk} \rfloor_{s'xr}$

Priority Matrix in Relation to Specific Factors

Consider the matrix $C^* = [c^*_{ik}]_{mxr} = A^* \Theta B^*$ of m industries by elementary regions, being its elements indicators to establish an order of priority in decision making with respect to the specific factors. The formation of this matrix is defined by the following criterion:

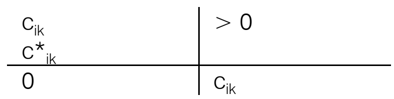
B^*_{jk} / a^*_{ij}	0	1
0	0	0
1	0	1

Priority Matrix in Relation to General and Specific Factors

Consider $P = [p_{ik}]_{mxr} = C \oplus C^*$, such that the special sum operation meets the following matrix:

c_{ik} / c^*_{ik}	> 0	0
0	0	0
> 0	$c^*_{ik} + c_{ik}$	c^*_{ik}

The elements of P represent the location advantages with respect to the general and specific factors. One may observe that the impossibility of location in relation to the specific factors automatically annuls the location advantage, however, if the project does not depend on the specific factor the operation must be:



Simulation with the COPPETEC-Cosenza model

The critical and conditioning factors have been adopted as being equal to 1, i.e., important, therefore the little conditioning and irrelevant factors are equal to 0, i.e. not significant. Thus, the demand matrix for the general factors can be completed as Table 5.

Table 5 : General factors demand matrix

General factors	Variable	
	Linguistics	Numerical
A	PC	0
LO	C	1
M	Cr	1
BM	Cr	1

Following the same procedure, the demand matrix for specific factors can be completed as Table 6.

Table 6 : Specific factors demand matrix

Specific factors	Variable	
	Linguistics	Numerical
HC	C	1
CS	C	1
AI	Cr	1
SS	PC	0

For the construction of the offer matrix, it was considered that the general and specific factors will assume 0 and 1 values, in case of absence and presence, respectively, in the considered sections. Thus, the offer matrix of general factors in the considered sections can be completed as Table 7.

Table 7 : General factors offer matrix

General factors	Section		
	1	2	3
A	0	0	1
LO	0	1	1
M	1	1	1
BM	1	0	1

The offer matrix of specific factors in the considered sections can be completed as Table 8.

Table 8 : General factors offer matrix

Specific factors	Section		
	1	2	3
HC	0	0	1
CS	1	1	0
AI	1	0	1
SS	0	1	1

The priority matrix resulting from the decision making in relation to the general factors is shown in Table 9.

Table 9 : General factors priority matrix

Gauging Site	Section 1	Section 2	Section 3	Sum
A	0.04	0.25	0.04	0.33
LO	0.00	1.00	1.00	2.00
M	1.00	1.00	1.00	3.00
BM	1.00	0.00	1.00	2.00
Sum	2.04	2.25	3.04	

The priority matrix resulting from decision making in relation to the specific factors is shown in Table 10.

Table 10 : Specific factors priority matrix

Gauging Site	Section 1	Section 2	Section 3	Sum
HC	0.00	0.00	1.00	1.00
CS	1.00	1.00	0.00	2.00
AI	1.00	0.00	1.00	2.00
SS	0.00	0.00	0.00	0.00
Sum	2.00	1.00	2.00	

The priority matrix resulting from decision making in relation to the general and specific factors is shown in Table 11.

Table 11 : General and specific factors priority matrix

General and specific factors	Gauging Site
HC	1
CS	1
AI	1
SS	0
A	0
LO	1
M	1
BM	1

The final results to the gauging site by the three sections are shown in Table 12.

Table 12 : Final results

Section	1	2	3
Gauging site	4.04	3.25	5.04

VI. Conclusion

The results of the simulations performed with the use of the electronic worksheet and displayed in Figure 5 allows to deduce that in the Crisp-Fuzzy criterion, the triangles resulting from the operation of fuzzy numbers are not superimposed, sequentially following, in ascending order of section 1 to 3, with respect to the suitability for the gauging site. With respect to the Fuzzy-Fuzzy criterion, section 3 remains to be the best candidate for the gauging site, but the resulting triangles of sections 1 and 2 are superimposed, indicating certain "cloudiness" about the hierarchy between them.

The simulations carried out using the COPPETEC-COSENZA model allowed to infer that, with respect to the general factors section 3 showed superior results compared to the other sections. With respect to the specific factors, sections 1 and 3 presented result equal and superior to that of section 2. In conclusion, section 3 is the most suitable for the implantation of the gauging site and section 2 is not appropriate for such. Based on the above, section 3 is the one that provides the best conditions for meeting the factors of general and specific demand of the project in question.

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Study On the Compressive and Split Tensile Strength Properties of Basalt Fibre Concrete Members

By Arivalagan.S
Dr.M.G.R Educational and Research Institute University

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Keywords : Concrete, Basalt fibre, basalt concrete cubes, basalt concrete cylinder.

GJRE-E Classification : FOR Code: 090503

STUDY ON THE COMPRESSIVE AND SPLIT TENSILE STRENGTH PROPERTIES OF BASALT FIBRE CONCRETE MEMBERS

Strictly as per the compliance and regulations of :

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I. Introduction

Basalt is a type of igneous rock formed by the rapid cooling of lava at the surface of a planet. It is the most common rock in the Earth's crust. Basalt rock characteristics vary from the source of lava, cooling rate, and historical exposure to the elements. High quality fibres are made from basalt deposits with uniform chemical makeup. The production of basalt and glass fibers are similar. Crushed basalt rock is the only raw material required for manufacturing the fiber. It is a continuous fiber produced through igneous basalt rock melt drawing at about 2,700° F (1,500° C). Though the temperature required to produce fibers from basalt is higher than glass, it is reported by some researchers that production of basalt fiber requires less energy by due to the uniformity of its heating. In addition to high specific strength, high specific modulus, BCF(Basalt concrete fibre) also has excellent temperature resistance (-260～700_), anti-oxidation, anti-radiation, thermal and sound Insulation, filtration, anti – compression strength and high shear strength, high availability, and good cost performance. It is found in nature as an inorganic non-metal material, and is a new basic material and high-tech fibre that can satisfy the demand for the development of basic infrastructures.

Basalt fibre is a "multi-performance" fibre. For example, it is resistant to alkalis and acids; it is thermally, electrically and sound Insulated; its tensile strength can be greater than large-tow carbon fibre, its elongation is better than small carbon fibre. Basalt has a 3-dimentional molecule and when compared with single infiltrating linear polymeric fibres. It is cost effectiveness, anti-aging, as well as other excellent Characteristics. Basalt fibre for cement and concrete is not expensive, it is a competitive alternative product of poly propylene fibre and polyacrylonitrile fibre. Basalt fibre is a typical ceramic fibre, it's easy to disperse when mixed with cement concrete and mortar. Therefore, basalt fibre reinforced concrete serves the functions of reinforcement, crack resistance, and can extend the life of construction in the fields of housing, bridges, Highways, railways, urban elevated roads, runways, ports, subway tunnels, the coastal Protection works, plant facilities. Banthia et al(2005)Performance of conventional Concrete is enhanced by the addition of fibres in concrete. The brittleness in concrete is reduced and the adequate ductility of concrete is ensured by the addition of fibres in concrete. In this paper the behaviour of RC beam structures strengthened by using hybrid fibre reinforced concrete (HFRC) is analyzed. Mattys et al(2005) experienced BFRP(basalt fibre reinforced polymer) is a new material in civil engineering compared to carbon, glass and aramid and has shown to be a promising material for infrastructure strengthening. They are made from basalt rocks through melting process and contain no other additives in the producing process which makes advantages in cost. Basalt fibres show comparable mechanical properties to glass fibres at lower cost and exhibit good resistance to chemical and high temperature exposure. Aggarwal et al(2007) presents the experimental investigations carried out to study the effect of use of bottom ash as a replacement of fine aggregates. The various strength properties studied consist of compressive strength, flexural strength and splitting tensile strength. The strength development for various percentages (0-50%) replacement of fine aggregates with bottom ash. Singaravadivelan et al (2012) conducted research is currently Basalt fiber reinforced polymer, is the (BFRP) application is very effective ways to repair and strengthen structures that have become structurally

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weak over their life of the span. BFRP Repair systems provide an economically viable alternative to traditional repair systems and materials. Experimental investigations of the cube, cylinder & flexural RC beams strengthened using basalt fiber unidirectional cloth is carried out. From the experiments it was found that Wrapping the concrete cube and cylinder specimen to 25%increase the strength compared to controlled specimens. The flexural strength of the element of the strengthened RC beams increases significantly after strengthening with BFRP cloth. There is little research concerning the application of basalt fibre in civil engineering and its strengthening efficiency on concrete elements. This paper presents the tests that were performed on BFC (Basalt fibre concrete) cubes and cylinder specimens under concentric compression loading and split tensile test.

II. Experimental Programme

The main objectives of the experimental program were (a) to investigate the effectiveness of confinement based on the basalt fibers preimpregnated and bonded with concrete (b) to compare the performance (in terms of strength)of different confinement techniques. This investigation was carried out on concrete16nos.cubes, (150mm x150mm x150mm) for finding compressive strength, 18_nos. cylinder (150mm x300mm) for compression as well as split tensile test. Each specimen was casted as per IS procedure. After casting the test M-20 and M-30 grade concrete specimen were demoulded and specimens were kept for a period of 7 days, 14 days and 28 days in the curing tank until the time of test. Detailed mix ratio of each grade of concrete is given in Table 1.Figure 1 and Figure 2 shows the test specimen of concrete cubes. The thermo and Physical properties of the Basalt fibres are given in Table 2 and Table 3.

a) Selection of raw materials

i. Cement

The ordinary Portland cement was classified into three Grades, namely 33 grades,44 grades and 53 grades depending upon the strength of cement at 28 days when tested as per IS4031-1988.If 28days strength is not less than 53 N/mm^2, it is called 53 grade cement. In this research M20 and M30 grade cement is selected for the study, coramandal king 53 grade(OPC) cement has been used for this research.

ii. Fine Aggregate

Natural river sand with fraction passing through 4.75 mm sieve and retained on 60 micron sieve is used and will be tested as per IS 2386. The fineness modulus of sand is 3.08 with specific gravity around 2.65.

iii. Coarse aggregate

Coarse aggregates of maximum sizes 20 mm, 16mm and 12.5mm and the compressive strength were obtained for maximum size of coarse aggregate. From that it was concluded that compressive strength using 12.5 mm aggregates gave the best result and it will be useful for our study. The physical properties will be tested as per IS 2386-1963.

iv. Water

Portable water available in the laboratory with pH value of 7.0 and conforming to the requirement of IS 456 -2000 is used for making the concrete and curing the specimen as well.

Table 1 : Mix design ratio of concrete cubes and cylinder

Grade of Cement	Cement (kg)	Sand(Kg)	Water(litres)	20 mm(Kg)	Basalt fibre(gm)
Mix ratio for M20 grade concrete cube					
Normal concrete	12.74	18.711	4.116	37.22	Nil
Basalt concrete	12.74	18.711	4.116	37.22	29.7
Mix ratio for M30 grade concrete cube					
Normal concrete	11.286kg	21.104kg	4.75litres	38.101kg	nil
Basalt concrete	11.286kg	21.104kg	4.75litres	38.101kg	29.7mg
Mix ratio for M20 grade concrete cylinder					
Normal concrete	6.678	10.017	2.226	20.03	Nil
Basalt concrete	6.678	10.017	2.226	20.03	15.9
Mix ratio for M30 grade concrete cylinder					
Normal concrete	6.042	11.309	2.544	20.44	Nil
Basalt concrete	6.042	11.309	2.544	20.44	15.9

Table 2 : Thermo physical properties

Working Temperature,(°c)	-267 to 700
Bond temperature,(°c)	1050
Thermal Conductivity, w/m(°K)	0.03-0.038

Table 3 : Physical Propertes

Sl No.	Filament Diameter(Mm)	7 to 15
1.	Density (kg/m³)	2650
2.	Elastic Modulus (kg/mm²)	10000 to 11000
3.	Tensile Strength (Mpa)	4150 t 4800
4.	Tensile strength under heat treatment, %	
5.	20(°c)	100
6.	200(°c)	95
7.	400(°)	82

Figure 1 : Basalt fibre

Figure 2 : Casting of concrete cubes

Figure 3 : Split tensile test

b) Test procedure

i. *Compression test*

Compression strength of concrete with and without basalt was conducted. The compression test was conducted as per IS 516 – 1959. The specimens were kept in water for curing for 7 days, 14 days and 28 days and on removal were tested in dry condition and grit present on the surface. The load was applied without shock and increased continuously at a rate of approximately 140 kg/sq cm/min until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen was then recorded and the appearance of the concrete for any unusual features in the type of failure was noted. Average of three values was taken as the representatives of the compressive strength of the sample as noted. Result are shown in above Table 4.

ii. *Splitting Tensile Test*

The split tensile test were conducted as per IS 5816:1999. The size of cylinder is 300mm length with 150mm diameter. The specimen were kept in water for curing for 7 days, 14 days and 28 days and on removal were tested in wet condition by wiping water and grit present on the surface. The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder along the vertical diameter. The maximum load applied to the specimen was then recorded and the appearance of the concrete for any unusual features in the type of failure was noted. Average of three values was taken as the representative of batch. The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder along the vertical diameter.

To find split tensile strength following equation has used. Figure 3 shows the testing of split tensile test.

Split tensile strength = $2P/(\pi DL)$

Where : P=split tensile load, D=diameter of the cylinder

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III. Result And Discussion

a) *Compression Test*

Compressive strength of concrete mixes made with and without basalt fibre was determined at 7, 14 and 28 days. The test results are given in Table 4 and Figures 4 and Figure 5.The gain of strength of basalt fibre concrete with respect to their compressive strength at the age of 7 days was 20%-24% of M20 and M30 grade of basalt concrete when compared to same grade of controlled concrete. In 19%-29% at 14 days of M20 and M30 grade of basalt concrete when compared to same grade of controlled concrete. Also 23%-25% varies at 28 days of of M20 and M30 grade of basalt concrete when compared to same grade of controlled concrete. The basalt concrete gains strength at a beginning stage onwards and acquires strength at faster rate due to pozzolanic action of basalt fibre. Therefore, the ultimate strength were taken at the peak load which was considered to represent the material strength of the BFC(Besalt fibre concrete). Figure shows the gradual and good increase of compressive strength of basalt concrete when compared to controlled concrete cubes.

Table 4 : Average Compression Strength value

Sl. no	M 20 Grade concrete		Sl. no	M 30 Grade concrete	
	Normal concrete	Basalt Concrete		Normal concrete	Basalt Concrete
7th day	16.02 N/mm^2	19.273 N/mm^2	7th day	22.013 N/mm^2	27.35 N/mm^2
14th day	18.75 N/mm^2	22.335 N/mm^2	14th day	25.257 N/mm^2	35.730 N/mm^2
28th day	21.33 N/mm^2	27.530 N/mm^2	28th day	32.875 N/mm^2	40.357 N/mm^2

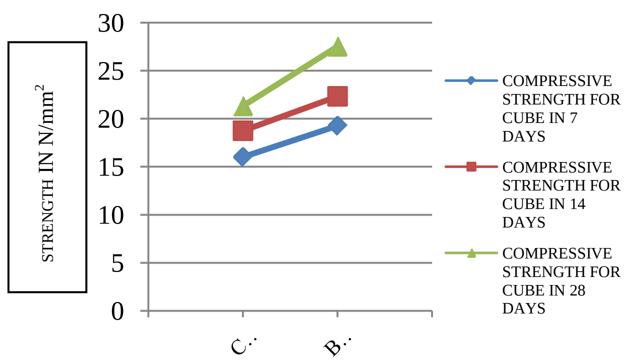

Figure 4 : Compressive strength of M20 grade concrete cubes

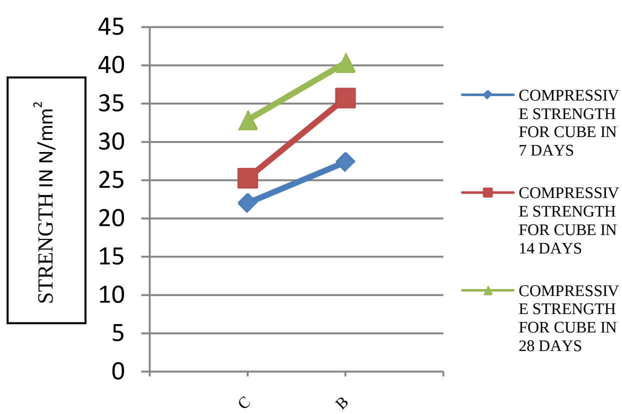

Figure 5 : Compressive strength of M30 grade concrete cubes

b) *Splitting Tensile Test*

The results of splitting tensile strength of concrete mixes with and without basalt fibre measured at 7, 14 and 28 days are given in Table 5 and shown in Figures 6 and Figure 7. Figures shows the variation of splitting tensile strength. Basalt concrete attains 35% & 25% split tensile strength at 7 days when compared to controlled concrete of M20and M30 grade. As 39% & 45% split tensile strength at 14 days when compared to controlled concrete of M20and M30 grade strength whereas 37% & 47% of split tensile strength at 28 days when compared to controlled concrete of M20and M30 grade strength respectively All cylinders show a good ductile behavior. Splitting tensile strength increases with the age of curing. Where the maximum gain is at M30 grade concrete added with basalt fibre attain higher split tensile strength at an age of 28 days curing period.

These results review the efficiency of BF concrete as a strengthening material for concrete columns but as this paper only presents tests on small concrete specimens like cubes and cyliners, further research needs to be done on reinforced columns of different cross sections.

Table 5 : Average Splitting tensile Strength value

Sl.no	M20 Grade Concrete		SL.NO	M30 Grade Concrete	
	Normal concrete	Basalt Concrete		Normal concrete	Basalt Concrete
7th day	1.708 N/mm^2	2.820 N/mm^2	7th day	2.551 N/mm^2	4.477 N/mm^2
14th day	1.944 N/mm^2	3.183 N/mm^2	14th day	2.641 N/mm^2	4.576 N/mm^2
28th day	2.137 N/mm^2	3.376 N/mm^2	28th day	2.806 N/mm^2	5.250N/mm^2

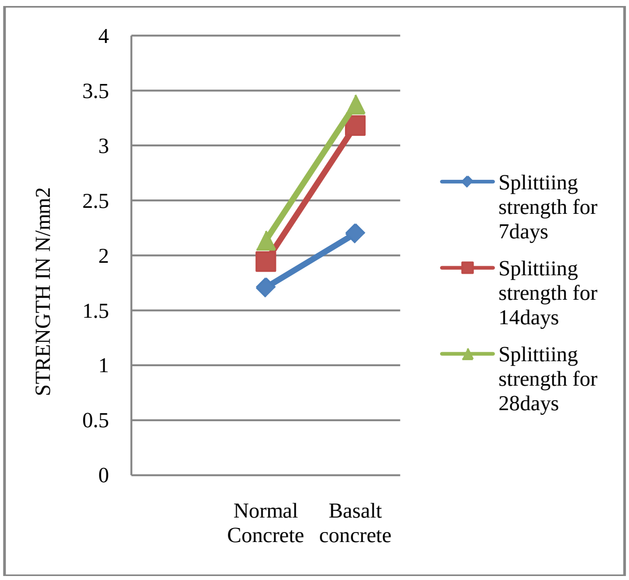

Figure 6 : Split tensile strength of M20 grade concrete

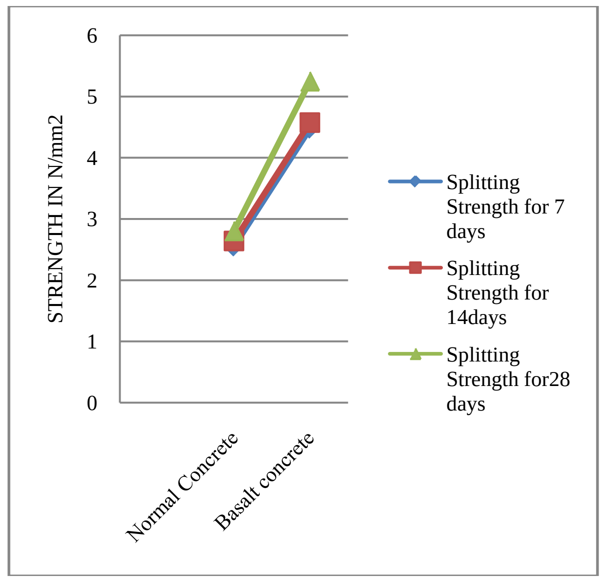

Figure 7 : Split tensile strength of M30 grade concrete

V. Conclusion

From the research following conclusions were obtained Compressive strength and Splitting tensile strength of basalt fibre concrete specimens were higher than control concrete specimens at all the ages.

Compressive strength of basalt fibre concrete containing 40% basalt fibre is acceptable for most structural applications since the observed compressive strength is more than 20 MPa at 28 days for M20 and M30 grade control concrete. So basalt enables the large utilization of basalt fibre in concrete.

The strength difference between basalt fibre concrete specimens and control concrete specimens became high distinct in the beginning age of curing itself.

M 20 and M30 grade basalt fibre concrete at 28 days strength attains the compressive strength equivalent to 120% and 123% and attains splitting tensile strength in the range of 123-125% at 28 days of flexural strength of control concrete at 28 days.

From the research it was proposed that, the usage of Basalt fibers in low cost composites for civil infrastructure applications gives good mechanical properties like strength and lower cost predicted for basalt fibers. Basalt fibre has used as a cost effectively replace to fiberglass, steel fiber, polypropylene, polyethylene, polyester, aramid and carbon fiber products in many applications.

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30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page

- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.
- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.

- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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