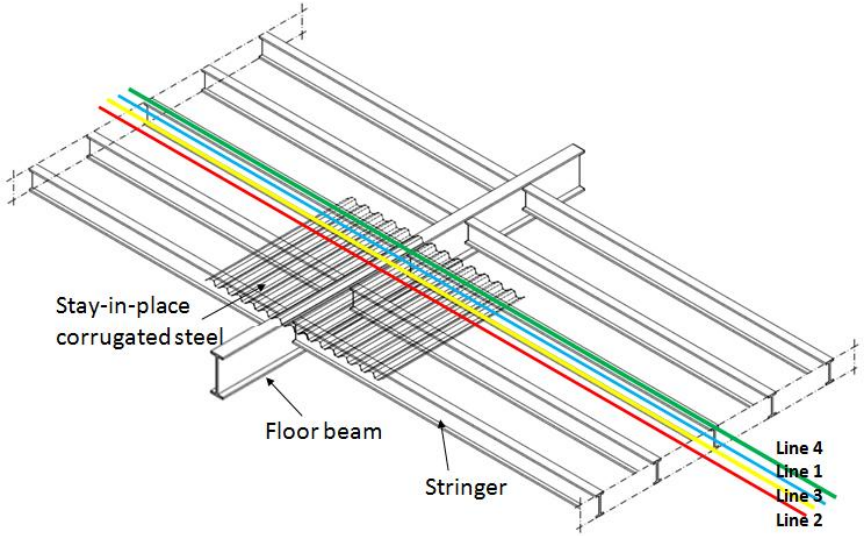
ASSESSMENT, REPAIR AND HEALTH MONITORING FOR CONCRETE-STEEL DECK OF HIGHWAY BRIDGES



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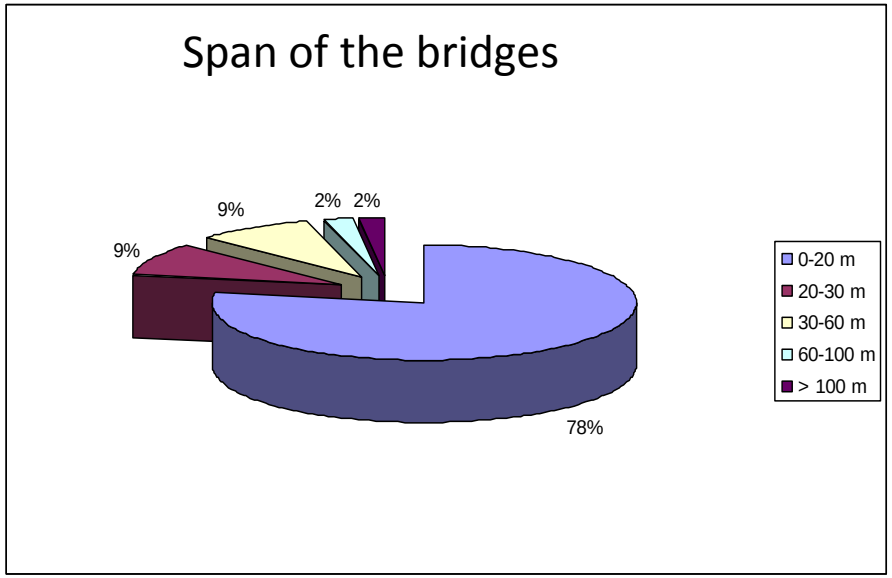
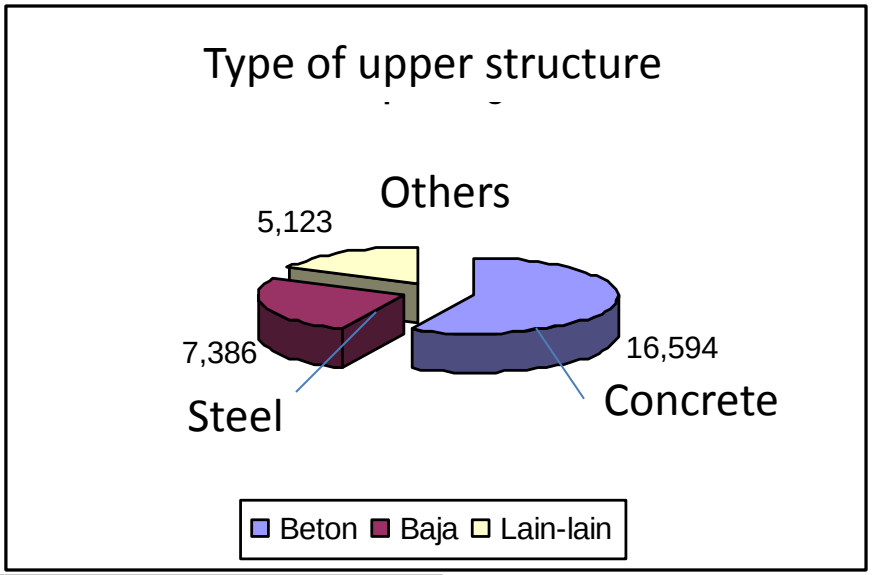
Outline of presentation

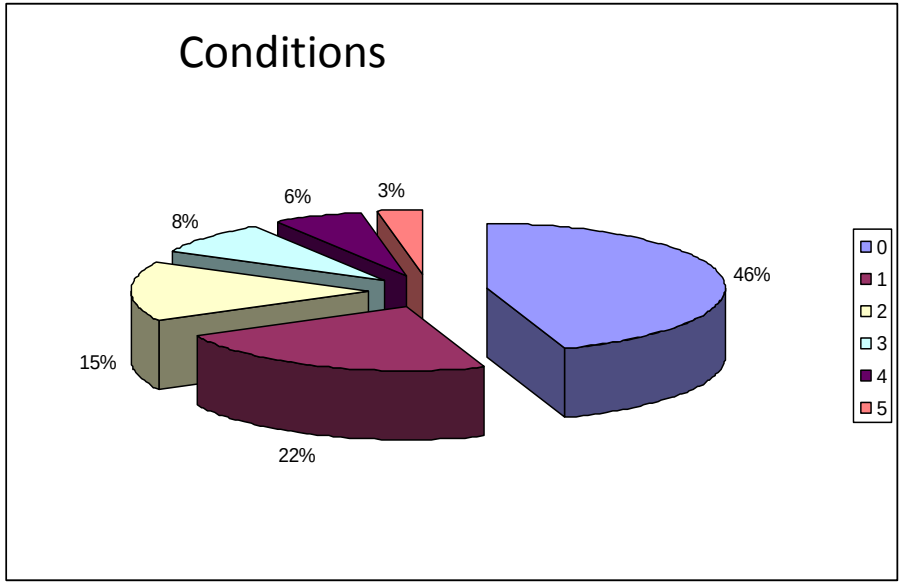
- Background
- Cracking of the Concrete Deck Slab
- Idealization of Analysis and Design of Concrete Deck Slab
- Repair Methods
- Inspection Procedures for Evaluation of the Damage
- Conclusions

Background

Bridges in Indonesia

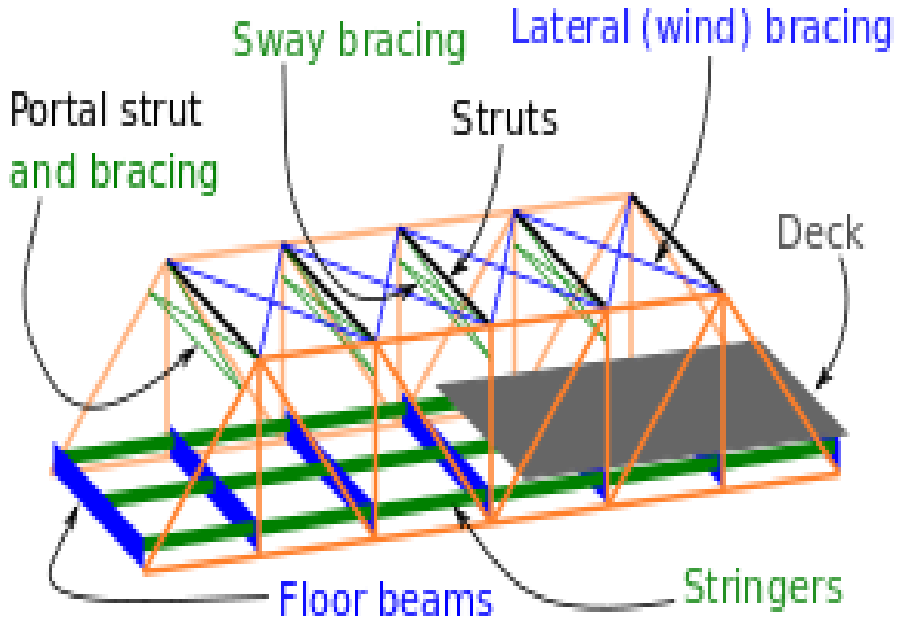






Background

- The concrete deck slab is commonly use for highway bridges in Indonesia, because the material is easy to find everywhere
- The concrete slab can constructed with corrugated steel as stay-in-place formwork
- After a period of time, cracks appear in the slab in transverse direction near floor beams



Bridge deck system using corrugated steel

Cracking of the Concrete Deck Slab

- Cracks appear in transverse direction near floor beams along the wide of the bridge deck
- The cracks is usually caused by vehicle loads
- Overloads cause excessive the cracks and degradation of the stiffness of the slab
- Wave deflection of the slab in longitudinal direction → produce vibration and advanced cracking

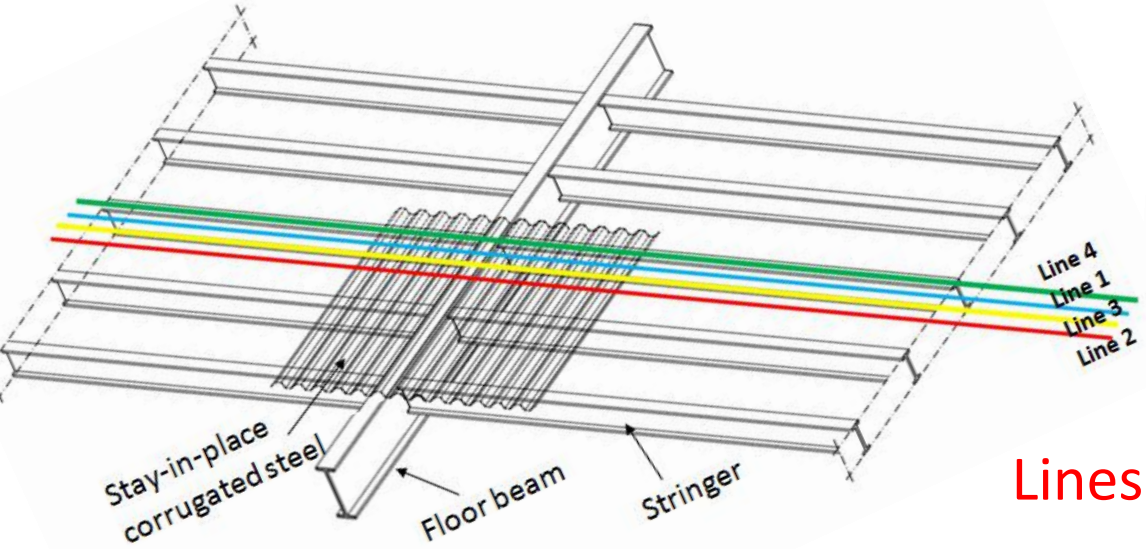
Cracking of The Concrete Deck Slab

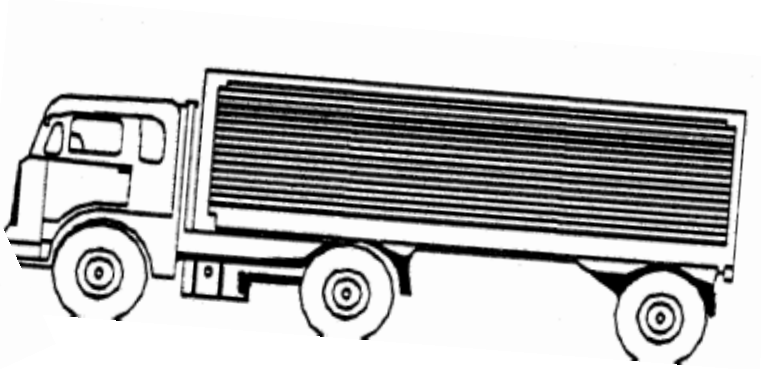
Cause of Cracking

- Idealization of analysis and design of concrete: the deck slab is assumed as one way slab in transverse direction
- The slab has strong flexural capacity only in one direction (transverse direction)
- The corrugated steel and the main reinforcement are placed in the transverse direction

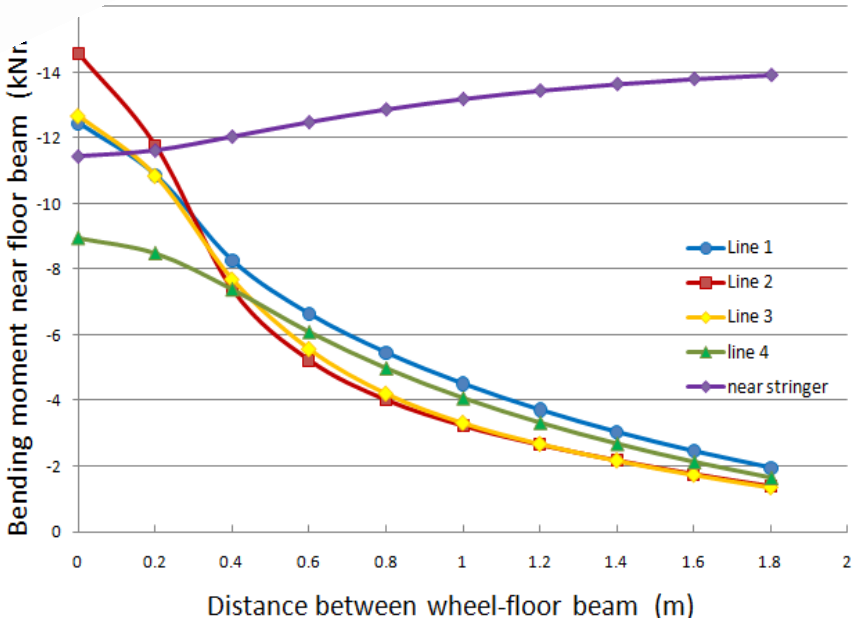
How the vehicle load cause cracks of the slab

- Slab is modeled as plate element
- Vehicle wheel load (standard truck for Indonesian Loading) is rolled on the deck parallel to the longitudinal direction of bridge
- The flexural bending moment in transverse and longitudinal direction are observed by using some line loading arrangement





Lines of the wheel loads



Flexural bending moment M of the slab cause by movable wheel load

Result of the model

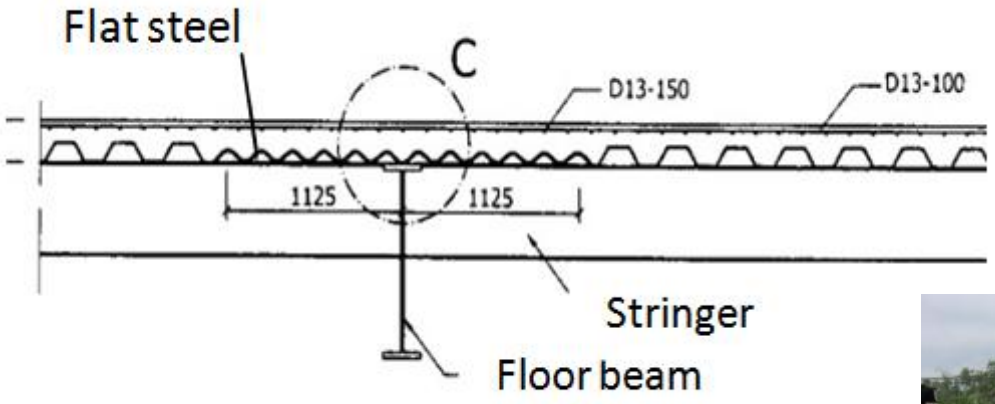
- If the wheel is still far away from the floor beams, almost the whole load is transferred to the stringers. It support the assumption of idealization of the analysis and design.
- If the load come nearer, the partial of the wheel is transferred to the floor beams and appear negative bending moment above the floor beam in longitudinal direction. It can not be found by using the idealization
- This flexural moment is getting higher if the load is coming closer to the floor beams

Result of the model

- This negative bending moment caused high tension stress in the concrete under standard loading → cracks in transverse direction
- Degradation of the stiffness of the deck slab

Repair methods

- The main purpose of the repair is prevent cracks and enhance bending moment capacity → thickening of the deck slab
- In order to maintain the same surface level, thickening must be done in the bottom site of the slab
- Removing and replacing of the concrete and corrugated steel in the deterioration zone
- Removing the whole concrete if the cracks have been spread in a large area



Thickening of the concrete slab

Repaired concrete deck slab with stay-in-place flat steel

Inspection procedures for evaluation of the deck

- Visual inspection to know cracks in the top layer of the deck, spalling, exposure of reinforcement s and rust staining of steel
- Non destructive test can also be used to know more detail of the damages: crack width and depth, deflection of the slab, corrosion of reinforcement and corrugated steel,

Conclusions:

- Concrete deck slab is commonly used for highway bridges in Indonesia. The concrete slab is made as combination of reinforced concrete-corrugated steel
- After a period of time cracks appear above and near floor beams in the transverse direction along the wide of the bridge deck. The initial cracks usually caused by standard load
- The main purpose of the deck's repair is to prevent cracks and to enhance the bending moment capacity of the slab. Thickening of the deck slab can be applied in the deterioration zone.
- Simple visual inspection procedures can be applied to evaluate the damages of the deck. It can also applied to monitor the health of the deck slab

Thank you
for your attention