SIGNIFICANCE OF SHEAR FORCE AND BENDING MOMENT DIAGRAMS FOR DIFFERENT CIVIL ENGINEERING STRUCTURES (A REVIEW)

Syed Nasir Abbas[*1], Talha Faisal, Saad Hassan Azhar Iqbal, Danial Anwar, Abdullah bin Naeem
[1]Departmenof Engineering Technology, College of Engineering and Technology, University of Sargodha, Sargodha, Pakistan
[*] Corresponding Author, E-mail: nasir051@gmail.com

ABSTRACT: *The paper discusses the significance and requirement of a bending moment diagram that works with different civil engineering structures and discusses its use in civil engineering in order to understand the importance of the shear force acting on the structure and the importance of bending moment. They are also specified in their goals. It outlines the effect on various structures in the building such as columns, beams, trusses, stacks, and foundations of heart and bending moment. The research conducted by different researchers has references to show the importance of share power and banding time for each member in order to show the importance of banding and sharing force. Finally, a number of propositions were made for improvement and increase the effectiveness of shear force and bending diagrams.*

Keywords: Shear force, Bending Moment, Types of beams, Conjugate beam Method

I. INTRODUCTION

The overall force that is perpendicular to the longitudinal axis of the beam due to its own or external loads is known as "the shear strength." This shear force is shown as a particular type of drawing called a Shear Force Diagram (SFD).

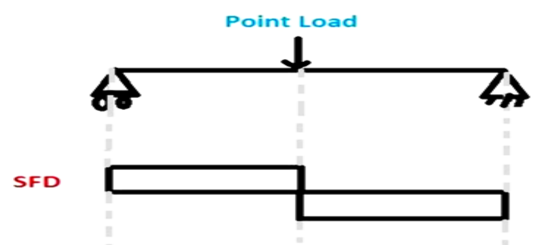

Figure. 1 Shear force diagram due to central point load

The arithmetic sum of all forces acting from one end of the beam to that point is analyzed in order to determine the share force on a particular section of a beam, which is the share force at that point. In beam design, the share force and extreme share forces must be known at various places of the beam.

The graph shows a load beam. It is supported simply in two places when the reactions are supposed to divide up into 2 parts by section XX. The resulting loads and reactions upon its right side of AA are F upward, and the resulting force on the right side of AA must be F downward while the whole beam is equilibrated. F is known as the AA Section Shearing Force.

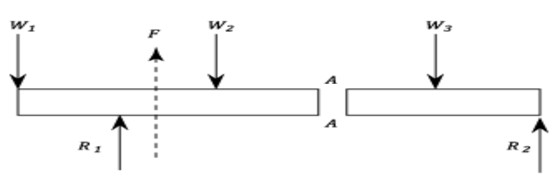

Figure. 2 Shear force distribution along the span of a beam

Whenever the force acts on a beam and its own load the moment of bending is called because it continues to try to flex the beam.

The moment of bending is expressed with a certain type of drawing called the Bending Moment Diagram (BMD).

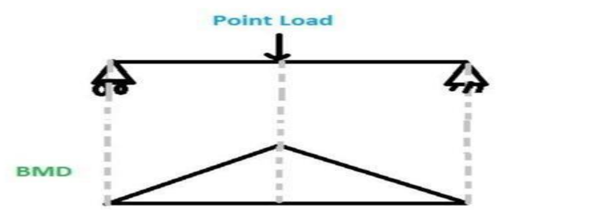

Figure. 3 Bending Moment diagram due to central point load

The quantity of all the applied force at one end of the beam to that point and the product of their distance away are found in order to maximize the value of a moment at any point on the beam.

Similarly, if the bending moments (BM) of the forces to the left of AA is in a clockwise motion, then the bending moments of the forces to the right of AA must be in an inverted position. Bending Moment is described by AA as the sum total of the moments in each section of the forces. When the moment on the left side is clockwise, and on the right anti-clockwise, bending moments are considered positive. This is called a bending moment because at AA the beam tends to become concave up. A negative moment of bending is recognized as hogging.

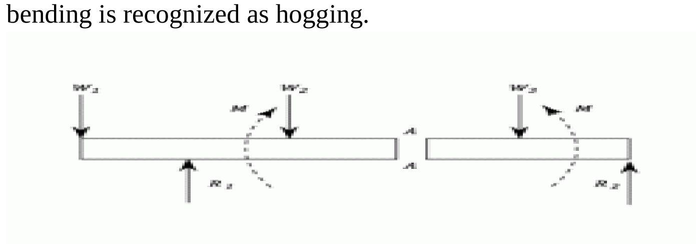

Figure. 4 Bending Moment distribution along the span of a beam

II. OBJECTIVES

The main goal of this research is to analyze the shear strength and moment of bending in civil engineering. The main aims are as follows:

- For analyzing beams, we would have to use a shear force diagram.
- A diagram with shear force signifies that the beam section is resistant to shear force along the length of the beam.
- The drawing of the bending moment signifies the tried-to resist a moment of the beam all along beam length.
- Curve diagrams and bending time diagrams are analytical methods used in the analysis of structures to assist schematic analysis by measuring the values of shear strength and moment of bending at a given element point.
- These diagrams allow easy determination of the type and size of a member of a certain material.
- Further use of shear and moment diagrams involves an easy evaluation of diversion using the moment-area method or conjugate beam method.

III. LITERATURE REVIEW

In civil engineering, we evaluate every member's shear force and bending time to develop a building to improve it in advance when required. We can especially find it.

In the numerical simulation of continuous structures subjected to a moving system modeled in a series of spring masses, two methods are presented that can record disturbances with different evaluation levels in the bending moment and shear force legislation. The two methods are based on the dynamic correction method, which enhances the customary enlargement of series by means of a pseudo-static term, and the extension of the system response by Eigenfunction series, which considers the structure effect of moving masses respectively [1].

Accurate shear strength and bending time charts (V/M charts) are one of the most essential skills that students are able to learn in the Statics course because brilliance is a condition for successful beam and shaft design in courses such as Mechanical Materials, Machine Design, Structural Analysis and Structural Design (MSM). Sadly, a large number of statics pupils are not sufficiently competent in V/M diagrams construction. A number of computer-based education supports have in recent years been developed to improve student performance in drawing up V/M diagrams in response to this problem. While results are encouraging, there have been many limitations in the evaluation of the effectiveness of these educational aids. University of Missouri-Rolla Engineering Mechanics Instructor(s) have dealt with this problem by researching and developing a number of V/M diagram computer-based training aids for students and instructors of statics. The evaluation was attended by about 230 students. About 40% used computer-based learning aids and the remainder was used as a control team. Comparison measures were used with qualitative research measures and subjective remarks from every group were sought. The results of learning and ability assessments were much higher for students in an experiential group in relation to the goals covered by the computer-based learning aids. This paper describes and evaluates the computer-based exercises for V/M diagrams [2]

This article describes how a load cell is designed, constructed, and tested to measure axial strength, shear force, and the moment of bending at the end of the structural beam. The load cell capacity includes an axial load of 780 kN, a shear of 350 kN, and a bending rate of 200 kN/m. This magnitude, in conjunction with the specifications that the applied load be kept as simple as possible, required a new design with three stainless steel components machined to produce localized enhancement of the stress. The load cell was made from grade 55 steel using thorough finite element analysis. After stress measurement, a wide range of calibration tests were performed. Two load cells are being used to measure the behavior of steel frame knee elements, in conjunction with some earliest experiments [3].

In several studies, the behavior of a pre-stressed concrete beam subject to MM bending moment coupled with sheer force VV was an essential component of the design. Certain methods suggested by researchers and international codes measure the shear strength of pre-tensioned beams by altering Moesch's Truss model such that the various slopes of web stress fields are taken into consideration owing to the prestressing effect. More modern techniques add a model to the conventional concept of the truss. This article generalizes a model previously presented for cross-sections of structural components in the boxes and I-shaped reinforced concrete sections. The model, now including the impact of precautionary tendons, comprises variable-depth stress areas applied to the X section, separated into layers, and allows the assessment of standardized m–vm–v design areas based on the web, flanged reinforcement, and on the steel tendons slope. By evaluating its number of findings to the strength of tests carried out in reinforced concrete beams and thin-woven pre-stressed concrete beams mentioned in the literature, the dependability of the approach has been confirmed. Finally, a pretension bridge beam was designed with the aim of evaluating the further strengthening required in bolts in order to reinforce the web [4].

This work provides a mathematical method in order to calculate the ultimate strength of the rectangular reinforced concrete columns, which are combined with the shear. The technique suggested is based on the statically limit analysis theorem and uses reduced stress fields for simulating stress in steel bars and (unconfined and confined) concrete. Both impacts of bow and arch are considered. In order to estimate the efficacy of the approach, the relations between the theoretical and experimental data are used with regard to a huge number of columns that many researchers have examined in the past. Finally, the outcome of the suggested approach is compared with the outcomes of the use of simpler methods in literature [5].

Conclusions of a publication in the Shanghai Yangtze River Tunnel (SYRT) longitudinal beam action analysis are assessed against the expertise acquired in Dutch longitudinally beam action research. The former aimed to characterize the sheer force of the tunnel line in relation to the filling procedure during the building phase of the tunnel. A newly constructed one-dimensional beam action model is used for the evaluation of predicted shear forces. The article contrasts the concepts of the two techniques of computation and the results. The earlier estimates for the SYRT were anticipated to have massive shear forces, whereas according to this latest model they were significantly less. The difference in treatment of border circumstances is ascribed to this, especially with respect to the longitudinal bending moment in the tunnel line. A technique to measure the shear force is recommended, which is transferred between the TBM and the tunnel line by means of the hydraulic jacket set. [6]

As early as1973, Mr. Menkes and Mrs. Opat (Exp Mech1973; 1:480–6) performed an experimental study to assess dynamic plastic response and failure of completely sealed metal beams, which were treated to uniformly distributed impulsive loadings, identifying three main pathways for collapse (Mode III). Jones (Trans ASMEJ England 1976; 98(B1):131–6) later performed a rigid-plastic analysis which used a primary failure criterion for the estimation of impulse thresholds on the beginning of a mode II or mode III collapse. For failure analysis of diverse structures under intensive dynamic loads, a comprehensive understanding of these three basic modes is of essential relevance. The present study re-examines the plastic shear failure (Mode III) of instantaneously loaded restrained beams with two effects as the focus: I the relationship between the shear force and the bending moment. For a general form of the reactive speed threshold, dimensional analysis is done, which takes into consideration successive concrete analyses. The criteria for elementary breakdown are therefore changed to include the weakening impact of sliding parts. The relationship between the shear force and the force of the bending at the end ends must be evaluated by a circular yield curve, or a slip-line-based yield condition, Robinson's, Int J solids structure 1973; 9:819, J Appl Mech 1957; 24:453–6. Taking consideration of the temporal variation of the shear strength and the bending moment on the failed cross-section, the beam flexural strength and breakdown are dealt with and the plastic shear wastage ratio is thus computed with regard to the total plastic dissipation. Followed by a debate on a criterion for shear stress failure. Furthermore, the estimates based on different methods are contrasted and the necessary experimental findings are evaluated [7].

The plates can be attached to an expanded reinforced cement (RC) beam to enhance the elastic modulus of the reinforced polymer (FBP) fiber. Many types of research in this respect have proven that the FRP plate has suddenly failed before the full flexural capabilities of the plate are achieved and a de-bonding fault mode most often observed takes place at or on the plate end. This study describes the findings of research into the interplay of shear force and bending time at the end of the plate when FRP plated beams are disconnected by changing the plate length. Compared to a plate end de-bonding force model previously suggested by the authors, the experimental values are disregarded in this interaction. The interaction between shear force and bending moment on the end of the platform is then suggested to be described as binding during de-assembly based on the current results. The impact of U-strip end anchoring is also evaluated in this study to postpone or avoid plate end debonding. It is demonstrated, however, that only minimal strength increase is provided by U strip end anchorage [8].

For the early design of cantilevered truss-braced high-hear wall constructions with unstable bases susceptible to horizontal loads, a graphical analysis method is provided. Six structural characteristics are calculated: bending rigidity for the shear wall, bending and sticking shear rigidity for the cantilever, bending rigidity from the external columns, and rotating stresses for shear and column substructure [9].

The arrangement of longitudinal shears on the interaction between steel and cement in composite trusses is typically very consistent (unless after plastic redistribution). The research reported here analyses the behavior by employing a perforated shear connector to achieve full shear connection of two steel and concrete composite shear girders. The non-linear 3D numerical FE model created using the ANSYS software package was then calibrated with experiment results. More than 30 versions of sharp links between a basic truss and the Vierendeel panel were investigated mid-term and had different load-slip connections derived from prior research. Inelastic behavior – notably significant in fatigue-loaded connector systems, followed by plastic distribution in the plastic area – distinctive shear flow maxima have been identified on the aforementioned truss nodes. Detailed analysis is provided to the comparison of the numbers with the suggestions in Eurocode 4 and the effect of shear connection increasing density above truss nodes. Finally, several practical design pieces of advice are provided [10].

There are issues concerning the shear strength of the circular and rectangular columns under earthquake forces. A review of existing design equations indicates a broad variety of expected answers. Models that reflect the relationship between bending ductility and shear strength are particularly highlighted. A simple technique is suggested by which the axial compression strength improvement is distinct from the concrete shear strength component and is viewed as a result of the action on the structure. With an enhance in ductility, the strength of the concrete component is lowered. The shear strength estimates of the suggested and alternative techniques are compared to the results of a wide variety of columns' shear failure tests. The suggested technique has proven that the relationship with experimental findings is considerably enhanced. The approach to be utilized for design is subject to reasonable amendments [11].

Bridge columns are sensitive to composite axial strength, shear force, and bending time during earthquakes, due to temporally complicated earthquake motions, structural design aspects, and the interplay between features of input and reaction. Combination activities can have a major effect on RC columns' strength and deformation capacity and lead to unforeseen severe deformations and extensive damage, which in turn affect bridges' performance as critical transport systems components. The seismographic reaction of three prototypes strengthened concrete bridges is evaluated by extensive mathematical simulations which simulate the complicated soil-structural influences and nonlinear column behavior. In order to describe genuine non-linear behavior of RC columns, including pinch behavior, strength degradation, and stiffness relaxation, the combined effects of shear power, axial strength, and bowing moment, an analytical method can capture the shear-flexional-interacting behavior. On the test bridges of sequences of ground movement, seismic behavior analyses were performed. Bridge responses are examined and analyzed in order to determine the impacts of vertical motion, structural features, and shear-flexural relationship with the earthquake forces of bridges (e, displacement, acceleration, sectional force, and section moment). [12]

The Ruytenschildts bridge in August 2014 was evaluated until the Netherlands failed to provide such a strong concrete enhanced deck bridge in grassland. The objective of the test is to evaluate and compare the failure method of a platform bridge under a 4-wheel charge tandem, to gain an idea of the residue, the strength of existing bridges, and the capabilities of complete bridge construction of the expected outcomes. The approaches employed are experimental (testing the two-fold failure bridge) and theoretical. The analysis included forecasting the ability of the bending moment, the sheer abilities, and the bridge piercing ability. The bridge failed in bending across both spans. In the experiment, overall capacity was substantially more than expected indicating that conventional shear rating techniques for deck bridges benefiting from transversal charge distribution are extremely conservative[13].

One of the most common types of bridges in the world is Girder Bridge. While a lot of effort was made to research the influence factor (IF) of simply supported car loading passageways, few studies on continuous passageways were documented. Moreover, most of the earlier IF investigations concentrated on the influence of a bending force, whereas relatively few researches focused on the shear effect. Mathematical calculations for the static IFs of both supported and continuous bridges owing to traffic were carried out in this work. IFs have been examined both for shear force and bending moment. Interesting conclusions have been found concerning links between IFs for the shear and bending times, of reinforced concrete and continuous bridges. These observations can be utilized by practical engineers as supplementary recommendations to bridge codes[14].

Earthquakes are natural dangers, largely due to the destruction of buildings and other architectural structures, or to the failure of buildings. Experience has proven that the establishment and execution of earthquake-resistant measures is a key protection against seismic damage for new structures. It is necessary that the structures be constructed in such a way that their strength, high flexibility, and even when applied to extremely significant deformities remain a suitable structure. The results of scientific and technical advances are socio-economic improvement and high-rise structures. As large cities expand, urban land shortage, urban land price rises, and contemporary high-rises structures arise, elevators are built to make them more elevated. In an increasingly fierce commercial competition, but also a major part of the work, this spectacular high-rise structure is a sign of economic power. In order to minimize the misperceptions of torque in structures, shear walls in structures must be situated uniformly. They might be uniformly positioned in one direction or in either direction. When positioned around the external perimeter of the structure, shear walls are more efficient, such a configuration enhances resistance to bending. In fact, it will certainly increase the earthquake capability of the construction if the shear wall is installed on a structural system. The objectives of this research are therefore to explore the influence of the position of the shear wall in seismic behavior, and to compare it with the shear wall at a different position, as axial forces are measured, bending moments, displacement is parameters. In this study, an exhaustive literature survey and analysis will be made on 10 story structures for zones II and IV of the earthquakes. Keywords Earthquake impacts, wall shear, displacement, moment bending, force shear, etc[15].

The components of the pile above the land and integrated into the soil are referred to correspondingly as the first section and the second. The 4th range of partial differential equations in both regions is achieved by combining small-displacement theory and the Winkler model for vibration analysis of a partly supported pile subject to bending time, axial strength, and shearing force. The behavior of the material is defined to be linear-elastic, and the axial power is constant during the second area in relation to the pile length and sub-grade response module.

The Shear impact of the second derivative of the flexible curve component with regard to crack propagation is incorporated in the partial differential equations. For the non-trivial solution of the linear homogenous system of equations achieved because of the values of axial forces on the pile, the form factors, and border conditions of the pile, both ends free and both ends simply supported, naturally circular vibrations and relative tightness of the pile are estimated. The outcomes are displayed in diagrams[16].

The function of vertically laden open-head piles in sand experiencing sideways soil motion was investigated using an experimental device (wf). There have been a huge number of tests to date. Here are 14 example model pile tests with two diameters, two vertical pile loads, and a different depth of sliding, powered by a triangle loading block, using the WF motion. Driving force as well as the resultant shear (T), bending moment (M), and bending (y) on the wf/standardized movable depth piles will be supplied with results. The tests allow simple phrases taken from the theory of a simply supported stack to be suggested. With the present model testing and a 3-5 times variation in the maximal bending moment (Mmax) of various load modes, the new expressions well describe the development of M, T, and Y. They also give a positive assessment of Mmax for 8 in situ battery tests and 1 rotational test battery. The study evaluates the slid ability of the specified wf profiles, battery locations (boundary-relative) and vertical load by a battery. It determines the linear connection of the feel the power (resistance T) to Mmax irrespective of wf quantity[17].

IV. CONCLUSION

The document emphasizes the relevance of bending diagrams in the civil engineering sector and sharing force. Studies demonstrate that if we disregard the shaft force and banding moment it is impossible to construct a robust and stable construction. Indeed, as a result of the structure's internal load and external load, the shearing force is the maximum vertical force of the y-axis. To discover out particular situations. When the load acts on a building and weighs itself, the moment of banding is termed because the building wants to bend. Also covered is the impact of bending force on various structural elements, such as beams, columns, stacks, bases, and trusses. Some suggestions for enhancing bending times and shear force diagrams have also been given.

V. RECOMMENDATIONS

The following are suggestions that will further enhance banding moment diagrams in civil engineering and share force.

- By enhancing our knowledge of the bending and bending moment and the diagrammatic, we can make things much easier and more successful.
- We would be further enhanced by developing new techniques to explore existing methods to learn more and to create them more reliable.
- We can thus enhance the shear force and bending force of a component by increasing the quality of building materials with strength such as pressure & impact resistance.
- In the modern world of today, we have created the suitable technology such as the auto disc in our work, to know the shear force and bending time and to correct it as quickly as possible.
- The work performance in Practical Life may be improved by enhancing and improving further the shear strength and time detecting machines of the various items, thereby increasing the accuracy of the findings.
- We can also create various soft goods in this respect, to facilitate, exact and swift the development of shear strength and bending moment diagrams.

As research continues in modern period and so forth, we may get our relevant findings, which will enhance working in the next times, and utilize our time further, by considering the above-mentioned suggestions.

VI. REFERENCES

1. B. Biondi, G. Muscolino, and A. Sidoti, “Ways to determine bending moment and shear force in the subject of movement,” J. Vib. Acoust. Trans. ASME, vol. 126, no. 4, pp. 542–552, 2004, doi: 10.1115/1.1804992.
2. R. Hall, C. Campbell, N. Hubing, and T. Philpot, “Shear Force and Bending Moment Diagram Evaluation of Collaborative Course content,” pp. 10.235.1-10.235.16, 2020, doi: 10.18260/1-2--14778.
3. A. Blakeborough, D. Clément, M. S. Williams, and N. Woodward, “Innovative load cell in mass structure determination to measure axial force, shear force, or bending moment,” Exp. Mech., vol. 42, no. 1, pp. 115–122, 2002, doi: 10.1177/0018512002042001796.
4. A. Recupero, A. D’Aveni, and A. Ghersi, “Moment bending–Shear Force Relationship Fields for Pressure Structural members,” J. Struct. Eng., vol. 131, no. 9, pp. 1413–1421, 2005, doi: 10.1061/(asce)0733-9445(2005)131:9(1413).
5. P. P. Rossi, “Assessment of the maximum stress of rectangular columns undergoing axial strength, moment of bending and shear force,” Eng. Struct., vol. 57, pp. 339–355, 2013, doi: 10.1016/j.engstruct.2013.09.006.
6. A. M. Talmon and A. Bezuijen, “Shanghai Yangtze River Tunnel estimate of the longitudinally bending moment and shear force: application of Dutch research lessons,” Tunn. Undergr. Sp. Technol., vol. 35, pp. 161–171, 2013, doi: 10.1016/j.tust.2013.01.001.
7. T. X. Yu and F. L. Chen, “Further investigation of plastic cutters in the impulse loaded bands,” *Int. J. Impact Eng.*, vol. 24, no. 6–7, pp. 613–629, 2000, doi: 10.1016/s0734-743x(99)00038-x.
8. S. T. Smith and J. G. Teng, “The shear-bending effect of FRP-plated RC rays in deformation collapse,” Adv. Struct. Eng., vol. 6, no. 3, pp. 183–199, 2003, doi: 10.1260/136943303322419214.
9. J. C. D. Hoenderkamp, “Shear wall with trusses on the base of the wall and the column,” Struct. Des. Tall Spec. Build., vol. 13, no. 1, pp. 73–87, 2004, doi: 10.1002/tal.235.
10. J. Machacek and M. Cudejko, “Composites steel longitudinally shear and cement structures,” *Eng. Struct.*, vol. 31, no. 6, pp. 1313–1320, 2009, doi: 10.1016/j.engstruct.2008.07.009.
11. M. J. N. Priestley, R. Verma, and Y. Xiao, “Prestressed steel concrete columns Seismic Shear strength,” J. Struct. Eng., vol. 120, no. 8, pp. 2310–2329, 1994, doi: 10.1061/(asce)0733-9445(1994)120:8(2310).
12. J. Zhang and S. Y. Xu, “Calculation of bridge seismic behaviour assuming a shear-flexive column relationship,” Struct. Eng. Mech., vol. 31, no. 5, pp. 545–566, 2009, doi: 10.12989/sem.2009.31.5.545.
13. E. O. L. Lantsoght, C. van der Veen, and A. de Boer, “Ruytenschildt Bridge's shear and moment limit,” Maintenance, Monit. Safety, Risk Resil. Bridg. Bridg. Networks - Proc. 8th Int. Conf. Bridg. Maintenance, Saf. Manag. IABMAS 2016, pp. 2212–2219, 2016.
14. A. González, D. Cantero, and E. J. Obrien, “Shear force static increase led to huge vehicles that cross a

road bridge," Comput. Struct., vol. 89, no. 23–24, pp. 2261–2272, 2011, doi: 10.1016/j.compstruc.2011.08.009.

15. S. Gupta, S. Akhtar, and A. Hussain, "The impact of the Shear Wall positioning on the bending moment of the multi-purpose building Loading," Int. J. Comput. Adv. Eng. Res., vol. III, no. II, pp. 1–21, 2016.

16. H. H. Catal, "Free vibrations of substantially reinforced piles with radial and shear moment impacts," Eng. Struct., vol. 24, no. 12, pp. 1615–1622, 2002, doi: 10.1016/S0141-0296(02)00113-X.

17. W. D. Guo and H. Y. Qin, "Strength and bending time of stiff soil-moving piles," Can. Geotech. J., vol. 47, no. 2, pp. 180–196, 2010, doi: 10.1139/T09-092.