Pavement (material)

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Pavement (American English) or **road surface** (British English) is the durable surface material laid down on an area intended to sustain traffic (vehicular or foot traffic). Such surfaces are frequently marked to guide traffic. The most common modern paving methods are asphalt and concrete. In the past, brick was extensively used, as was metaling. Today, permeable paving methods are beginning to be used more for low-impact roadways and walkways.

Contents

Metalling

Metal or metalling has had two distinct usages in road paving. Metalling originally referred to the process of creating a carefully engineered gravel roadway. The route of the roadway first would be dug down several feet. Depending on local conditions, French drains may or may not have been added. Next, large stone was placed and compacted, followed by successive layers of smaller stone, until the road surface was a small stone compacted into a hard, durable surface.

Road metal later became the name of stone chippings mixed with tar to form the road surfacing material tarmac. A road of such material was called a "metalled road" in British usage, although this would be very rare in modern usage. It would be more common to refer to a macadam road. The word *metal* is derived from the Latin *metallum*, which means both "mine" and "quarry", hence the roadbuilding terminology.

Asphalt paving

Asphalt (specifically, asphalt concrete) has been widely used since 1920-1930, though in ancient times asphalt was already used for road-building. The viscous nature of the bitumen binder allows asphalt concrete to sustain significant plastic deformation, although fatigue from repeated loading over time is the most common failure mechanism. Most asphalt pavements are built on a gravel base which is generally at least as thick as the asphalt layer, although some 'full depth' pavements are built directly on the native subgrade. In areas with very soft or expansive subgrades such as clay or peat, thick gravel bases or

stabilization of the subgrade with Portland cement or lime can be required. In some countries with soft soils, a foundation of polystyrene blocks is used instead. The actual material used in paving is termed HMA (Hot Mix Asphalt), and it is usually applied using a free floating screed.

Advantages of asphalt roadways include relatively low noise, relatively low cost compared with other paving methods, and ease of repair. Disadvantages include less durability than other paving methods, less tensile strength than concrete, the tendency to become slick and soft in hot weather and a certain amount of hydrocarbon pollution to soil and groundwater or waterways.

A road in the process of being resurfaced, showing both old and new asphalt surfaces.

Concrete paving (white paving)

Concrete pavements (specifically, Portland cement concrete) are created using a concrete mix of Portland cement, gravel, and sand. The material is applied in a freshly-mixed slurry, and worked mechanically to compact the interior and force some of the thinner cement slurry to the surface to produce a smoother, denser surface free from honeycombing.

Concrete pavements have been refined into three common types: jointed plain (JPCP), jointed reinforced (JRCP) and continuously reinforced (CRCP). The one item that distinguishes each type is the jointing system used to control crack development.

Jointed Plain Concrete Pavements (JPCP) contain enough joints to control the location all of the expected natural cracks. The concrete cracks at the joints and not elsewhere in the slabs. Jointed plain pavements do not contain any steel reinforcement. However, there may be smooth steel bars at transverse joints and deformed steel bars at longitudinal joints. The spacing between transverse joints is typically about 15 feet for slabs 7-12 inches thick. Today, a majority of the U.S. state agencies build jointed plain pavements.

Jointed Reinforced Concrete Pavements (JRCP) contain steel mesh reinforcement (sometimes called distributed steel). In jointed reinforced concrete pavements, designers increase the joint spacing purposely, and include reinforcing steel to hold together intermediate cracks in each slab. The spacing between transverse joints is typically 30 feet or more. In the past, some agencies used a spacing as great as 100 feet. During construction of the interstate system, most agencies in the Eastern and Midwestern U.S. built jointed-reinforced pavement. Today only a handful of agencies employ this design, and its use is generally not recommended as JPCP and CRCP offer better performance and are easier to repair.

Continuously Reinforced Concrete Pavements (CRCP) does not require any transverse contraction joints. Transverse cracks are expected in the slab, usually at intervals of 3-5 ft. CRCP pavements are designed with enough steel, 0.6-0.7% by cross-sectional area, so that cracks are held together tightly. Determining an appropriate spacing between the cracks is part of the design process for this type of pavement.

Continuously reinforced designs generally cost more than jointed reinforced or jointed plain designs initially due to increased quantities of steel. However, they can demonstrate superior long-term

performance and cost-effectiveness. A number of agencies choose to use CRCP designs in their heavy urban traffic corridors.

Advantages of cement concrete roadways include that they are typically stronger and last longer than asphalt concrete pavements. They also can easily be grooved to provide a durable skid-resistant surface. Disadvantages are that they have a higher initial cost, are more difficult to repair, and are also somewhat noisy if jointed, but unjointed concrete pavement is actually a method of roadway noise mitigation.

Additionally, in areas with cold winters, road salt can damage concrete roadbeds; due to the high cost of replacing the bed, exposed concrete roadbeds are infrequently seen in areas with harsh winters. However, reinforced concrete slabs are more resistant to frost-related ground heaves and pothole formation; heavily used roads in winter-prone urban areas often have concrete roadbeds covered with a thin (3cm) layer of asphalt concrete. This layer can be "skimmed off" and replaced very cheaply when it wears and deteriorates, while the concrete beneath is protected from the harsh elements. In these conditions, concrete roadbeds can last upwards of 50 years when a pure asphalt roadbed is expected to need to be completely replaced several times in this time period, offsetting the higher initial cost.

The first street in the United States to be paved with concrete is Court Avenue in Bellefontaine, Ohio, but the record for first mile of concrete pavement to be laid in the United States is claimed by Michigan.

Bituminous Surface Treatment (BST)

Bituminous Surface Treatment (BST) is used mainly on low-traffic roads, but also as a sealing coat to rejuvenate an asphalt concrete pavement. It generally consists of aggregate spread over a sprayed-on asphalt emulsion or cut-back asphalt cement. The aggregate is then embedded into the asphalt by rolling it, typically with a rubber-tired roller. BSTs of this type are described by a wide variety of regional terms including "chip seal", "tar and chip", "oil and stone", "seal coat" or "surface dressing".

Concrete pavers

BST is used on hundreds of miles of the Alaska Highway and other similar roadways in Alaska, the Yukon Territory, and northern British Columbia. The ease of application of BST is one reason for its popularity, but another is its flexibility, which is important when roadways are laid down over unstable terrain that thaws and softens in the spring.

Other types of BSTs include micropaving, slurry seals and Novachip. These are laid down using specialized and proprietary equipment. They are most often used in urban areas where the roughness and loose stone associated with chip seals is considered undesirable.

Other paving methods

Pavers, generally in the form of pre-cast concrete blocks, are often used for aesthetic purposes, or sometimes at port facilities that see long-duration pavement loading. Pavers are rarely used in areas that see high-speed vehicle traffic.

Brick, cobblestone and wood plank pavements were once common in urban areas throughout the world, but due to their high manual labor requirements they are in some countries typically only maintained for historical reasons, while in other countries they are still common in local streets. They make maintenance of cabling and pipelines under the pavement easier but are also harder to walk on.

Likewise, macadam and tarmac pavements can still sometimes be found buried underneath asphalt concrete or Portland cement concrete pavements, but are rarely constructed anymore.

A brick main street in Lebanon, Illinois

In Kronstadt, there is a road paved with cast iron. It required no repairs for nearly a century.

Acoustical implications

Roadway surfacing choices are known to affect the intensity and spectrum of sound emanating from the tire/surface interaction.[1] Initial applications of this knowledge occurred in the early 1970s. Roadway surface types contribute differential noise effects of up to four dB, with chip seal type and grooved roads being the loudest and concrete surfaces without spacers being the quietest. Asphaltic surfaces perform intermediately relative to concrete and chip seal. These phenomena are, of course, highly influenced by vehicle speed.

Cobbles

Although this is a wall, this image shows a common pattern for pavement, in the symmetry category "wallpaper group cmm"; the same pattern is possible with other length/width ratios; square tiles are also common

Bricks in a Herringbone pattern, in the symmetry category "wallpaper group pgg"; the same pattern is possible with any length/width ratio

Street pavement in Zakopane, Poland in the symmetry category "wallpaper group p3"

Pavement deterioration

As pavement systems primarily fail due to fatigue (in a manner similar to metals), the damage done to pavement increases with the fourth power of the axle load of the vehicles traveling on it. Civil Engineers consider truck axle load, current and projected truck traffic volume, supporting soil properties and sub-grade drainage in design. Passenger cars are considered to have no practical effect on a pavement's service life.

Several pavement design methods have been developed to determine the thickness and composition of pavement required to carry predicted traffic loads for a given period of time. Pavement design methods are continuously evolving. Among these are the Shell Pavement design method, and the AASHTO 1993 "Guide for Design of Pavement Structures". A new mechanistic-empirical design guide has been under development by NCHRP since 1998, but has not yet been adopted by AASHTO.

According to the AASHO Road Test, heavily loaded trucks can do more than 10,000 times the damage done by a normal passenger car. Tax rates for trucks are higher than those for cars in most countries for this reason, though are not levied in proportion to the damage done. [2]

The physical properties of a stretch of pavement can be tested using a falling weight deflectometer.

Further research by University College London into pavements has led to the development of an indoor 80 sq metre artificial pavement at a research centre called Pedestrian Accessibility and Movement Environment Laboratory (PAMELA). It is used to simulate everyday scenarios, from different pavement users to varying pavement conditions. [3]

See also

- Road

Line notes

1. ^ C.M. Hogan, *Analysis of highway noise*, Journal of Water, Air, & Soil Pollution, Volume 2, Number 3, Biomedical and Life Sciences and Earth and Environmental Science Issue, Pages 387-392, September, 1973, Springer Verlag, Netherlands ISSN 0049-6979 (http://www.springerlink.com/content/x1707075n815g604/)
2. ^ http://epw.senate.gov/107th/Dull_093002.htm
3. ^ http://news.bbc.co.uk/1/hi/sci/tech/5333936.stm

References

- When to pave a gravel road (http://www.wsdot.wa.gov/TA/T2Center/Mgt.Systems/PavementTechnology/AppendixD-WhentoPaveAGravelRoad.pdf)

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