Urban Heat Island effect of floors made from Concrete, Foam Concrete, Palm Kernel shell foamed Concrete and Natural Grass.

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Abstract

Urban Heat Island affects our environment through warmer climate and increase in the embodied heat of building materials which might results in thermal discomfort for occupants of buildings. This research examines the Urban Heat Island of floors made from Concrete, Foam Concrete, Palm Kernel shell foamed Concrete and Natural Grass using surface Temperature approach. Tests were conducted on specimen at 30 minutes interval between 7amand 10pm daily for 90 days. It was discovered that Concrete Floor absorbs more heat and has the highest surface temperature than other materials while Natural Grass Floor maintained the lowest surface temperature. The research recommends the use of Foam Concrete, Palm Kernel shell foamed Concrete and Natural Grass floors as an alternative to concrete floor where applicable to reduce urban heat Island effect.

Keywords: urban heat Island, Embodied heat, Thermal discomfort, Surface Temperature.

1.0 INTRODUCTION

Urban heat island (UHI) is a situation in which the urban area is significantly warmer than its surrounding rural areas. It can also be defined as any area that is consistently more hot than areas that surrounds it. It can also be described as when materials used for building or construction are vehemently absorbing heat from the sun instead of reflecting it and this causes temperature to rise (Brian, Lionel and Tien 2011). The UHI will be maximally felt 3-4 hours after sun set (UCAR 2011). Voogt. (2017) states that UHI is the relative warming of air temperature near the ground and describes its types as Boundary layer UHI, Canopy layer UHI and Surface UHI.

UCAR (2011), Voogt. (2017) and Brian et al (2011)stated the causes of UHI to include decrease in amount of vegetation and trees, heat capacity and thermal conductivity of materials, too much carbon dioxide in the air and blocking of winds by buildingsand they opined that the effect of UHI could be increase in energy demand for cooling , air pollution and greenhouse gas emission.Kleerekoper, Van and salcedo (2012) beleives it reduces human health and comfort and water quality. Huang, Jianlong, Zhao and Zhu (2008) declared that wrong choice of ground cover which results in Diurnal changes in micro climate could also cause UHI.

Brian et al (2011) and Santamouris (2013) profer the following solution to UHI

i. Materials selection for roof and surface of structures
ii. Suitable materials for pavement
iii. Incorporation of trees and grass in the environment
iv. Reduction of absorption of solar radiation of building materials
v. Dissipation of accumulated heat without transferring it indoor.
vi. Using materials with improved permeability for pavement

Bin and Qing (2014) and Li, Harvey and Kendali (2013) are of the opinion that albedo effect on land cover materials can also be used to mitigate the effect of UHIwhile Santamouris (2013) and huang et al (2008) suggested that the use of cool pavement can also reduce the effect of UHI.

Previous research on UHI had explored Albedo effects, thermal mass of materials, cool pavement and atmospheric temperature but there is still more to be done on surface temperature approach.

This study will help in improving thermal comfort and reducing air cooling needs in buildings.

2.0 METHOLOGY

This research focused onurban heat Island effect using surface temperature approach, thermal remote sensing method was adopted and infra-red thermometer (Surface Temperature Pro) was used to obtain data from the specimens.The specimen for this research were prepared using 1.2x1.2x0.15m mould which was used to prepare specimen for Normal concrete (with mix ratio 1:2:4), foam concrete (1600kg/m^3), palm kernel foam concrete (1600kg/m^3), and 1.2x1.2 floor area was used for natural grass.

3.0 DATA PRESENTATION

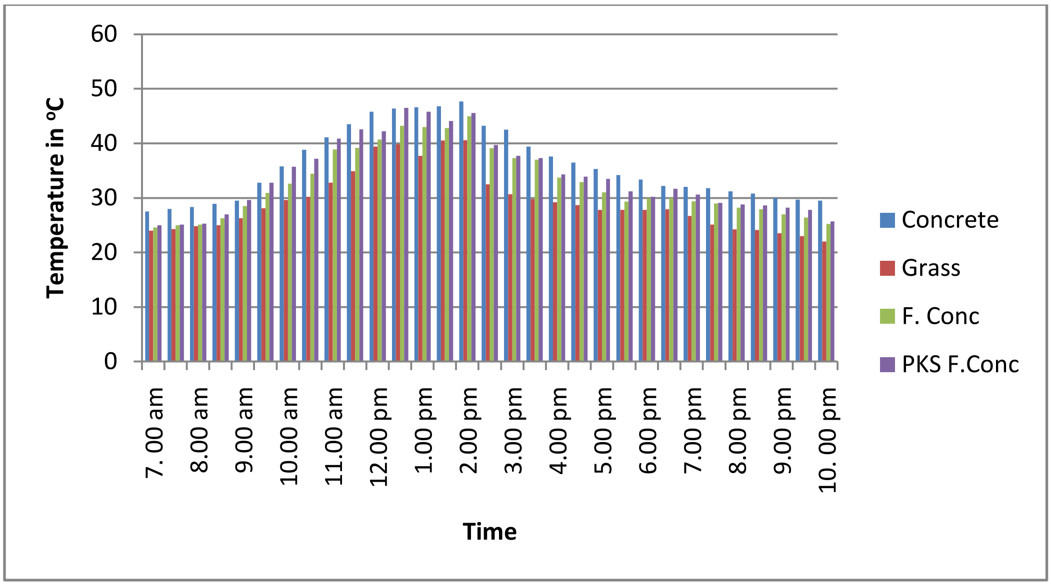
Data were collected for 90 days at 30 minutes interval between 7:00 am and 10:00 pm , the average temperature for the test period is as presented below.

Table 1.0 Average Surface Temperature for the Observed Period in ^{0}C

Time	Concrete	Grass	Foam concrete	PKS Foamed Concrete
7:00 am	27.5	24.0	24.6	25.0
7:30 am	28.0	24.3	25.0	25.1
8 am	28.3	24.8	25.1	25.3
8.30 am	28.9	25.0	26.3	27.0
9 am	29.5	26.3	28.5	29.6
9.30 am	32.8	28.1	30.9	32.8
10 am	35.8	29.6	32.6	35.7
10.30am	38.8	30.2	34.4	37.2
11am	41.1	32.8	38.9	40.9
11.30am	43.5	34.9	39.2	42.6
12pm	45.8	39.4	40.7	42.2
12.30pm	46.6	39.8	43.2	46.5
1pm	46.6	37.7	43.0	45.8
1.30pm	46.8	40.5	42.8	44.1
2pm	47.7	40.6	45.0	45.6
2.30pm	43.2	32.5	39.1	39.7
3pm	42.5	30.7	37.3	37.7
3.30pm	39.4	29.8	37.0	37.3
4pm	37.6	29.2	33.7	34.3
4.30pm	36.5	28.7	32.9	33.9
5pm	35.3	27.8	31.0	33.5
5.30pm	34.2	27.8	29.3	31.2
6pm	33.4	27.8	29.9	30.2
6.30pm	32.2	27.9	30.0	31.7
7pm	32.0	26.7	29.4	30.6
7.30pm	31.8	25.1	29.0	29.1
8pm	31.2	24.2	28.2	28.8
8.30pm	30.8	24.1	27.9	28.6
9pm	30.0	23.5	27.0	28.2
9.30pm	29.7	23.0	26.4	27.8
10pm	29.5	22.0	25.2	25.7

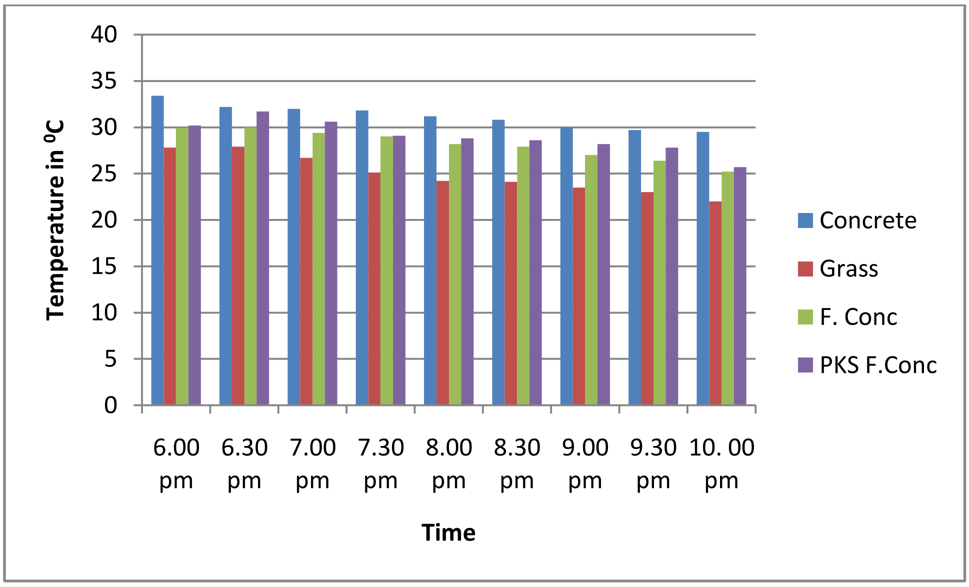
4.0 DISCUSSION OF RESULTS

Figure 1.0 Average surface temperature for the observed period



From the table and figure above, it can be seen that concrete has the highest temperature throughout the period of the test while natural grass has the lowest temperature, the highest surface temperature for concrete occurs at 2:00 pm with the value of 47.7 ^{0}C at that time grass was 40.6 ^{0}C , foam concrete was 45.7^{0}C while PKS foam concrete was 43.4 ^{0}C. **This indicates that concrete absorbs more heat while natural grass absorbs lesser heat than the other materials at the peak temparature.**

Figure 2.0 Average surface temperature after sunset



According to UCAR (2011) ,the UHI will be maximally felt 3-4 hours after sun set. Results of the test betweem 6.30pm and 10pm shows that concrete has the highest temperature, followed by PKS foam concrete, followed by foam concrete and natural grass has the lowest temperature. **This implies that grass can better control urban heat island than the other materials.**

5.0 CONCLUSION

i. Concrete absorbs more heat than the other materials.
ii. Growing of natural grass as land cover can significantly mitigateUrban heat island.
iii. Palm kernel shell foam concrete and foam concrete has a lesser embodied heat compare to concrete hence they can be used to replace concrete where applicable.
iv. The rate of dissipation of embodied heat is faster in allspecimen except in concrete
v. Base on this result , the Eco friendliness of the specimens can be rated as follows ; 1 --- Very Friendly, 2 ----- Friendly, 3 ------ Slightly friendly

Natural Grass =1, Foam Concrete = 2,PKS Foamed Concrete = 2 and Concrete = 3

6.0 RECCOMMENDATION

Green environment should be encouraged in the urban environment to reduce the negative effect of UHI and encourage vegetative cooling which can improve natural ventilation and reduce the cost of creating comfort in building.

Materials like Foam Concrete and PKS Foam Concrete should be used where applicable to replace concrete in order to reduce UHI and improve thermal comfort.

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