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PLANNING FOR IMPROVEMENT OF KRIAN ROAD -KEMANGSEN

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Abstract

Pavement improvement on Kemangsen road is necessary to repair the old concrete pavement, which is corrugated/subside so that it hinders the movement of passengers and goods. Therefore, the improvement of road pavement must comply with predetermined standards. The general objective of the Road Pavement Improvement activity on the Kemangsen road section is to make a technical road plan that follows the heavy vehicle traffic that passes through the road section. The specific objective of the Road Pavement Improvement activity on the Kemangsen road section is to analyze the structure of the old concrete pavement and to plan for field survey-type road pavement improvements to be carried out in this Preliminary Survey is a visual inspection. The Krian–Kemangsen Road was the location where the study took place. Traffic analysis is very decisive in obtaining the optimal corridor and the priority for implementing its development. Land use in the planned alignment area is strongly influenced by the development of the surrounding area, which is expected to develop into a residential area. The consultant will carefully investigate the physical condition of the land because it greatly influences the implementation aspects of Road construction. The selection of construction methods and types of construction is expected to support and follow the natural characteristics around the location of the development plan so that the planning is more economical and environmentally friendly.

Keywords: Improvement, Planning, Road Pavement

1. INTRODUCTION

Sidoarjo, as a city that is the center of the economic lifeblood of one of the regions in East Java, is a city that is growing rapidly both in terms of population and economic growth, so it is required to have a high level of accessibility. The provision of easy, cheap, and efficient transportation fast supports it.

The highway is one of the land transportation whose existence is needed to support smooth transportation and a good economy. The availability of good roads will provide services to vehicles to increase the ease of access for an area (Khumairo' et al., 2019). Roads are the public's most widely used land transportation infrastructure for daily mobility compared to water and air transportation, so the volume of vehicles passing through these roads must be able to be supported by pavement on the roads they pass (Mubarak et al., 2020). The Kemangsen road section is where heavy vehicles pass through the road, which is the access road to and from the city of Sidoarjo.

Improvement of the road pavement on Kemangsen road is necessary to repair the old concrete pavement, which is wav or subside so that it hinders the movement of passengers and passengers. Therefore, the improvement of road pavement must be following predetermined standards. The scope of area in the Road Pavement Improvement Plan on the Kemangsen road section is ± 900 meters.

Figure 1 Road Network

Figure 2 Road Sections

The general objective of the Road Pavement Improvement activity on the Kemangsen road section is to make a technical road plan following the traffic of heavy vehicle loads passing through the road section. The specific objectives of the Road Pavement Improvement activity on the Kemangsen road section are: (a) Analyzing the old concrete pavement structure; (b) Planning for improvement of road pavement. In order to obtain the expected results, in the Planning for Pavement Improvement on the Kemangsen road section, the scope of activities that must be carried out are: (a) Carry out an inventory of the necessary data through surveys and literature studies. (b) Conduct a technical analysis of the development plan for improving road pavement and canals as part of the Kemangsen road network plan (c) Analyze the condition of the soil structure in the study area. (d) Planning design alternatives and selecting the best design and the structure/construction used.

2. LITERATURE REVIEW

2.1. Roads

Roads are all parts of the road, including auxiliary buildings and their equipment, designated for public traffic, which are at ground level, above ground level, below ground and water level, and above water level, except for railroads and cable roads (Jehadus, 2019). Following local economic and social conditions, the planned road is expected to provide adequate efficiency, safety, and comfort.

Pavement thickness planning is the basis for determining pavement layer thickness. Road pavement is a construction built on sub-grade soil, which supports its traffic load. According to Andriyani (2013), Classification of roads is distinguished as follows:

1) According to the road surface
   a) Asphalt/hot mix roads: roads whose surface consists of asphalt or other hardened mixtures.
   b) Gravel road: a road whose surface consists of small gravel, and usually, this type of road is found on pre-asphalt roads.
   c) Dirt road: a road whose surface consists of earth.
2) According to Road Functions Road
   Classification according to road function, according to Sulaiman (2013), is divided into:
   a) Arterial
      Roads Arterial roads serve as the main transportation with the characteristics of long-distance travel, high average speed, and a limited number of entries.
   b) Collector
      Road Collector Road is a road that serves collection transportation with restricted entry characteristics.
   c) Local
      Roads Local roads serve local transportation with the characteristics of short-distance travel and low average speed, and the number of access roads is unlimited.
3) According to the primary road network system
   a) Roads that have the role of serving the distribution of goods and services connecting all national regions and between cities.
   b) Secondary roads: roads that have a distribution service role for goods and services only in urban areas
4) According to the road status
   a) National roads: roads that connect provincial capitals, including toll roads.
   b) Provincial roads: roads that connect provincial capitals to district/city capitals.
   c) Regency/city roads connect district/city capitals, sub-districts, and local activity centers.
5) According to road conditions
   a) Vehicles can traverse good roads at speeds exceeding 60 km/h and for the next 2 years without maintenance on paving.
   b) Medium roads are roads that can be passed by vehicles at 40-60 km/hour and for the next 1 year without road paving rehabilitation.
   c) Slightly damaged roads are roads that can be traversed by vehicles at speeds of 20-40 km/hour and need the repair of road foundations.

d) Heavily damaged roads are roads that can only be traversed by vehicles under 20 km/hour and usually have rough rocky, or muddy soil surfaces.

2.2. Concrete

Concrete has recently been widely used as a building material. Concrete consists of approximately 15% cement, 8% water, and 3% air, the rest is sand and gravel. Plain concrete is obtained by mixing *cement*, fine aggregate, coarse aggregate, water, and sometimes other mixtures. The strength of concrete depends on many factors: the proportions of the mix and the temperature and humidity conditions of the place where the mix is placed and hardens (Sutrisno & Widodo, 2013).

Concrete is formed by hardening a mixture of cement, water, fine aggregate, coarse aggregate, and sometimes *a mixture* when needed. This still plastic mixture is cast into the mold and cured to speed up the hydration reaction of the cement-water mixture, which causes the concrete to harden. The formed material has high compressive and low tensile strength, or approximately 0.1 times the tensile strength (Mukhlisin & Marsudi., 2016). Concrete is a material or materials that have high compressive strength but are weak to tensile strength. Concrete has a tensile strength range from 8-14% of its compressive strength (Ulfa, 2013).

3. RESEARCH METHOD

3.1. Approach to the Problem

Planning consultants need to develop an approach methodology in carrying out this work. This was necessary so that the course of the planning work can achieve the targets expected by the assignor based on the allocated time provided and the required manpower. First of all, what must be carried out was a survey and field investigation (Site Plan), then proceed with detailed design techniques for its physical construction. Most of this primary data were collected through interviews with respondents (user elements), field observations, and measurements. Field surveys and measurements may include (a) Preparation of tools and equipment; (b) Field technical survey; (c) Measurements, descriptions, and photographs of existing conditions.

3.2. Stage of preparation activities and location data survey

3.2.1. Data Collection and Data Compilation

The first step taken by the planning consultant after receiving the Work Order (SPK) was to review the Terms of Reference (KAK) again and start collecting the data needed in planning, both field data and institutional data (standards and references).

3.2.2. Development, Detail, and Engineering Activity Stages

Results of the assistance/coordination above would be improvements to the pre-planned drawings and then developed into detailed drawings and construction drawings in accordance with the construction calculations. It was required in such a way that, in the end, it became a complete drawing as a working drawing ready to be used as an implementation tender document

3.3. Introduction Survey

An introduction survey or Reconnaissance Survey aims to collected supporting data to carried out detailed surveys and collected other data to complete detailed survey data before topographic surveys, traffic surveys, soil carrying capacity surveys, utility surveys, hydrological surveys, environmental surveys, as well as pre-design that would be carried out, because most of the technical data required would be taken during the next survey stage, the type of field survey that will be carried out in this preliminary survey was reviewed.

The overview of Kemangsen visual was intended to: (a) Make preparations so that field work can be carried out as well as possible before the detailed and design surveys are carried out (b) Collect supporting data to carry out detailed surveys. (c) Collect other supporting data to complete detailed survey data. (d) Develop an implementation strategy including the necessary Personnel and Equipment.

3.4. Scope of Work

Scope of work that the consultant had carried out in the Introduction survey activities includes: (1) Preparing a base map in the form of a Topographical Map of 1: 250,000, 1: 100,000 scale, and other supporting maps (Geological Map, Land Use Map) used for determining the outline of the road. (2) Studying the location of the road alignment plans and roads in the surrounding area in terms of geography, socio-economics, and the environment in general. (3) Studying and analyzing rainfall data in the planned route area through existing observation stations or at the local meteorological service. (4) Visually analyze the condition of the subgrade soil in the road and road alignment plan area (5) Made field documentation photos at important locations along the alignment plan.

3.5. Location of Activities

The following map (Figure 3 and Figure 4) provides a visual representation of the location of the Krian - Kemangsen Road Improvement Plan.

Figure 3 Location of Kemangsen Road

Figure 4 Location of Krian Kemangsen Road Improvement Plan

3.6. Criteria Reviewed

The consultant developed the Krian-Kemangsen Road improvement plan from an alternative corridor. This was based on the criteria reviewed as follows: (a) System Road Network (b) Traffic Conditions (c) Topographical Conditions (d) Land Use Conditions (e) Physical Soil Conditions (f) Rivers (g) Utilities (h) Environmental Impact (i) Construction Implementation Aspects.

3.7. Overview of Site Conditions Activities Against Several Aspects of Traffic Flow Traffic

Law No. 22 of 2009 was highlighted the movement of vehicles and people in the Road Traffic Space, while what was meant by the Road Traffic Space was infrastructure designated for the movement of vehicles, people, and goods in the form of roads and supporting facilities.

Traffic analysis was very decisive in obtaining the optimal corridor and the priority for implementing its development. The consultant would be carried out traffic counting on the spot on the road sections around the location with the number of observation points (Traffic Survey Post) at one identified point of the road segment.

Figure 5 Traffic Photos on the Roads around the Road Plan

3.8. Aspects of Topographic

Topographical conditions would determine construction costs, shorter distanced or flat terrain would get lower prices, and land that required stockpiling would also add to construction costs. From the data obtained by the Consultant and field observations, the topography of the study plan area was classified as flat terrain. It was necessary to raise the

road surface so that the surface level of the gulungrejo highway must be added, as shown in the following photo documentation:

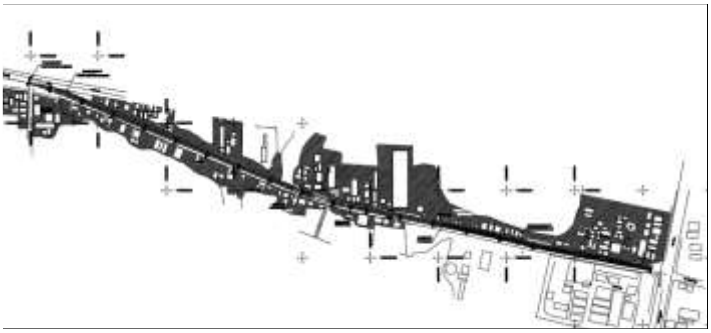

Figure 6 Measurements at the planned location

3.9. Aspects of Land Use Conditions

Topographical land use in the planned alignment area was strongly influenced by the development of the surrounding area, which was expected to develop later as a residential area. In the location survey, there will be densely populated and neatly arranged settlements, offices, industrial areas, tourist areas, military sites, socially vulnerable areas, activity centers, etc.

Figure 7 Condition area at the study plan location

3.10. Aspects of Physical Conditions of Land

The consultant would carefully investigate the soil's physical condition because it greatly influenced aspects of road construction implementation. The physical nature of the soil to be investigated includes soil carrying capacity and classification because the area where the road was located has soft soil and close to rice fields.

Figure 8 Site plan for taking soil samples

3.11. Utility

No high-voltage PLN transmission lines were in the alignment area, so no "clearance" was required around the site. Likewise, with gas pipelines, there were no gas pipelines in the surveyed area around the planned road and road alignment.

3.12. Environmental Impact Aspect

The consultant recommends that UKL / UPL be prepared before the construction phase in the study plan area for environmental impact aspects.

3.13. Aspects of Construction Implementation

The Selection of construction methods and types of construction was expected to support and be in accordance with the natural characteristics around the location of the development plan so that the planning was more economical and environmentally friendly.

Figure 9 Construction Improvement Plan

4. RESULT AND DISCUSSION

4.1. Maintenance and Damage Problems of Rigid Pavement

Road maintenance is a routine activity to maintain existing physical buildings, so they continue to function as planned. Damage that requires maintenance work can be classified into three categories: damage due to initial work, damage due to usage and time, and damage due to special causes / natural disasters.

4.2. Forms and Types of Damage

Types of damage that commonly occur in rigid pavements can be grouped into several types, namely as follows:

1) Deformation. Examples: collapse, fracture, pumping, and rocking
2) Cracks. Example: block, corner, diagonal, longitudinal, transverse, and irregular
3) Damage to filler joints
4) Chipped
5) Damage to slab edges
6) Damage to surface texture. Example: aggregate wear, aggregate roughness
7) Perforated
8) Improper Drainage

Table 1 Recapitulation of Concrete Repair Methods

No	Damage Type	REPAIR METHOD								
		PROTECTION		CORECTION						
		PPK1	PPK2	PPK3	PPK4	PPK5	PPK6	PPK7	PPK8	PPK9
I	Deformation									
1	Vanished				V					V
2	Fault				V					V
3	Pumping					V				V
4	Rocking					V				V
II	Cracked									
1	Block	V							V	
2	Corner	V							V	
3	Diagonal	V							V	
4	Elongated	V							V	
5	Transverse	V							V	
6	Irregular	V								V
III	Seal the joint filler		V							
IV	Chipped			V				V		
V	Slab Edge Damage	V			V					
VI	Surface Texture Damage									
1	Scalling							V		
2	Polished aggregat						V	V		
VII	Hole			V						
VIII	Inadequate Surface Drainage						V	V		

Source: Rigid Pavement Ari Suryawa

Note:
PPK = Maintenance / Repair of Rigid
PPK1 = Filling of Cracks
PPK2 = Closing of Joints Gaps
PPK3 = Filling
PPK4 = Levelling Layer
PPK5 = Injecting
PPK6 = Channeling
PPK7 = Coating
PPK8 = Local Reconstruction
PPK9 = Reconstruction

4.3. Existing Concrete Pavement Study

Table 2 Number of Vehicles and Axis Load

Vehicle type	Number of Vehicle	Number of Axle
Light vehicle 2 tons (1+1)	-	-
Small truck 6 tons (2+4)	1.344	2.688
Large truck 2 axle 13 ton (5+8)	720	1.440
3-axle tandem truck 20 tons (6+7.7)	384	1.152
5-axle tandem truck 30 tons (6+7.7+5+5)	144	720
Total	2.592	6.000

Source: Researcher Calculations

Concrete quality K = 500 kg/cm
Concrete slab thickness = 20 cm
fc = 500 / 10.2 = 49.02 Mpa
fr = 4.34
life 4%, traffic growth 6%

Table 3 Calculation of the Total Fatique

Load axis	Coef axis (ton)	Load plan FK= 1,1	Repetition load	Repetition load x 1,1	Load that occurs (Mpa)	Comparison of stress	Repetition number allowable load	Percentage Fatique (%)
1	2	3	4	5	6 7 8	8	9	10
STRT	2	2,2	37.969.344	41.766.278	1,84,34	0,415	9.470.788	4,41
STRT	5	5,5	20.340.720	22.374.792	1,84,34	0,415	9.470.788	2,36
STRT	4	4,4	37.969.344	41.766.278	1,84,34	0,415	9.470.788	4,41
STRT	5	5,5	4.068.144	4.474.958	1,84,34	0,415	9.470.788	0,47
STRT	5	5,5	4.068.144	4.474.958	1,84,34	0,415	9.470.788	0,47
STRT	6	6,6	10.848.384	11.933.222	1,84,34	0,415	9.470.788	1,26
STRT	6	6,6	4.068.144	4.474.958	1,84,34	0,415	9.470.788	0,47
STRT	6	6,6	-	-	1,84,34	0,415	9.470.788	-
STRT	6	6,6	-	-	1,84,34	0,415	9.470.788	-
STRG	8	8,8	20.340.720	22.374.792	2,24,34	0,507	400.000	55,94
STRG	10	11	-	-	2,24,34	0,507	400.000	-

Load axis	Coef axis (ton)	Load plan FK= 1,1	Repetition load	Repetition load x 1,1	Load that occurs (Mpa)	Comparison of stress	Repetition number allowable load	Percentage Fatique (%)
STRG	10	11	-	-	2,24,34	0,507	400.000	-
STRG	10	11	-	-	2,24,34	0,507	400.000	-
STRG	10	11	-	-	2,24,34	0,507	400.000	-
STRG	10	11	-	-	2,24,34	0,507	400.000	-
SGRG	14	15,4	10.848.384	11.933.222	1,74,34	0,392	16.836.956	0,71
SGRG	14	15,4	4.068.144	4.474.958	1,74,34	0,392	16.836.956	0,27
SGRG	14	15,4	-	-	1,74,34	0,392	16.836.956	-
SGRG	14	15,4	-	-	1,74,34	0,392	16.836.956	-
							Total	70,77

Source: Researcher Calculations

Total Fatique = 70.77% < 100% (OK)

Table 4 Dowel Dimension Requirements

Pavement plat thickness		Dowel diameter		Dowel length		Dowel range	
inch	mm	inch	mm	inch	mm	inch	mm
6	150	¾	19	18	450	12	300
7	175	1	25	18	450	12	300
8	200	1	25	18	450	12	300
9	225	1 ¼	32	18	450	12	300
10	250	1 ¼	32	18	450	12	300
11	275	1 ¼	32	18	450	12	300
12	300	1 ½	38	18	450	12	300
13	325	1 ½	38	18	450	12	300
14	350	1 ½	38	18	450	12	300

Source: Researcher Calculations

4.4. Hydrological Study of Calculation of Drainage Channels

Table 5 Design Flood Discharge With 25 Years

t (hour)	U (t, 1) (m^3/s)	Q Due to Net Rain (m^3/s)						Q Flood (m^3/s)
		55.7193	35.1010	26.7870	22.1122	19.0557	16.8748	
0	0	0.000						0.000
1	0.062823	3.500	0.000					3.500
2	0.214071	11.928	7.514	0.000				19.442
3	0.331583	18.476	11.639	8.882	0.000			38.997
4	0.394432	21.977	13.845	10.566	8.722	0.000		55.110
5	0.39249	21.869	13.777	10.514	8.679	7.479	0.000	62.318
6	0.372542	20.758	13.077	9.979	8.238	7.099	6.287	65.437
7	0.272433	15.180	9.563	7.298	6.024	5.191	4.597	47.853
8	0.22113	12.321	7.762	5.923	4.890	4.214	3.732	38.842
9	0.179489	10.001	6.300	4.808	3.969	3.420	3.029	31.527
10	0.145689	8.118	5.114	3.903	3.222	2.776	2.458	25.590
11	0.118377	6.596	4.155	3.171	2.618	2.256	1.998	20.793
12	0.118288	6.591	4.152	3.169	2.616	2.254	1.996	20.777
13	0.110341	6.148	3.873	2.956	2.440	2.103	1.862	19.381
14	0.102928	5.735	3.613	2.757	2.276	1.961	1.737	18.079
15	0.096013	5.350	3.370	2.572	2.123	1.830	1.620	16.865
16	0.077932	4.342	2.735	2.088	1.723	1.485	1.315	13.689
17	0.072697	4.051	2.552	1.947	1.607	1.385	1.227	12.769
18	0.059007	3.288	2.071	1.581	1.305	1.124	0.996	10.365
19	0.051345	2.861	1.802	1.375	1.135	0.978	0.866	9.019
20	0.044677	2.489	1.568	1.197	0.988	0.851	0.754	7.848
21	0.035515	1.979	1.247	0.951	0.785	0.677	0.599	6.238
22	0.035145	1.958	1.234	0.941	0.777	0.670	0.593	6.173
23	0.030848	1.719	1.083	0.826	0.682	0.588	0.521	5.418
24	0.027792	1.549	0.976	0.744	0.615	0.530	0.469	4.882
25	0.021412	1.193	0.752	0.574	0.473	0.408	0.361	3.761

Source: Researcher Calculations

Drainage calculation
Road length = 900 meters

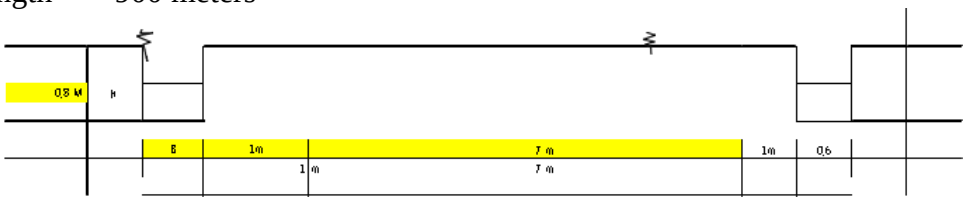

Figure 10 Cross Section of Road

C1 = 0.95
A1 = 7,200 m^2 = 0.0072 km^2
I =135.00
Q = 1/3.6 x C x I x A = 0.256496664 m^3/s
n = 0.02
v = 0.4 m/s
Canal Dimensions
A = Q/V = 0.641241659 m^2
Highest river level = 0.6 meters
B = 1 ,068736098 m
B/2 = 0.5 meter

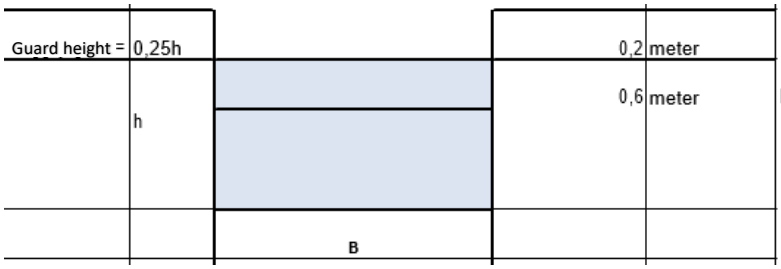

Figure 11 Cross Section of Drainage Channel

4.5. Implementation Method and Equipment and Materials Used

4.5.1. Cross Stitching in Rigid Pavement Maintenance

This method is designed to maintain the strength of rigid pavements, either those with longitudinal cracks or for fastening longitudinal joints experiencing separation. The purpose of cross-stitching is to prevent vertical and horizontal movement so that the width of the crack/joint gap remains in a tight state. Tailoring is considered effective if it distributes the load on the rigid pavement with cracks/elongated joints.

Table 6 Dimensions of Tie Rods and Drilling Hole Locations

Tie Rod Angle	Plate Thickness, mm							
	175	200	225	250	275	300	325	350
	The distance from cracks to holes, mm							
35°	125	145	165	180	195	210	-	-
40°	-	-	-	-	165	180	195	205
45°	-	-	-	-	-	150	165	175
	Tie rod length, mm							
35°	200	240	275	315	365	400	-	-
40°	-	-	-	-	315	350	400	465
45°	-	-	-	-	-	300	350	415
	Tie rod diameter, mm							
	13	19	19	19	19	19	25	25

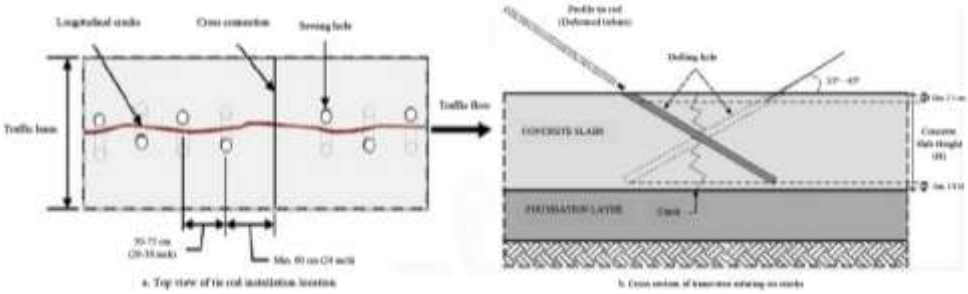

Figure 12 Schematic of Locations of Installation of Tie Rods

4.5.2. Load Distribution Restoration on Rigid Pavements

This method is a rigid pavement maintenance activity carried out by installing several dowel bars in joints or transverse cracks in rigid pavements. The purpose of load distribution restoration is to improve load distribution in the joint or transverse crack so that the difference in the deflection of the two plates separated by the joint/crack is minimized.

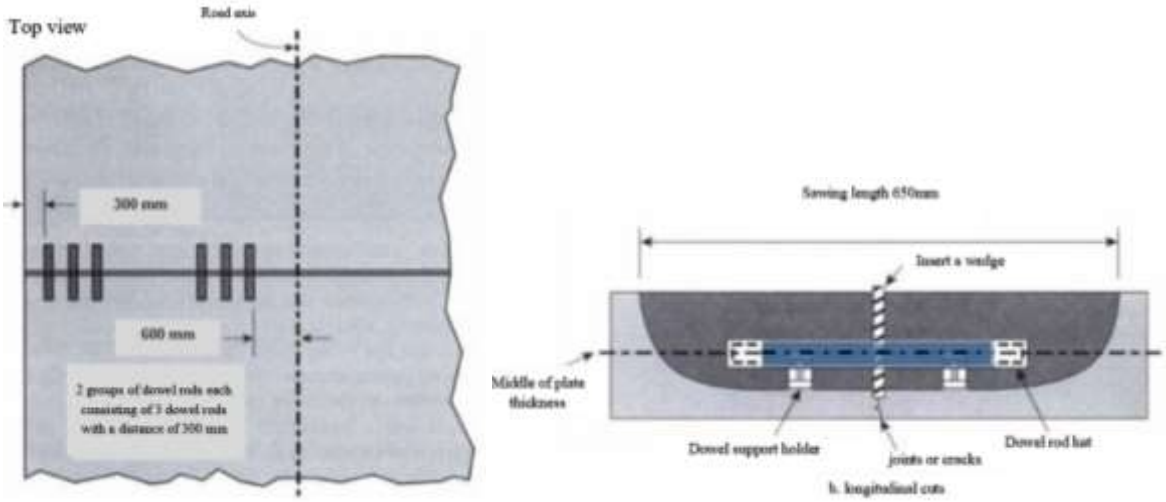

Figure 13 Detailed Gap Design for Dowel Installation -Stabilizing

4.5.3. Restoring the Elevation of Concrete Slabs with Grouting

This method is carried out to restore the bearing capacity of the slab by filling in the cavity under the slab so that the deflection of the slab is reduced and the development of other damage to the slab can be slowed down. Slab stabilization shall be carried out on joints and active cracks (working cracks) that are known to lose their bearing capacity beneath the slab.

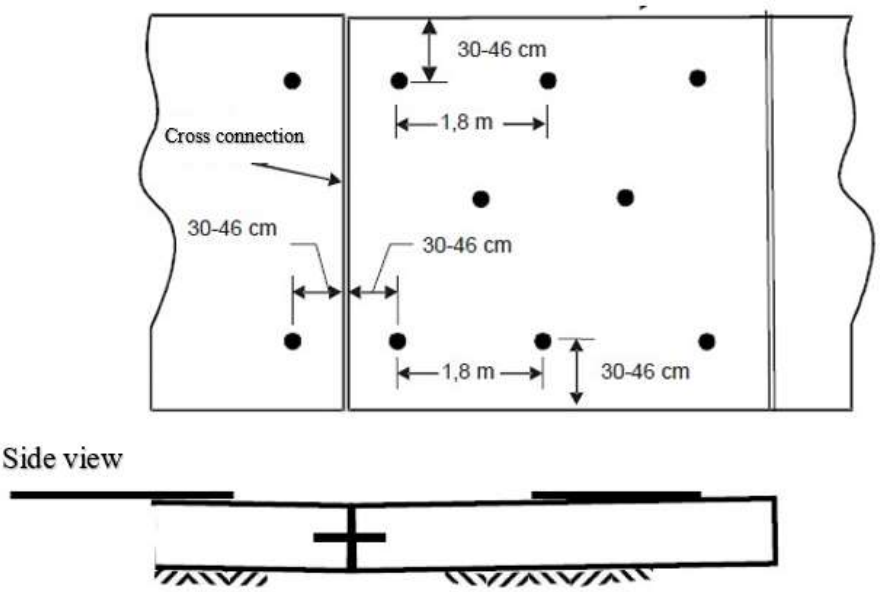

Figure 14 Typical Grouting Hole Patterns to Overcome a Dropped Plate

5. CONCLUSION

Based on the results of the analysis, it can be concluded as follows:

1) From the results of the calculation study, the thickness of the concrete slab is 20 cm, and K-500 meets/can be used
2) Dowels and Tie Bars are not functioning properly, concrete slab segments move horizontally and vertically and experience uplift on one side and open joint cracks and the distance between dowels and tie bars is too far not according to MDP
3) The bottom of the concrete slab needs a layer of lean concrete (Lean-Mix Concrete). Hit by rain.
4) Adding dowels with a diameter of 25 mm of plain iron reinforcement is necessary as a traffic loading restoration.
5) Requires concrete stitching in a longitudinal direction with a diameter of 19 mm threaded iron reinforcement.
6) Requires grouting injections below the surface of the concrete pavement to stabilize the existing concrete pavement.
7) Need to layer the surface using 4 cm asphalt as a leveler to increase the comfort of vehicles crossing.
8) Requires a right-left roadside channel with a wide cross-sectional size in channel width of 600 mm and a height of 800 mm

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