



ROAD PAVEMENT SETTLEMENT DETERMINATION

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ABSTRACT

Settlement is a type of pavement defect that occurs majorly due to induced stresses from vehicular wheel load repetitions on the pavement. Though pavement settlement after construction cannot be avoided it is a continuous process but the degree at which it settles, that take the center stage. In this work the factors that can cause settlement were spelt out and analysed, the response of the pavement to these factors was observed using the dumpy level to take the differential settlement of the pavement on periodic basis of two weeks, a settlement of 5mm, 9mm and 13mm respectively was observed for the duration of the study, from the observed result it can be said that the pavement was subjected to mild stresses because there are less trucks and buses using the road way. The small settlement noticed shows that the pavement design satisfies the traffic load and environmental condition.

Keywords-: Settlement, traffic load, wheel load, pavement.

1 INTRODUCTION

Road transportation is one of the most common modes of land transportation. Roads in the form of tracks, human pathways etc. were in use long before now, but many improvements has been made to this mode of transportation make it safe and comfortable. Thus road construction became an inseparable part of civilization and growth of empires. (Carpenter, 1993).

A road is therefore said to be paved or unpaved track or path on land to ease transportation of people and materials between two points. It can also be defined as a route, thoroughfare or way on land between two places, which typically has been paved or improved to ease transportation (Hart-Davis and Adam, 2001).

The paved surfaces of the road are commonly constructed of asphaltic materials. It consists of mineral aggregates bound together with bitumen laid in compacted layers, which has been in use since the eighteenth century facilitated by the advancement in road construction technology call pavement (Abaza, and Abu-Eisheh, 2003).

Pavement types include flexible, rigid and composite pavement. The flexible pavements also known as asphaltic pavement has its surface layer made of asphalt which is laid on underlying strata, made up of the sub-grade, sub-base and base layers. Contrarily; the rigid pavement are made of concrete while the composite pavements have their bases stabilized with asphaltic materials and the top layer bonded with cement or pozzolanic materials (O'Flaherty, 2010).

Asphalt paving mixes are usually prepared at an asphalt mixing plant. There are three types of asphalt mixes: Hot-Mix, Warm-Mix and Cold-Mix (www.wikipedia.com). Hot-Mix asphalt (HMA or HMAc) is more commonly used especially in developing countries that has little or no access to cold asphalt technology, while the use of

Cold-Mix asphalt has replaced the use of Warm-Mix asphalt (WMA) and Hot Mix Asphalt (HMA) developed countries. Cold-Mix asphalt (generally made with emulsified or cut back bitumen) is used for light medium traffic secondary roads, or for remote location or maintenance uses. Hot mix asphalt (HMA) pavement as it is more commonly called, refers to the top layers of a flexible pavement structure. For most application asphaltic concrete is placed as HMA, which is a mixture of coarse and fine aggregate, and bitumen binder.

The term Hot-Mix is derived from the process of mixing the aggregate and bitumen under elevated temperature of about 150 and 166 degree centigrade for virgin and polymer modified asphalt respectively to obtain sufficient fluidity and remove water from the aggregate for proper mixing and easy laying.

The determination of the settling rate of cold asphalt is one of the methods used to determine the suitability of cold mix asphalt for pavement work. This can be done either by subjecting the asphalt to traffic and atmospheric conditions or by laboratory analysis. (Kolo, 2014)

Asphaltic settlement generally occurs due to traffic loading and environmental changes resulting in the volumetric change of the asphaltic thickness, soil moisture reduction. Settlement of asphaltic pavement is the differential variation of the pavement thickness due to traffic load or usage of the pavement, which occurs when the asphalt pavement is subjected to variations in traffic loading and atmospheric conditions such as rainfall and temperature etc.

Pavement settlement is a form of road defect among others like rutting, corrugation, raveling etc, it is said to be gradual downward movement (sinking) of the asphalt surface after construction in relation to its initial level on the road surface when it was newly constructed (Kings, 2010). They result from the surface stresses that the pavement is subjected to.



Pavement stresses are observed on structural response model, which is said to be the model that defines the response of the asphaltic pavement to loadings in terms of stresses, deflections and strain, how pavement respond to applied stresses determine their structural behavior (Kolo, 2017). The surface layer of the entire pavement is looked upon for its responses to load bearing. The surface layer of the newly constructed Bahago road situated in Minna; (lat. 9.61524 and longitude 6.54776) with an estimated population of 321,687, which is a dual carriage road with sidewalks linking Bahago roundabout. The construction project cost is about ₦1.4bn is a 3.4km road intended to reduce the cost and time of motorists between Minna and Maitunbi (Alhaji Muazu Bawa, 2014) former Niger state commissioner of works.

2. METHODOLOGY

The method adopted for this research work is in to form (a) traffic count (b) settlement determination and (c) Temperature Determination.

- (a) Traffic count was conducted on the study area to estimate the load on the pavement per day the manual method of count was adopted, from 6am – 6pm daily for a period of one week on both carriages. This gives the estimated volume of traffic weekly and the vehicle classifications passing the roadway. The vehicle classification considered were passenger cars, trucks and buses.
- (b) Settlement determination: In determining the rate of settlement with traffic load the dump level was used, the road was marked from chainage 0+00 to 0+500 at 25m intervals (total of 20 points) with measurement taken with the odometer wheel tape and the points being marked with paint for proper identification and accuracy.

The steps taken in determining the settlement rate of the pavement are outlined below.

- i. The distance between each chainages were measured as 25m and marked
- ii. The Temporary bench mark was established
- iii. The leveling instrument was set up at the mid-point of the entire distance for easy coverage.
- iv. The staff was placed at the temporary benchmark and the level at that point was recorded as back sight
- v. The staff was moved to the first point 'chainage 0+00' the reading at this

point was recorded as intermediate sight.

- vi. The staff reading for the next point was also taken as the backsight and so on to the last reading termed foresight

The levelling process was repeated at interval period of about 2 weeks at the established points; this was done to determine the different in level of the road with respect to traffic and time.

- (c) Temperature determination: the daily temperature of the environment was obtained on daily basis, this accounts for the air or Environmental temperature, this is done with the aid of the Microsoft weather application software. (weather version 4.3.193.0), the highest temperature for the day is considered as the air temperature for the area, with asphaltic pavement absorbing more of the air temperature and cooling off very slowly the environmental (air) temperatures obtained were added to 24°C, since asphaltic pavement absorbs the environmental temperature to an estimated temperature of 24°C (Meizhu Chen et al, 2014)

3. RESULT AND DISCUSSION

The summary of traffic census conducted on the selected road is display in Figure 1, it was discovered that in a week 2,038 passenger car, 149 Buses while truck is 160 moves on the road which then translate to 97,824 veh/year passenger car, 7,152 veh/year Buses and 7,680 veh/year truck per year. According to Kolo et al (2015) Equivalent factor (E.F) for car is 0.00033, bus is 0.00864 while truck is 111.68. Resulting to 857,796.47 kN loading on the experimental road per year resulting in 13mm initial settlement for one week which is in conformity with FHA (1979) stipulation of an initial settlement between 6mm to 12.5mm as can be seen in Figure 3.

Figure 2, show the settlement with time on experimental road, the height of the pavement is seen to have settled a little from the initial height of the pavement in week one. With the initial height represented as blue and the subsequent heights represented as pink and grey, the pink line shows the week one settlement with an averages settlement of 5mm along the pavement, while the grey line shows the week two settlement which averages 9mm along the pavement length. The road can be said to have settle for about 13mm in week three.

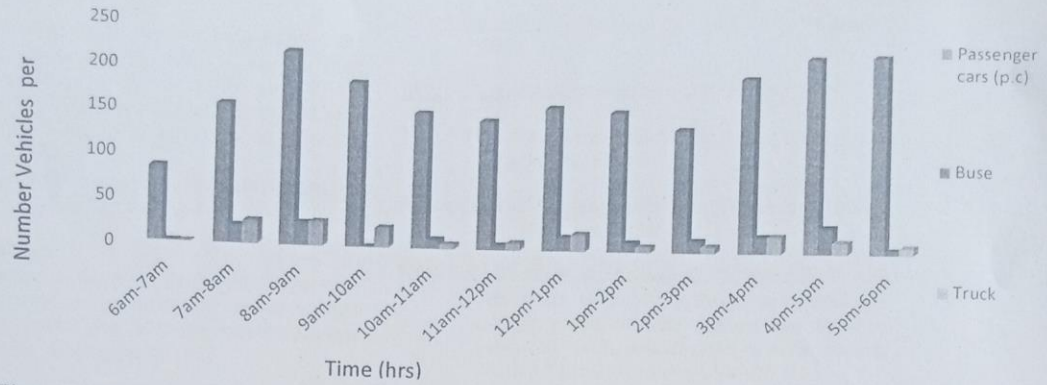


Figure 1: Proportion of passenger cars, buses and trucks on experimental road

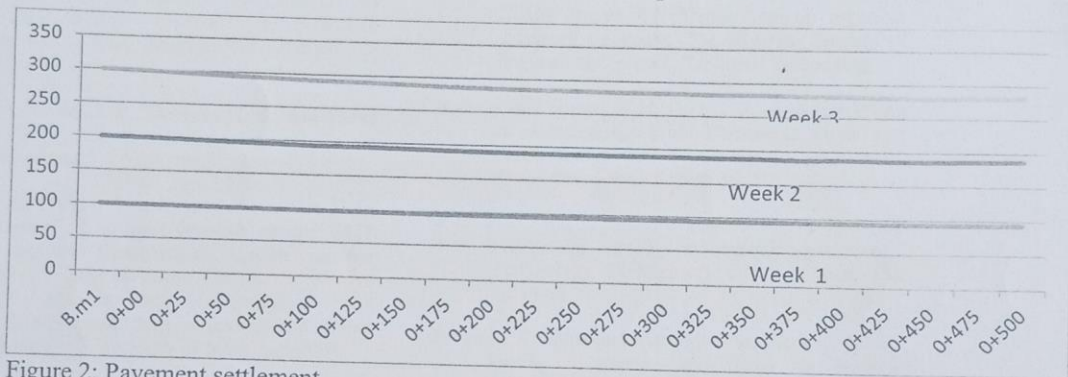


Figure 2: Pavement settlement

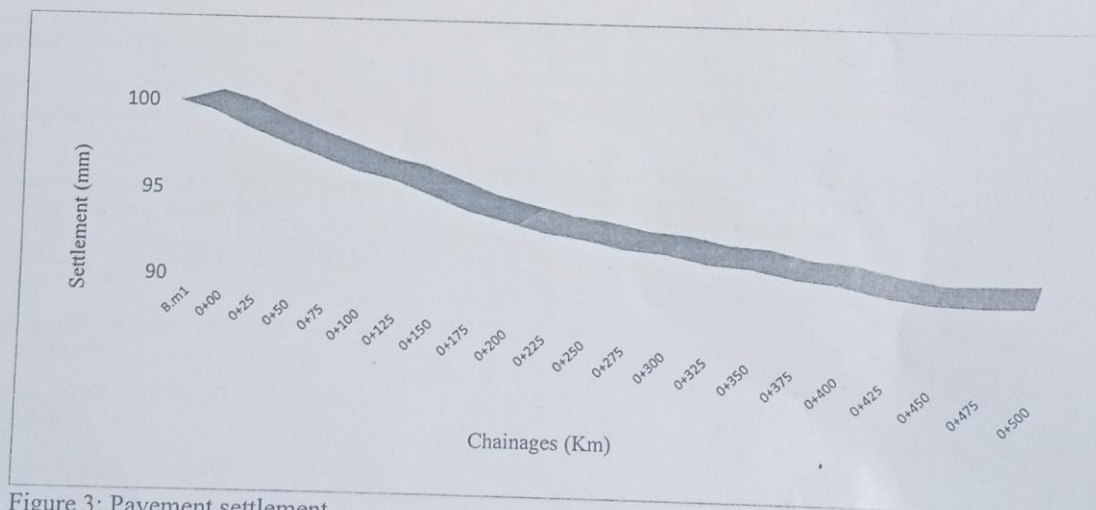


Figure 3: Pavement settlement



4. CONCLUSION

It can be seen that asphaltic pavement has the ability for settlement. The pavement was seen to have a little settlement that averages 5mm, 9mm and 13mm respectively for the first 3weeks; this value is negligent or not obvious to cause the pavement to fail with the predominant traffic load.

The imposed traffic load was seen to be mild, as they are less trucks and buses passing the route.

5. Recommendation

Based on the study conducted the pavement design; with respect to its thickness, satisfies the environmental condition and the traffic load. So the pavement thickness is okay to the traffic loading on the road.

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