Advanced Engineering Days

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Joints in rigid pavements

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Cite this study: Tanyıldızı, M. (2022). Joints in rigid pavements. 4th Advanced Engineering Days, 67-70

Keywords
Road
Flexible Pavement
Rigid Pavement
Joint
Cracks

Abstract

Road pavements are generally divided into two groups as flexible pavements and rigid pavements and they are named according to the material used as a binder in the construction phase. In flexible pavement, bitumen is used as a binder material. On the contrary, Portland cement is the binder agent in the rigid pavement. Rigid pavements are constructed in situ in three different types: Jointed Plain Concrete Pavement (JPCP), Jointed Reinforced Concrete Pavement (JRCP), and Continuously Reinforced Concrete Pavement (CRCP). In this study, joint types in rigid pavements were addressed. The joint types and their applications were investigated and presented apprehensible within the scope of this study.

Introduction

Roads are structures that transfer the loads applied to them to the sub-structure and can effectively withstand unfavorable environmental effects efficiently [1]. Road pavements are generally divided into two groups: Flexible and Rigid pavements. They are named depending on the material used as binding in the construction. The bitumen used as a binder in the construction of pavement is flexible or asphalt pavement. On the other hand, in the construction of rigid or concrete pavements, Portland cement is used as a binder material. The asphalt roads consist of three main parts. These are sub-base, base, and pavement. The rigid pavements are constructed on a subgrade or sometimes subbase and behave like a rigid concrete beam when transferring the loads. The pavement types change according to the high and low standards of road. If the daily number of commercial vehicles in one direction on a road is more than 5000, it is highly recommended by many institutions to build pavement as rigid [2]. In this study, joint types in rigid pavements were handled. The joint types and their applications were investigated and presented apprehensible within the scope of this study.

Joints in Rigid Pavements

Rigid pavements are generally constructed in three types in situ. These are Jointed Plain Concrete Pavement (JPCP), Jointed Reinforced Concrete Pavement (JRCP), and Continuously Reinforced Concrete Pavement (CRCP). The jointed plain concrete pavements are generally constructed in square blocks shape that is formed by connecting each other with tie and dowel bars to restrain the natural cracks. In jointed reinforced concrete pavement, the joint distances are enlarged by adding reinforced steel bars. The number of reinforced bars has an important role to restrain the cracks in the pavement. Even though there is reinforcement in steel-reinforced concrete blocks, tie and dowel bars come into play when the reinforcement is insufficient. In continuously reinforced pavement, both transverse and longitudinal reinforced bars are used to ensure the transfer of loads. This type of road pavement that does not contain transverse joints is high cost with higher comfort in driving [3].

Rigid pavements are generally constructed as jointed plain concrete pavement types because of being less costly, and their schematic diagram is presented in Figure 1 [3-4].

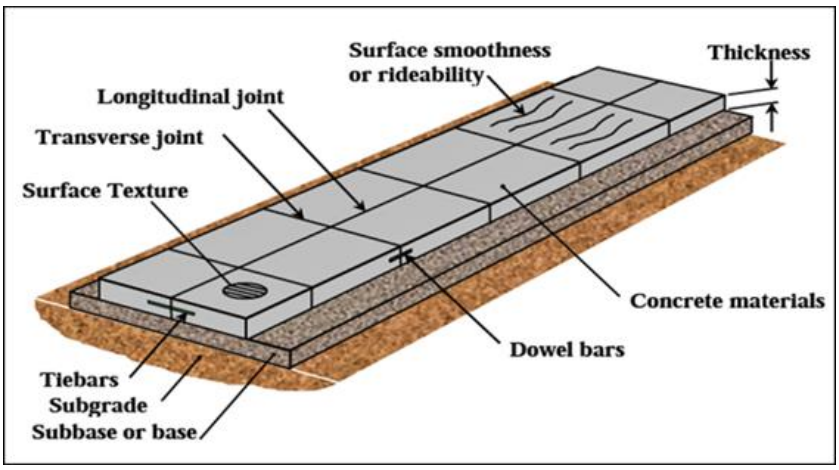

Figure 1. A schematic diagram of JPCP

Joints are deliberately placed discontinuities along a rigid pavement surface. They are generally constructed in two directions: transverse and longitudinal [5].

Transverse Joints

Transerve joints are constructed to restrain the transverse cracks. Transverse joints are placed perpendicular to the center line along the full width of pavement as shown in Figure 1. This type of joint is mainly divided into three parts. These are contraction joints, expansion joints, and construction joints. These joints are formed in two ways. Contraction joints are generally sawed after the placement of rigid pavement. Other joints are created by formwork before constructing the pavement.

Contraction Joints

Contraction joints are the most common type of joint in the rigid pavement, so the generic term "joint" generally refers to a contraction joint [5]. Contraction joints are created to minimize the tensile stresses formed by heat, moisture, and friction, thus keeping cracks under control. It is sawed in the rigid pavement to create a weakened part to regulate the location of cracking resulting from dimensional change of different parts of the concrete structures [6]. If such joints are not created, random cracks will form on the pavement surface. The width of contraction joints is generally 1 cm, and height is approximately 1/3 or 1/4 of the thickness of pavement [4]. A schematic diagram of the contraction joint is presented in Figure 2 [3]. In traverse joints, dowel bars are placed to provide a mechanical connection between adjacent slabs without restricting horizontal joint movement and it is given in Figure 3. Dowel bars increase load transferability from one slab to an adjacent slab and reduce joint failure and corner cracking [5]. A dowel bar is commonly used as 50 cm in length and 32-38 mm in diameter and it is preferred in general that the distance between two dowel bars be 30 cm. Dowel bars should be flat iron painted/oiled with anti-corrosion paint [3].

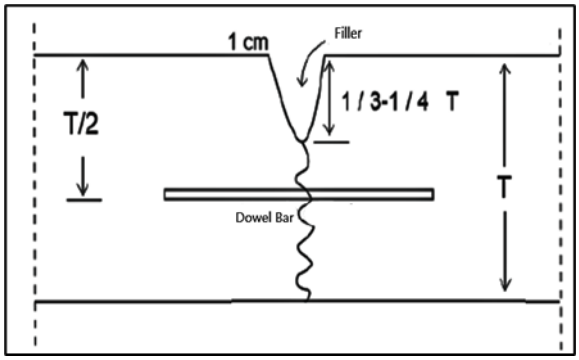

Figure 2. A schematic diagram of contraction joint

Figure 3. Dowel bars used in transverse joints

Expansion Joints

One of the main aims of expansion joints is to minimize the compressive stresses by permitting the expansion of pavement and thus preventing the buckling of pavement. These types of joints are full joints type and they are created along the full depth of the pavement. In this type of joint, also dowel bars are used to supply the load

transfer between adjacent slabs. The joints should be filled with a compressible filling material. The filling material should not deteriorate under variations of moisture and temperature. In general, cork materials can be used as bottom filling material and bituminous materials can be used for top filling [3]. The schematic view of an expansion joint is presented in Figure 4 [3].

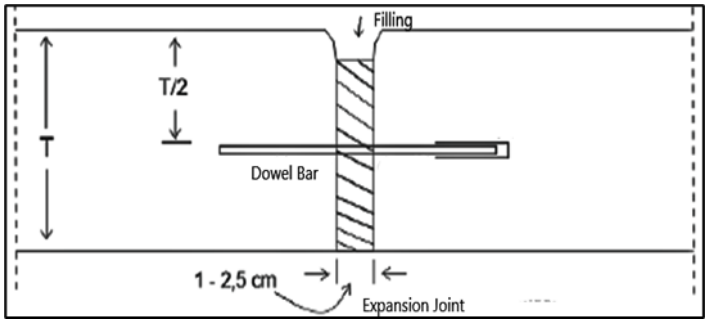

Figure 4. A schematic diagram of expansion joints

Construction Joints

A construction joint is an interface between concrete placements deliberately created to ease construction. In the construction of rigid pavements when the pouring of concrete is stopped at the end of the day or concrete paving is suspended due to any other reason, a construction joint is created. In other words, a construction joint is a joint type that results when concrete slabs are constructed at different times. The construction joints can be created either along the transverse or longitudinal direction. A schematic diagram of the construction joint is presented in Figure 5 [3].

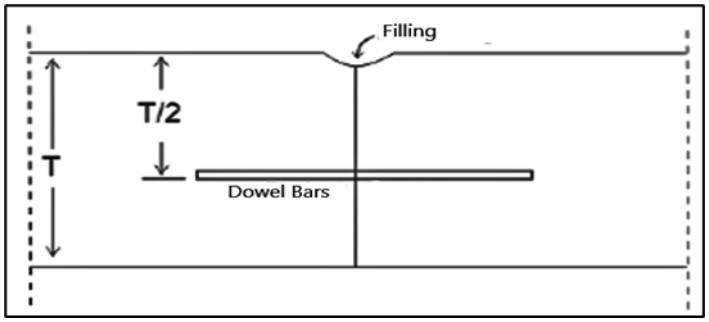

Figure 5. A schematic diagram of construction joints

Longitudinal Joints

The longitudinal joints are created to restrain the longitudinal cracks. These joints are provided longitudinally in rigid pavements that have a width of more than 5 meters. The 7th International Road Congress that took place in 1934 accepted the usage of longitudinal joints when a road has a width of more than 5 meters in principle. And, if the road width is more than 9 meters, it should be used two longitudinal joints along the width of the pavement. Insulation material is applied on the surface of longitudinal joints to prevent the sticking of slabs. In longitudinal joints, tie bars are used to prevent lanes from separation and differential deflection to reduce transverse cracking. Tie bars are chosen as ribbed bars. In general, it is common to use tie bars as 80 cm in length and 12-14 mm in diameter. The distance between two tie bars is generally 80 cm. The schematic diagram of the longitudinal joint is presented in Figure 6 [3].

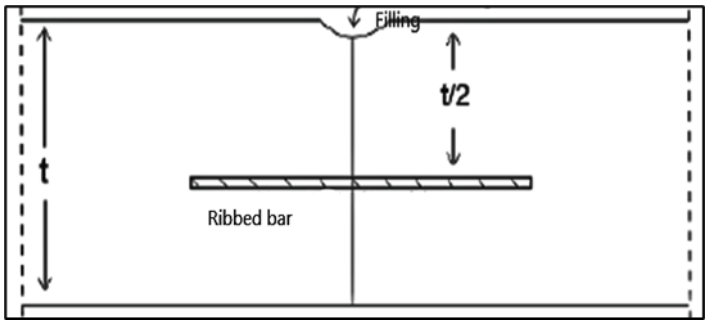

Figure 6. A schematic diagram of longitudinal joints

Conclusion

This study focused on the joints applied in the rigid pavement. The main aim of the joints created in the rigid pavement is generally to restrain the formation of cracks. The knowledge about the joints applied in the rigid pavement presented here is crucial in understanding them and their applications. And also, it is important to look for other parameters that can be learned through comprehensive experience and knowledge.

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