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Wearing characteristics assessment of pervious concrete pavements

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Seven different concrete mixtures were prepared to estimate the possibility of using pervious concrete for light traffic urban areas. The total porosity, density, compressive strength, flexural strength, abrasion resistance, and traffic noise absorption capacity were tested for all the concrete specimens. The first mixtures corresponded to a standard dense concrete mixture (M1), while the other mixtures were pervious concrete mixtures involving two different types of aggregates (dolomite and steel slag) and different proportions of aggregate fractions. The total porosity, density, compressive strength, flexural strength, abrasion resistance, and traffic noise absorption capacity were tested in the case of all concrete specimens. The total porosity increased, whereas the compressive and flexural strength decreased simultaneously with an increase in the share of coarse aggregate fractions. The abrasion resistance and acoustic characteristics improved if only a fraction of the aggregate was used in pervious concrete preparation.

Keywords: pervious concrete; porosity; mechanical properties; abrasion resistance; traffic noise absorption capacity

1. Introduction

Pervious concrete is also referred to as porous or permeable concrete. It is a material with basic components that are identical to those of standard concrete but is designed to have a high porosity (the void content is between 11% and 35%) (Putman & Neptune, 2011; Schaefer, Wang, Suleiman, & Kevern, 2006) and permeability (typically approximately 2–6 mm/s). It is a mixture of cement and uniform coarse aggregates, and may or may not have a small amount of fine aggregates and water (Huang, Wu, Shu, & Burdette, 2010). Pervious concrete possesses good drainage properties and high noise absorption characteristics due to its high porosity. These are important elements for quality pavements. Owing to its drainage properties, pervious concrete is used in the construction of shoulders, bases, and subbases of roads. Its potential for mitigating the urban heat island effect as well as reduce electricity demand and lighting costs for paved roadways makes it a valuable solution for highly urbanised areas (Hao, Beibei, Zhuo, & Jian, 2017; Hilal & Peiman, 2016). Due to its characteristics, placing and maintenance of pervious concrete is different from conventional concrete: stiff consistency dictates its handling and placement requirements; mixtures cannot be pumped so site access need to be taken into consideration; curing with plastic sheeting after placement is necessary for at least seven days after which can

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be opened to construction or public traffic; maintenance consists primarily of prevention of clogging of the void structure (Tennis, Leming, & Akers, 2004), clogging is more pronounced within material with large porosity and horizontal runoffs has little influence on the final clogging ratio (Jiong, Xinzhuang, Li, & Dan, 2017).

A more recent application of pervious concrete involves using its acoustic properties in the construction of the top layer or overlay of concrete pavements in a manner similar to that for porous asphalt (Putman & Neptune, 2011). The high porosity of pervious concrete is also its main disadvantage since it is associated with a decrease in the strength of the material. Pervious concrete mixtures can develop compressive strengths in the range of 3.5 to 28 MPa (typical values are approximately 17 MPa) and flexural strengths generally ranging between 1 and 3.8 MPa (Tennis et al., 2004). The low strength of pervious concrete influences the stability and durability of structures because of the susceptibility to frost damage and low resistance to chemicals. This leads to the limited application of pervious cement in the construction of high traffic highways. Hence, studies examined different and new components in pervious concrete to address this issue (Huang et al., 2010; Pindado, Aguado, & Josa, 1999; Gerharz, 1999).

With respect to proper pavement material characterisation, it is essential to assess wearing characteristics to produce resistant, durable, and environmental friendly material. Thus, given this viewpoint, the main advantages of pervious concrete include its benefits in reducing runoff water, improving water quality, enhancing pavement skid resistance during storm events by rapid drainage of water, and reducing the on-site noise level (Gesoğlu, Güneyisi, Khoshnaw, & İpek, 2014). Gaedicke, Marines, and Miankodila (2014) concluded that the aggregate type plays an important role in abrasion resistance, as determined by ASTM C1747 standard (Los Angeles method). Chang, Yeih, Chung, and Huang (2016) suggested that pervious concrete composed of electric arc furnace slag (EAFS) corresponded to a higher British Pendulum Number (BPN) as the index of anti-skid performance compared to gravel aggregate concrete due to the rougher surface of the EAFS. Yeih, Fu, Chang, and Huang (2015) indicated that pervious concrete composed of EAFS provides a greater anti-skid capability that can prevent accidents in rainy weather. According to Gesoğlu et al. (2014), rubber utilisation results in a positive effect on the abrasion and freeze–thaw resistance of pervious concrete. Dong, Wu, Huang, Shu, and Wang, (2013) used fibre and latex to modify pervious concrete, and the study results indicated superior abrasion resistance.

The noise resulting from the interaction between tyres and the pavement is increasingly recognised as a significant environmental issue and is a major problem in urban areas. Noise environment can cause various types of diseases related to living conditions in these types of “unpleasant” environments. Hence, several studies document proven connections between traffic noises and diseases including cardiovascular and neuro-vegetative diseases (Sørensen et al., 2013; Welch, Shepherd, McBride, Dirks, & Marsh, 2013). The traffic noise is a summary of noise components including aerodynamic, vehicle propulsion system, and tyre-to-road contact noises (Sangiorgi, Bitelli, Lantieri, Irali, & Girardi,, 2012). Predominant noise sources vary with vehicle speed. The dominant component of traffic noise at low speeds corresponds to the sound produced by engine propulsion. The tyre/road noise dominates at speeds exceeding 50 km/h noises (Sangiorgi et al., 2012; Zmavc, 2004). Additionally, noise produced by moving vehicles largely depends on the geometrical properties of the road surface. Hence, previous studies focused on finding new methods to reduce noise at the place of origin, that is, the road surface, through observing the behaviour of different pavement types and compositions. Studies indicated that the modification of pavement surface types and/or textures can result in significant tyre/pavement noise reductions and that the proper selection of the pavement surface is an appropriate noise abatement procedure (Hanson & James, 2004). Concrete pavements are generally worse choices when compared to asphalt pavements with respect to tyre/road noise impact. The only type of a concrete surface course that can be considered as "quiet" corresponds to pervious concrete. The key factors dictating the efficiency of pervious concrete in absorbing sound include the porosity that can be accessed by the sound waves, pore size, pore aperture size, and thickness of the porous layer. An acoustically efficient material is material with smaller pore sizes and high pore constriction (Neithalath, Weiss, & Olek, 2006). According to Kim and Lee (2010a) aggregates of approximately 10–20 mm are most effective in the fabrication of pervious concrete with high acoustic absorption properties. In contrast, pervious concrete is barely affected by the aggregate shape when the material is well compacted. A double-layered porous concrete with enhanced absorption characteristics relative to a single-layered porous concrete is used to improve pervious concrete acoustic properties (Kim & Lee, 2010b). Park, Seo, and Lee (2005) concluded that with respect to a void ratios of 20%, 25%, and 30%, the absorption coefficient corresponded to maximum values in the frequency ranges of 315–400, 400–500, and 500–630 Hz, respectively. This is because the absorption increased with increases in the specific surface area of voids. According to a previous study (Kim & Lee, 2010a), the gradation of aggregates mainly affects the maximum acoustic absorption coefficient but does not substantially influence the peak frequency although maximum absorption coefficients decrease with increases in the gradation of the aggregate.

Several methods are used to assess the influence of pavement surface properties on noise reduction. These methods can be divided into two groups; namely in situ methods for outdoor tyre/road noise measurements and laboratory methods to determine noise-relevant pavement surface characteristics. In situ methods are used to measure the noise level at the place of origin (tyre–road contact point) or measuring noise at the roadside. Noise performance is evaluated by a simple but robust method involving a long measurement duration, high cost, and data-location specific related results. In a laboratory, tyre/road noise measurement is performed by using test rolling drums (simulates paved road) with maximum possible diameters (often as high as 15 m) to ensure that the test pavement surface is as flat and realistic as possible (Bernhard & Wayson). The disadvantage of this type of measurement technique corresponds to the influence of the test drum curvature related to the distortion of the tyre deflection that influences the noise picture to a certain extent. The other laboratory tyre/road noise measurement method relies on pavement material sound properties measurement and qualitative evaluation. The acoustic absorbance is a measure of material sound absorption and is measured through an impedance tube based on (ISO, 10534-2, 1998) standards. Within this method, the acoustic absorption performance of specimens can be affected by the existence of a specimen sealant (Sandberg, Zurek, Ejsmont, & Ronowski, 2013). The other problem involves the tube length that must be sufficiently long to present a stable plane-wave sound field with respect to the sample being tested. A more precise measurement method for material noise absorption figure forming is required since aggregate particle size and void content of the paving mixture affect noise absorption differently.

Although it is not possible for the in situ method to offer satisfactory sound analysis especially through separate sound spectral components, laboratory methods often focus on overall sound suppression results albeit without an in-depth analysis of sound features of the analysed material.

A full spectrum image should indicate the material sound properties and significantly shorten their development cycles. The full spectral sound analysis relies on measuring the sound level pressure absorbance ratio of tested materials with respect to several sound spectral testing reference components and sinusoidal sound waves. The signal suppression rate is defined the system transfer function given in Equation (1) as follows:

$$G(s) = \frac{X(s)}{Y(s)}, \tag{1}$$

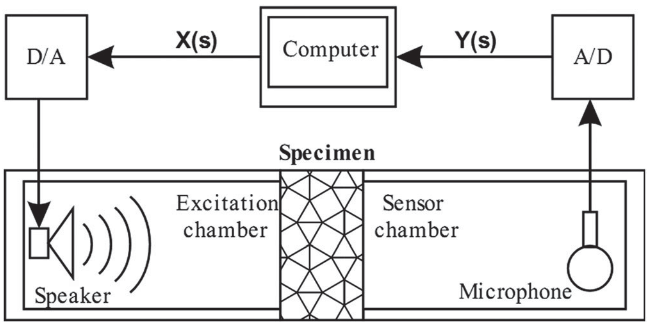

Figure 1. Test setup for sound spectral analysis (Keser, Barišić, Kovačević, & Pović, 2014).

where $X(s)$ denotes an excitation function and $Y(s)$ denotes the relevant system output. Thus, $G(s)$ represents a *spectral model* of an analysed system. Additionally, ***s*** represents a spectral analysis domain (*Laplacian*) and it can be considered as $j\omega$, where ω denotes the frequency of an excitation function, and j shows its complex nature. By applying a *chirp* excitation signal of amplitude A as shown in Equation (2) on the test system in Figure 1, the absorbance image of the tested material can be determined as follows:

$$x(\omega) = A \times sin(\omega t). \tag{2}$$

The system consists of an excitation chamber where sinusoidal waves of different frequencies are generated, a measurement chamber where a noise measurement sensor is placed, and a specimen holder where the specimen is placed. This setup configuration is used to measure the level of transported noise pressure through material transmittance.

The test setup consists of the following: a PC-based computer as a sound generator and data logger, an excitation chamber with an integrated speaker, a measurement chamber, and specimens. There were no practical ways to correctly perform the readout noise measurement of tested specimen excited with a chirp signal due to the manual nature of data/results readout at the moment when the tests are conducted. Therefore, a discrete spectral vector with several characteristic frequencies of excited signals $x(\omega)$, $\omega\ \varepsilon$ [0.5, . . . ,16 kHz] is used as a replacement for the chirp signal. Traffic noise caused by the tyre/road contact for speeds exceeding 40 km/h is approximately 1 kHz (Can, Leclercq, Lelong, & Botteldooren, 2010), and thus frequencies in the range of 0, 5–1, 5 kHz are selected for detailed analyses.

The ratio between the excitation and measured signal directly leads to the $G(s)$ function of the specimen. The test setup configuration refers to only to a single measurement sensor, and thus only one aspect of measurement can be considered at the time. Several sound properties of the fore-mentioned analysis can be defined but only sound conductivity with this configuration can be considered as truly measured. The absorbance ratio is another property that can be defined. Sound conductivity, $C(s)$, is a rational measure of the reference signal $Y_{ref}(s)$ and measured $Y_m(s)$. Specifically, $Y_{ref}(s)$ denotes the reference output and is a function of the testing setup in which $G(s) = 1$ without the test specimen. The absorbance ratio, $A(s)$, is a measure of the difference between $Y_{ref}(s)$ and $C(s)$ for a given specimen, as shown by Equation (3). A tested material that is a sound conductor exhibits poor absorbance abilities and vice versa.

$$C(s) = \frac{Y_m(s)^{*}100}{Y_{ref}(s)}, A(s) = 1 - C(s). \tag{3}$$

The main objective of this paper included assessing wearing characteristics of pervious concrete for light traffic urban areas. In order to increase the potential environmental benefits of using pervious concrete, steel slag was used as waste material to reduce the amount of natural materials extracted from quarries and riverbeds.

2. Experimental programme

2.1. *Material characterisation*

In this study, seven different mixtures were prepared. The first mixture corresponded to a standard dense concrete mixture, while the other mixtures were pervious concrete mixtures with two different types of aggregates and different proportions of aggregate fractions (Table 1).

Crushed dolomite stone was used as a natural material, and steel slag from a Croatian landfill near the town of Sisak was used as a substitute aggregate material.

Pervious concrete mixtures M2, M4, M6, and M7 were prepared from coarse dolomite aggregate (fractions of 4–8 mm and 8–16 mm) in different proportions of fractions and sand from the Drava River (fractions in the range of 0–2 mm); mixtures M3 and M5 were prepared from a coarse steel slag aggregate (fractions in the ranges of 4–8 mm and 8–16 mm) with different proportions of fractions and sand from the Drava River (fractions in the range of 0–2 mm); and the reference mixture (M1) was prepared entirely from dolomite (fractions in the ranges of 0–4, 4–8, and 8–16 mm). Each pervious concrete mixture contained 10% sand from the Drava River. The grain size distribution of all aggregate fractions is shown in Figure 2. The grain size distribution of the aggregates was determined according to EN 933-1 (2012).

The steel slag aggregate in mixtures was used with different proportions of finer and coarser fractions (ratio 60:30 and 30:60) as well as dolomite aggregates (ratio 60:30, 30:60, and 100%). The densities of crushed dolomite aggregate, sand, and steel slag used corresponded to 2.75, 2.65, and 3.21 kg/dm^3 according to EN 1097-6 (2013). For all the mixtures, the water to cement ratio (w/c) corresponded to 0.33 with water from the water supply. The cement used was ordinary Portland cement, CEM II/A-M(S-V) 42.5 N according to EN 197-1 (2011), with a density of 3.0 kg/dm^3 according to EN 196-6 (2010). The cement content corresponded to 300 kg/m^3 for all the mixtures. Table 1 presents the proportions of all constituents in the mixtures.

Aggregates used for preparing concrete were first saturated and then surface-dried. This was achieved in an artificial way by dipping the aggregates into a water tank for 24 h, removing them, and then wiping excess water from their surfaces. Aggregates, cement, and water were mixed together for 5 min in a pan mixer (DZ 100VS, Diemwerke). Three specimens were prepared to determine each property. Specimens of all concrete mixtures were cast with a compacting rod by rodding 25 times. All specimens were extracted from the molds 24 h after the casting and were placed in a water tank for 27 days at a temperature of 20°C ± 5°C according to EN, 12390–2 (2009).

2.2. *Testing of hardened concrete specimens*

After 28 days, the properties of the hardened concrete specimens were tested as follows:

- Compressive strength was tested on cube specimens with 15 cm edge length with a constant rate of loading of 0.5 MPa/s according to EN 12390–3 (2009).
- Density and void content (total porosity) were tested on the same specimens as that used for compressive strength tests based on the ASTM C1754/C1754M-12 (2012) standard.

Table 1. Mixture compositions.

	Mixture						
Characteristics	M1	M2	M3	M4	M5	M6	M7
Water/cement proportion (w/c)	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Cement [kg]	300.0	300.0	300.0	300.0	300.0	300.0	300.0
Water [kg]	99.0	99.0	99.0	99.0	99.0	99.0	99.0
Aggregate [kg]	2134.0	1783.7	2053.3	1783.7	2053.3	1783.7	1783.7
Sand 0–2 mm [% – kg]	–	10 – 178.4	10 – 205.3	10 – 178.4	10 – 205.3	10 – 178.4	10 – 178.4
Dolomite 0–4 mm [% – kg]	40 – 853.6	–	–	–	–	–	–
Dolomite 4–8 mm [% – kg]	30 –640.2	60 – 1070.2	–	30 – 535.1	–	–	90 – 1605.3
Dolomite 8–16 mm [% – kg]	30 – 640.2	30 –535.1	–	60 – 1070.2	–	90 – 1605.3	
Steel slag 4–8 mm [% – kg]	–	–	60 – 1232.0	–	30 – 616.0	–	–
Steel slag 8–16 mm [% – kg]	–	–	30 – 616.0	–	60 – 1232.0	–	–
Total [kg]	2533.0	2182.7	2452.3	2182.7	2452.3	2182.7	2182.7

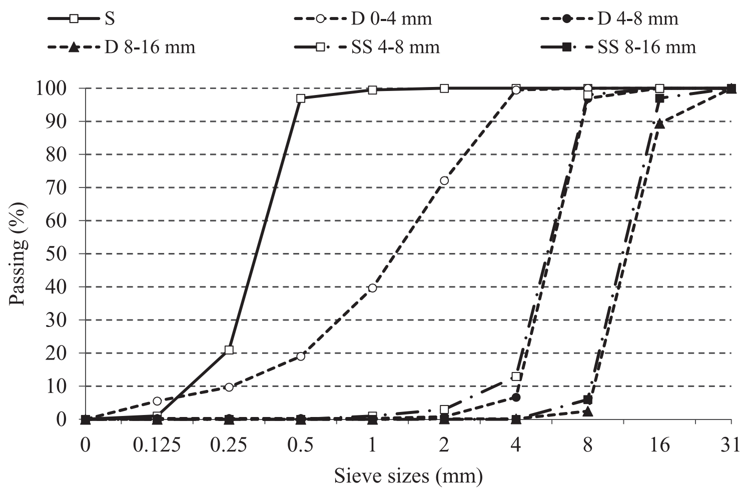

Figure 2. Grain size distribution.

Figure 3. Pervious concrete slab for sound spectral analyses.

- Flexural strength was tested on prism specimens with measurements of $10 \times 10 \times 40\,\text{cm}^3$ by loading the specimens at a constant rate of 0.05 MPa/s according to EN 12390–5 (2009).
- Abrasion resistance was determined on concrete specimens with a cross-sectional area of $50\,\text{cm}^2$ by using a rotating Boehme abrasion table with powdered corundum as an abrasive as specified in EN 1128 (2007).
- Full spectral sound analysis was used to obtain the ability of the concrete to reduce noise on concrete slabs with dimensions of 50×50 cm and a thickness of 5 cm (Figure 3).

3. Results and discussion

Results of the tests performed in Section 2.2 are listed in Table 2 and 4 and 5.

The results for pervious concrete mixtures composed of dolomite as shown in Table 2 were compared. The observations indicated that the total porosity of mixture M4 exceeded the total porosity of mixture M2, and the total porosity of M6 exceeded that of M7. When the same property was compared with respect to pervious concrete mixtures composed of steel slag, it was observed that the total porosity of mixture M5 exceeded that of case M3. With respect to the porosity, it was unanimously concluded that the porosity increased with increases in the share of coarse aggregate fractions. As expected, the density of pervious concrete mixtures decreased with increases in the total porosity. The increase in the coarse fractions share also resulted in lower values of compressive and flexural strength values. That is, mixture M4 exhibited lower values of compressive and flexural strength when compared to those of mixture M2, mixture M5 exhibited lower values of compressive and flexural strength when compared to those of mixture M3, and mixture M6 exhibited lower values of compressive and flexural strength when compared to those of mixture M7. These results were in accordance with the conclusions of a previous study (Dong, Wu, Huang, Shu, & Wang, 2010) that indicated that using small size aggregates improved compressive strength and reduced total porosity. According to European standards, the only minimum requirement for concrete pavement is compressive strength determined on cores as defined in EN 13877-2 (2013) and minimum strength class CC20 (characteristic core strength of 20 MPa) is recommended. American standards distinguish regular and pervious concrete as materials for pavement applications. According to ACI 522.1 (2013), specifications for pervious concrete pavements, compressive strength is not listed as an acceptance criterion. However, since there is no ASTM or EN test standard for compressive strength of pervious concrete, test standards for regular concrete are used and properly placed pervious concrete pavements with compressive strength of 20.5 MPa and flexural strength of more than 3.5 MPa is suitable for most low-volume pavement applications (Jiong et al., 2017). According to that, only M7 satisfy compressive strength criteria, while none of the tested mixtures satisfy criteria for tensile strength. Unexpectedly, the reference mixture (M1) revealed a considerably high value of total porosity and consequently considerably low values of compressive and flexural values, and this was attributed to concrete compaction. Hence, all concrete mixtures were cast with a compacting rod by rodding 25 times, which is not the most appropriate way of compacting an ordinary concrete mixture (reference mixture).

Table 2. Results of hardened concrete tests.

	Mixture						
Characteristics	M1	M2	M3	M4	M5	M6	M7
Compressive strength [MPa]	16.2	19.6	15.2	18.3	13.25	14.3	21.1
SD [MPa]	1.6	0.75	0.1	0.03	0.64	1.02	1.04
Flexural strength [MPa]	1.88	3.18	2.05	2.33	1.96	2.41	3.21
SD [MPa]	0.08	0.33	0.16	0.16	0.21	0.01	0.24
Density [kg/m^3]	1960	2038	2094	1911	2105	1948	1994
SD [kg/m^3]	25	10	55	71	11	9	23
Total porosity [%]	24	22	25	29	30	27	24
SD[%]	1.1	1.0	2.3	3.0	0.6	0.4	1.1
Abrasion (mm^3/5000 mm^2)	28.7	23.2	15.8	23.9	15.3	15.9	14.8
SD[mm^3/5000 mm^2]	1.4	0.6	0.3	1.3	0.2	0.1	0.5

With respect to abrasion resistance, a higher tendency for abrasion was recorded for mixtures prepared with dolomite when compared with mixtures prepared with steel slag. That is, the abrasion value in mixture M2 exceeds that in mixture M3 (both mixtures are prepared with a proportion of finer and coarser fractions corresponding to 60:30) and is consequently higher in mixture M4 when compared to that in mixture M5 (both mixtures are prepared with the proportion of finer and coarser fractions corresponding to 30:60). As mentioned earlier in the study, the characteristics of the steel slag examined in the study are similar to that used in a previous study (Netinger, Jelčić Rukavina, & Bjegović, 2010). Lower Los Angeles abrasion value of steel slag when compared to that of dolomite as reported in an extant study (Netinger et al., 2010) justifies the increase in the abrasion resistance of pervious mixtures with steel slag observed in this study. In comparison to the reference mixture (M1), all the other mixtures of pervious concrete prepared with dolomite (M2, M4, M6, and M7) showed better abrasion resistance. Thus, this study did not confirm the conclusion presented in a previous study (Dong et al., 2010) that using small size aggregate improved the abrasion resistance. However, it was observed that better abrasion resistance was achieved if only a fraction of aggregate is used in the previous concrete preparation (mixtures M6 and M7). Limit values for abrasion resistance of regular concrete for pavement according to standard (EN, 1128, 2007) is between 18 and 25/50 cm^2 depending on traffic load. From the results presented in Table 2, only M1 does not satisfy requirements for abrasion resistance. Test results shown in Kevern, Biddle, and Cao (2015) and Wu, Liu, Sun, and Yin (2016) have confirmed that adding latex to concrete mixtures improved their strength and, consequently, their abrasion resistance which will surely inspire the authors in their further research.

With respect to the mechanical properties of pervious concrete mixtures with steel slag (M3 and M5), a conclusion identical to that in a previous study (Netinger, Bjegović, & Vrhovac, 2011) was obtained in which mixtures of ordinary concrete prepared with steel slag and dolomite were compared and the mechanical properties of steel slag pervious concrete mixtures (M3 and M5) were slightly lower than the same properties of dolomite pervious concrete mixtures (M2 and M4).

From Figure 4, it is observed that noise suppression and conductance become nearly equal for frequencies higher than 2 kHz for mixtures M2, M4, and M7 with dolomite aggregate. With respect to steel slag aggregate mixtures (M3 and M5), the phenomena occurred at frequencies that exceeded 1 kHz in a manner similar to the referenced mixture. Pervious concrete with dolomite aggregate exhibited a better conductance property for a wider range of frequencies. With respect to mixture M6 with only course dolomite aggregate, the sound conductance exceeded the suppression for all tested frequencies. Similarly, mixture M6 without coarse aggregates exhibited higher sound conductance for frequencies below 5 kHz. Sound spectral characteristics of mixtures with uniform aggregate gradation (M6 and M7) differ from those of other mixtures. This could result from a difference in system pores with pronounced open porosity. Thus, from the viewpoint of an optimal noise reducing material, the total porosity of the material as well as characteristics of the pore system are important. In fact, open/connected porosity plays a key role in sound absorption of any material. Studying the papers comparing the total porosity and the permeability of pervious concrete mixtures (Mahalingam & Mahalingam, 2016; Fwa, Lim, & Tan, 2014), it can be noticed that the permeability increases as the total porosity increases. Knowing that open porosity is solely responsible for permeability of pervious concrete this actually means that an increase in total porosity leads to an increase in open porosity. This observation as well as the fact that the only standard that covers porosity determination of pervious concrete (ASTM C1754/C1754M-12, 2012) can determine total porosity solely has encouraged authors to estimate the acoustic properties of pervious concrete based on total porosity.

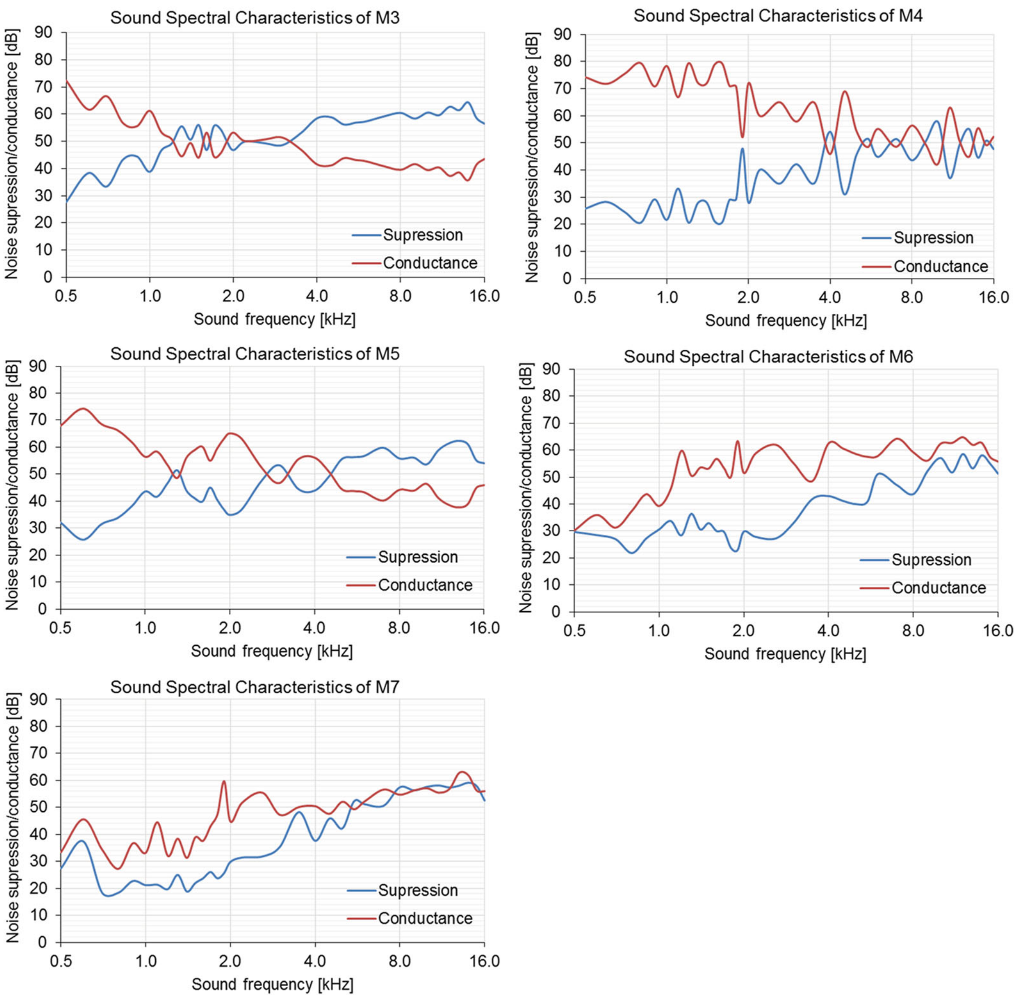

Figure 4. Sound spectral characteristics of pervious concrete.

From Figure 5, it is observed that mixture M7 (with only 4–8 mm dolomite aggregate) is the best sound conductor among all the tested specimens. This implies that it absorbed and channelled more of the traffic noise from road surface toward the subbase course. Mixtures with steel slag aggregate are relatively low sound conductors and appear to be less suitable for noise reduction in pavement.

Correlating acoustic characteristics with material porosity, M5 (60% coarse steel slag aggregate) has the highest porosity although it has poor acoustic characteristics. This can be explained by the fact the total porosity of material can reduce the effects of air pumping. However, higher effective/open porosity and smaller size of the voids are responsible for the potential enhancement in the traffic noise reduction in pavements (Dong et al., 2010). Additionally, the porous nature of steel slag aggregate forms a better interface bonding within pervious concrete material due to the interlocking effect (Yeih et al., 2015), and this makes the sound path through the material less effective. With respect to mixture M7, the total porosity corresponds to 24%, which presents the optimum void ratio and it is also in accordance with that obtained in a previous study (Chang et al., 2016).

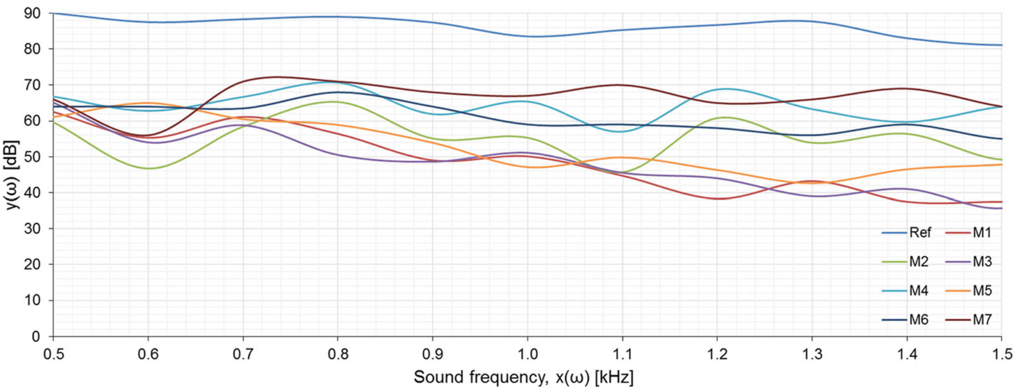

Figure 5. Spectral response of tested pervious concrete slabs.

4. Conclusions

The scope of this study involved obtaining more information on the surface characteristics of pervious concrete pavements. Extensive experiments were performed to characterise pervious concrete for a light traffic pavement surface course with respect to its surface layer characterisation. The results of this study can be summarised as follows:

- Total porosity increased with increases in the share of coarse aggregate fractions. Consequently, the density of pervious concrete mixtures decreased with increases in the total porosity. Steel slag as an aggregate ensured a higher total porosity in concrete specimens when compared with that of dolomite.
- Compressive and flexural strength decreased with the increases in the coarse fraction share. Dolomite as an aggregate ensured higher compressive and flexural strength values of concrete.
- Abrasion resistance improved if only a fraction of the aggregate was used in pervious concrete preparation. Steel slag as an aggregate ensured higher abrasion resistance to concrete.
- Acoustic characteristics were affected by aggregate type, granulation, and pore system. A mixture with dolomite aggregate displayed better acoustic characteristics when compared with mixtures with a steel slag aggregate.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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