Pavement Parameters Needed for 1D Heat Transfer Model

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| **Parameter** | **Units** | **Typical Range** |
| Albedo, | dimensionless | [0, 1] |
| Emissivity, ε | dimensionless | [0, 1] |
| Thermal Diffusivity, | m^2/s | [2, 12] |
| Thermal Conductivity, | W/(m2\*degK) |  |
| Density, | kg/m3 |  |
| Specific heat, | J/(kg\*degK) |  |
| *Volumetric heat capacity\*,* | *J/(m3 degK)* |  |
| Layer thickness | mm | [0, 3000] |
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|  |  |  |

\* Volumetric heat capacity is the product of specific heat and density, so you need either the former or both the latter parameters.

Questions for Kaloush

* Convergence of temperature at surface or first node below surface seems unachievable with different starting conditions of pavement temperature. In other words, if the initialized temperature throughout the pavement is 40C vs 30C with all other conditions being the same, the model does not converge to a simulation. Why is this? Is there an explanation for why this would be an artifact of this approach?
* Is the in-situ data from the original study available, and if so could I use it?
* Albedo varies diurnally but this is not incorporated in model. How much might this affect simulated results? How would this be specified in the model if so? Does albedo also vary by functional class within asphalt surfaces? E.g. do asphalt highways typically have different albedos than local roads?
* My validation exercise will use sample sites that have only concrete, asphalt, and bare ground/dirt/soil and then predict the surface temp to see how it compares with remotely sensed LST. In this case, will use Landsat-8 TIRS bands
* Are there a couple (e.g. 6-8 or so) typical/average pavement design profiles (in terms of material composition and layer depths) that would represent the majority of roadway and parking lot pavements in the Phoenix metro? I realize there are other parameters like flexible, previous that will influence design, but if there is no way to generalize by functional class and location, it will be difficult to include those design parameters into profiles
* Is three layers (surface, base, subbase) generally enough to capture typical pavement profiles?

Example Profiles of Different Pavement Types Based on Typical Functional Class

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| **Profile #1: Highway; Asphaltic Concrete (AC)** | | | | | | |
|  | Albedo | Thermal Diffusivity | Thermal Conductivity | Density | Specific heat | Thickness Range |
| *Units* |  |  |  |  |  |  |
| Layer 1;  Surface, AC |  |  |  | 2238 |  | [40, 130+] |
| Layer 2; Base |  |  |  |  |  | [40, 130+] |
| Layer 3; Subase |  |  |  |  |  | [100, 500] |

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| **Profile #1: Highway; Portland Cement Concrete (PCC)** | | | | | | |
|  | Albedo | Thermal Diffusivity | Thermal Conductivity | Density | Specific heat | Thickness Range |
| *Units* |  |  |  |  |  |  |
| Layer 1;  Surface, PCC |  |  |  |  |  | [80, 260+] |
| Layer 2; Subase |  |  |  |  |  | [100, 500] |

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| **Profile #1: Major Arterial; Asphaltic Concrete (AC)** | | | | | | |
|  | Albedo | Thermal Diffusivity | Thermal Conductivity | Density | Specific heat | Thickness Range |
| *Units* |  |  |  |  |  |  |
| Layer 1;  Surface, AC |  |  |  |  |  | [40, 130+] |
| Layer 2; Base |  |  |  |  |  | [40, 130+] |
| Layer 3; Subase |  |  |  |  |  | [100, 500] |

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| **Profile #1: Major Arterial; Portland Cement Concrete (PCC)** | | | | | | |
|  | Albedo | Thermal Diffusivity | Thermal Conductivity | Density | Specific heat | Thickness Range |
| *Units* |  |  |  |  |  |  |
| Layer 1;  Surface, PCC |  |  |  |  |  | [80, 260+] |
| Layer 2; Subase |  |  |  |  |  | [100, 500] |

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| **OpenStreetMap (OSM) Functional Class (fclass)** | **Assumed Pavement Type** | **Description** |
| bridleway | dirt | Paths for horse riding |
| cycleway | concrete | Paths for cycling |
| footway | concrete | Footpaths |
| living\_street | asphalt | Streets where pedestrians have priority |
| motorway | asphalt | Motorway/freeway. 10x 12ft lanes, 4x 10ft shoulder |
| motorway\_link | asphalt | Roads that connect from one motorway/freeway to another |
| path | dirt | Unspecified paths |
| pedestrian | asphalt | Pedestrian only streets |
| primary | asphalt | Primary roads, typically national (major arterial). 6x 12ft thru, 2x 6ft bike/park/shoulder |
| primary\_link | asphalt | Roads that connect from one primary roads to another, typically national. Assume no shoulder/turn lanes |
| residential | asphalt | Roads in residential areas (minor/residential collector). 2x 14ft thru lane, 2x 6ft bike/park lane |
| secondary | asphalt | Secondary roads, typically regional (minor arterial/major collector). 4x 12ft thru lane, 1x 10ft left turn lane, 2x 8ft bike/park/shoulder |
| secondary\_link | asphalt | Roads that connect from one secondary road to another, typically regional |
| service | asphalt | Service roads for access to buildings, parking lots, etc. 1x 10ft lane, typically in parking lots |
| steps | concrete | Flights of steps on footpaths |
| tertiary | asphalt | Tertiary roads, typically local (major/minor collector). 2x 12ft thru lane, 1x 10ft left turn lane, 2x 8ft bike/park/shoulder |
| tertiary\_link | asphalt | Roads that connect from one tertiary road to another, typically local |
| track | asphalt | For agricultural use, in forests, etc. Often gravel roads. |
| track\_grade1 | asphalt | track with asphalt or heavily compacted |
| track\_grade2 | asphalt | track with asphalt or moderately compacted |
| track\_grade3 | dirt | track lightly compacted |
| track\_grade4 | dirt | track un-compacted, visible |
| track\_grade5 | dirt | track un-compacted, hardly visible |
| trunk | asphalt | Important roads, typically divided. 6x 12ft lane, 2x 6ft shoulder |
| trunk\_link | asphalt | Roads that connect from one important road to another, typically divided |
| unclassified | asphalt | Smaller local roads (local/collectors in non-residential areas, typically industrial). 2x 14ft thru lane, 2x 6ft bike/park lane |

Thickness source (ADOT):

https://apps.azdot.gov/files/materials-manuals/Preliminary-Engineering-Design/PavementDesignManual.pdf