Compressive Membrane Action

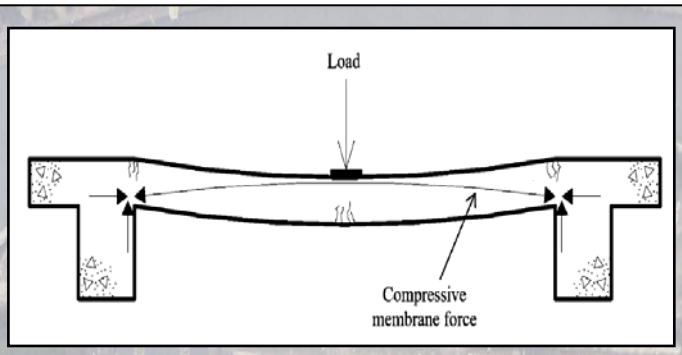
Assessment of ultimate load carrying capacity of concrete decks

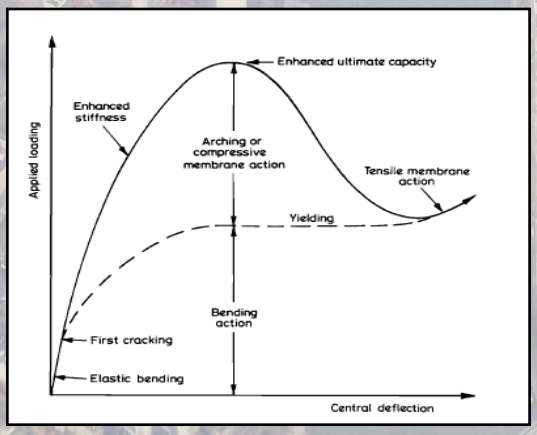
RESEARCH SCHOOL
INTEGRAL DESIGN OF STRUCTURES

Speerpunt BOUW

Subject

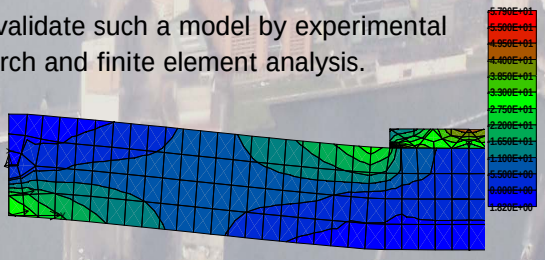
The strength enhancing effect of compressive membrane action is usually neglected while estimating the ultimate load carrying capacity of concrete bridges. Many bridges may not need strengthening if this arching phenomenon is taken into account while assessing their real capacities.

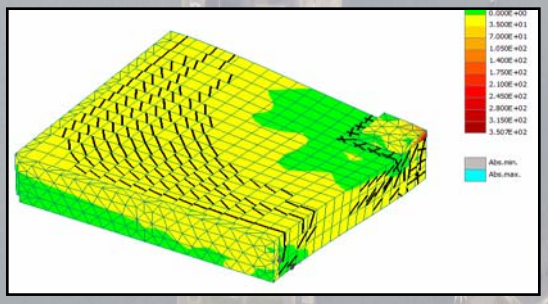




Goals

- To review existing methods that predict the ultimate capacity of laterally restrained deck slabs considering CMA.
- To develop an engineering model that calculates flexural and punching capacities of T-girder concrete bridges under concentrated loads.
- To validate such a model by experimental research and finite element analysis.





Expected Results

Development of a bridge assessment model that fully utilizes the effect of strength enhancement by CMA. Existing bridges can be analyzed and their safety can be predicted. New designs can be made with a low percentage of reinforcement leading to a saving in cost and fewer problems such as to large crack widths.

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Assessment of ultimate load carrying capacity of concrete decks

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Subject
In the Netherlands, there are a large number of bridges that were built back in the 60's and 70's or even earlier. Such structures were built using the knowledge of construction and design available at that time. Since then, not only the traffic flow has increased drastically but additional safety requirements have been incorporated into design codes. Therefore, there is a need for such structures to be analyzed in order to determine whether they should be strengthened or not. It may be the case that such bridges need not to be strengthened if the arching action or the compressive membrane action of concrete decks is taken into account while assessing their real capacities.

Goals
The objective of this research is to develop an engineering model that calculates flexural and punching capacities of T-girder concrete bridges under concentrated loads. Such a model will be validated by experimental research and finite element analysis.

Research Question
- Does the compressive membrane action enhance ultimate capacity to such an extent that rehabilitation or strengthening of bridges is not required? If yes, then, upto what extent?
- What are the factors that influence CMA and what type of failure becomes critical if a bridge deck is analyzed using this approach?

Strategy
The strategy is to first analyze various theories already used in past and to select the best way to approach this problem. Then to develop a theoretical model that incorporates the strength enhancing effect of compressive membrane action into structural analysis and validate this model experimentally and by finite element modeling.

Expected Results
It is expected that a bridge assessment model will be developed that fully utilizes the effect of strength enhancement by CMA. Existing bridges can be analyzed and their safety can be predicted accurately. New designs can be made with a low percentage of reinforcement leading to a saving in cost and fewer problems such as to large crack widths.

Preferred Partners Applications / Sponsors
Rijkswaterstaat (Ministry of Transport, Public Works and Water Management, the Netherlands)

Research Period
2009 - 2013