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Investigate the Zone of Plastic and Crack the Reason in Cylinder Bridge Piers Using Finite Element Method

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ABSTRACT: As of late, the transportation framework of our territory has grown quickly, and countless chamber spans have been inherent different spots. During the time spent building and utilizing spans, writes about the nature of the venture because of the event of breaks and, surprisingly, the breakdown of the scaffold are normal. Chamber span breaking can be supposed to be regular beginning and likely infection, frequently tormenting span designing and specialized work force. As a matter of fact, many breaks can be survived and controlled in the event that specific plan and development measures are taken. To additionally fortify the comprehension of breaks in chamber spans, attempt to keep away from the event of additional perilous breaks in the venture. In this task, we ought to make a thorough examination and synopsis of the sorts and reasons for breaks in chamber scaffolds to work with the plan and development to figure out the control. The plausible approach to breaking can accomplish the job of anticipation by utilization of plastic.

KEYWORDS: Bridge engineering; Cracks; Causes; Analysis, Plastic, FEA etc.

I. INTRODUCTION

Spans expect a crucial part in every transportation association. Whenever equal powers are thought about, the introduction of an extension depends commonly on the docks that help the superstructure. This further requires the supporting docks to act with the goal that the inspiration driving the extension is fulfilled reliably of organization while it very well may be presented to various powers including sketchy equal or seismic powers. This approach to acting of scaffold areas can be ensured by giving agreeable flexibility as the arrangement thinking for seismic examination is mainly addressed by malleability and the seismic energy is scattered by post adaptable distortion with the improvement of flexural turns at the wharf base. This is by and large unique when differentiated and the designs where most of the energy of seismic powers is dispersed by game plan of turns in the shafts while expecting the sections not to miss the mark. This speculation in building design is typically suggested as delicate shaft strong section theory. During the post adaptable stage, it is furthermore expected that the dock have sufficient fortitude to get through the powers moved by the superstructure to avoid frustration of the entire system. Anyway, recently the assessment and focuses on range docks, that failed to give sufficient strength after strong seismic quakes, have shown that paying little heed to going through energy dispersing by deforming in the inelastic region, disillusionment in shear was obligated for the critical damage. The distortions in the inelastic region that are as often as possible associated with the mischief to the segment, generally accumulate at the convergences in the end where second demands are most noteworthy..

II. LITERATURE REVIEW

Kwak and Filippou [1997] proposed another spread limited component model and a new building up steel model, which is implanted inside a substantial component, yet represents the impact of bond-slip. They presumed that a) the incorporation of pressure hardening is significant for the freedom of the scientific outcomes from the size of the limited component network, yet in addition for keeping away from mathematical issues regarding break development and engendering, b) the impact of bond-slip is vital in the examination of RC shafts and pillar section gatherings much

under monotonic burdens and c) strain solidifying and bond slip cause inverse impacts on the reaction of RC individuals.

Luna et al. [2003] completed an itemized subsurface examination to figure out the distortion instruments. They suggested a built up soil dike as an answer for the banks that are of huge level. The support ought to be stretched out from the projection a huge distance into the bank. Compressibility of the establishment soils ought to be assessed dependent upon the situation in light of extra boreholes finished before plan behind the extension projection.

Cai et al. [2005] examined the impact of bank settlements on the presentation of the methodology piece. A three dimensional limited component examination was directed considering the communication between the methodology section and the bank soil, and subsequently the partition of the piece and soil. The anticipated inner snapshots of the methodology chunk furnish configuration engineers with a logical premise to appropriately plan the methodology piece thinking about various degrees of bank settlements. Current American Association of State Highway Transportation Officials (AASHTO) code particulars don't give clear rules to configuration approach pieces thinking about the dike settlements.

Al-Nasra et al. [1994] have done a limited component examination of a chunk on-grade and have concentrated on the impacts of piece thickness, modulus of sub grade response, modulus of versatility of cement and so forth. It was presumed that the breaking load increments with decline in modulus of sub grade response..

III. METHODOLOGY

Bridge decks have problems with cracking. Concrete must be engineered to develop characteristics that provide sufficient protection against shrinkage and aggressive agents. Any micro and/or macro cracks network that will develop because of failure to produce high performance concrete will weaken the concrete and provide a path for steel corrosion, eventually leading to structural weakening. These problems are caused to a large extent by thermal movement, early-age shrinkage, and early age settlement. All three of these issues may be counteracted by the addition of polymer fibers. Polymer fibers also assist in reducing crack widths after cracking. Microfibers and microfibrs behave differently, and should be treated differently. Microfibers affect workability by drying the mix out; microfibrs by making finishing difficult. Low to moderate dosages of fibers improve early age compression strength significantly, but 28 day compression strengths are not influenced much. The addition of fibers slightly increases 24 hour splitting tensile strengths; 28 day effects are insignificant. Fibers slightly decrease ASTM unrestrained shrinkage results, measured from 24 hours to 28 days. Fibers drastically reduce early age shrinkage, depending on the dosage level; higher is better, up to a certain point that is different for each fiber.

GEOMETRIC AND MODELLING DETAILS

The hypothetical slender pier was modeled as a solid in MIDAS FEA using primitive box element feature. The height of the box was kept as 7000 mm and the other two dimensions as 500 mm X 500 mm to maintain the slenderness ratio of 14 in both plan directions. A total of 27 models were analyzed reinforcement in longitudinal direction was modeled using 3-D line element. The clear cover for longitudinal reinforcements in all the models was kept as 40 mm. The total number of reinforcing bars and the spacing of the reinforcement in a particular model varies as per the percentage of reinforcement provided in a particular model. The lateral ties are modeled as rectangular curve on the work plane to simulate stirrups in actual pier. The spacing of lateral ties vary as per percentage by volume provided in each model. The figure below shows geometric details of the model.

The percentage of longitudinal reinforcement was varied as 1.5%, 2% and 3%. For each percentage of longitudinal reinforcement, the percentage of shear reinforcement was kept as 0.5%, 1% and 1.5.

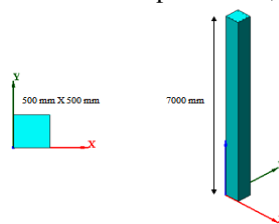


Fig. 2:- Geometric Details Common to all Models (MIDAS FEA)

Three axial load ratios were considered varying as 6%,7%,8% . Hence for each percent of axial load ratio, a total of 9 models were analyzed this way a total of 27 different models were analyzed using MIDAS FEA. Following figure shows the image of a particular model without meshing properties to get an insight about the modeling details.

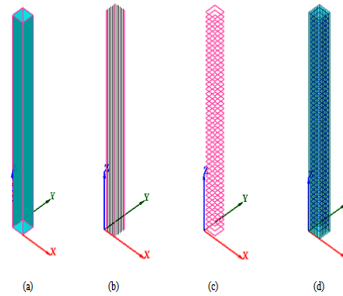


Fig. 3:- Elements Used for Modeling (MIDAS FEA)

In the above figure (a) is the solid primitive box element , (b) is the longitudinal reinforcement modeled as 3D line , (c) is the lateral ties modeled as rectangular curve (d) is the complete model including solid geometry along with longitudinal and lateral reinforcement.

In order to clearly differentiate the models, they were named in a specific manner based on the percentage of longitudinal reinforcement, percentage by volume of lateral ties present and axial load ratio applied on the model. For example, 1.5-0.5-6 refers to the model having 1.5 percent longitudinal reinforcement along with 0.5 percent by volume of lateral ties and subjected to axial load ratio of 6 percent.

Model No.	Name	Percentage of longitudinal reinforcement	Percentage by volume of shear reinforcement	Axial load ration(%)	Spacing between Lateral Ties
1	1.5-0.5-6	1.5	0.5	6	152
2	1.5-1.0-6	1.5	1	6	76
3	1.5-1.5-6	1.5	1.5	6	51
4	2.0-0.5-6	2	0.5	6	152
5	2.0-1.0-6	2	1	6	76
6	2.0-1.5-6	2	1.5	6	51
7	3.0-0.5-6	3	0.5	6	152
8	3.0-1.0-6	3	1	6	76
9	3.0-1.5-6	3	1.5	6	51
10	1.5-0.5-7	1.5	0.5	7	152
11	1.5-1.0-7	1.5	1	7	76
12	1.5-1.5-7	1.5	1.5	7	51
13	2.0-0.5-7	2	0.5	7	152
14	2.0-1.0-7	2	1	7	76
15	2.0-1.5-7	2	1.5	7	51

For all the models , the material properties , diameter of longitudinal reinforcement , diameter of lateral ties was kept same. The following table shows the details of the factors common to all the models.

Table No. 1:- Parameters Common to all the Models (MIDAS FEA)

S No	Description	Value
1	Grade of concrete	M40
2	Grade of longitudinal reinforcement	Fe 500
3	Grade of shear reinforcement	Fe 415

4	Diameter of longitudinal reinforcement	20 mm
5	Diameter of shear reinforcement	12 mm
6	Modulus of elasticity of concrete	31622 N/mm ²
7	Modulus of elasticity of steel	205000 N/mm ²
8	Poisson's Ratio for concrete	0.2
9	Poisson's ratio for steel	0.3

IV. RESULTS AND DISCUSSION

RESULTS FOR CONSTANT AXIAL LOAD RATIO

In this section the results are presented considering constant axial load ratio. For three different axial load ratios (i.e. 6% , 7% , 8%), results are presented in three different sub-sections. Nine models per axial load ratio were grouped together based on the longitudinal and lateral reinforcement provided. In each section , first the images obtained after analysis are shown and then the results are presented as graphical representation as per the variation of other two factors i.e. percentage of longitudinal reinforcement and amount of lateral ties expressed as percent by volume.

In the images obtained from analysis, the blue color zone depicts the zone of plasticity while the red color zone represents fully open or total cracked zone. The grey color depicts the portion of the model that is uncracked and still elastic.

Axial Load Ratio : 6 %

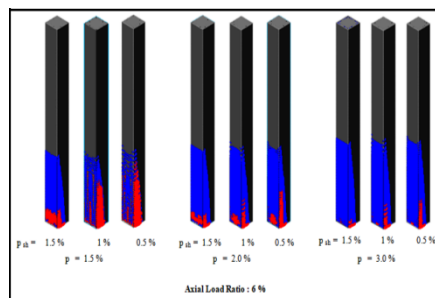


Figure No1.- Height of Fully Open Cracked Zone for Axial Load Ratio : 6% (MIDAS FEA)

The plasticity status of the meshed elements and fully cracked zone of nine models subjected to axial load ratio of 6% , (i.e. 2.4 N/mm² pressure applied on top of the pier) is presented in Figure 4.1. These results were extracted individually for each model and compiled and placed adjacent to each other to facilitate effective comparison. It can be clearly seen from Figure 4.1 and Figure 4.2 that the length of the zone where fully open cracks are spread (marked red) is increasing as the percentage of lateral ties decreases for a particular percentage of longitudinal reinforcement.

This is because with the decrease in volumetric percentage of lateral reinforcement the spacing between the individual ties increases. Here the variation in spacing is 51 mm, 76 mm and 152 mm for percentage of lateral reinforcement 1.5, 1.0 and 0.5 respectively. For a lesser spacing the chances of cracked concrete to spall away is less in comparison to the models with larger tie spacing. The part of concrete which may exceed tensile stresses more than the rupture stress is effectively confined for a lesser tie spacing, although the stresses in ties may increase. These results indicate that as the percentage of lateral reinforcement is increased the height of fully open cracked zone decreases. However, this does not mean that we should increase the percentage of lateral reinforcement as 2% or 2.5% to further decrease this height of fully open cracked concrete. This is because the clear spacing between the ties should never be lesser than the maximum size of aggregate used in concrete to allow concrete to be effectively poured and moved at the time of casting. If the lateral reinforcement is increased beyond a certain percentage, there are chances that the steel ties may not be properly embedded on all sides in the surrounding concrete and the composite action between steel and concrete may not be effective.



V. CONCLUSION

Fibers dramatically change failure types; all failures were more ductile. The optimum dosage rate for Stealth fiber seemed was approximately 3 lb per cubic yard; the benefits were moderate. Grace Microfiber's optimum dosage rate was 3 lb per cubic yard, and the benefits seen were significant. The best dosage rate for Strux 90/40 was about 10 lb per cubic yard, and that dosage showed exceptionally good plastic shrinkage benefits, greater than any other mix in this research. Finally, the HPP fiber had its optimum dosage rate at either 5 lb per cubic yard, and had the best strength results in this study. The unrestrained shrinkage from time zero test performed excellently. This test allowed good quantitative measurements to be made of plastic shrinkage starting at the batch time. The results correlated well with the ASTM unrestrained shrinkage test.

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