Pavement Parameters Needed for To Test Multiple Varied Profiles in 1D Heat Transfer Model

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| --- | --- | --- | --- | --- |
| **Parameter** | **Units** | **Typical Values** | | |
| ***Asphalt*** | ***Concrete*** | ***Soil/Ground*** |
| Albedo, | dimensionless | 0.07 – 0.10 1  0.05 (fresh) 2  0.10 – 0.15 (worn) 2  0.08 – 0.29 3 | 0.17 – 0.31 1  0.35 – 0.40 (fresh) 2  0.20 – 0.30 (worn) 2  0.31 – 0.43 4 | 0.15 – 0.35 (dry clay soil) 5  0.25 – 0.45 (dry sandy soil) 5  0.4 – 0.5 (light color soil) 5 |
| Emissivity, ε | dimensionless | 0.93 6  0.90 7  0.85 8 | 0.96 (PCC) 4  0.92 – 0.95 (PPCC) 4  0.70 9 |  |
| Thermal Diffusivity, |  | 8.53E-7 - 11.60E-7 10  2E-7 - 12E-7 8  4.0E-7 - 5.5E-7 (HMA) 11 |  |  |
| Thermal Conductivity\*, |  | 1.60 (base) 12  3.00 (agg subbase) 12  1.866 – 2.177 10  1.5 (non-subgrade) 7  1.79 (subgrade) 7  1.623 – 2.060 11  1.16 (5% air) 13  0.96 (13% air) 13  0.92 (17% air) 13  0.90 (22% air) 13  0.82 (25% air) 13 | 2.15 (PCC) 12  1.40 (PCC) 4  1.20 – 1.28 (PPCC) 4 | 1.0 (dry soil subgrade) 8  1.16 (subgrade) 12 |
| Density, |  | 2200 (subgrade) 7  2238 8  2281 – 2338 10  2370 (subbase) 7  2550 (overlay) 7  2300 - 2450 (HMA) 11  2372 (5% air) 13  2187 (13% air) 13  2093 (17% air) 13  2005 (22% air) 13  1906 (25% air) 13 | 2400 | 1500 (dry soil subgrade) 8 |
| Specific heat capacity, |  | 805 (subbase) 7  810 – 959 10  850-860 (overlay) 7  1100 (subgrade) 7  964 (5% air) 13  958 (13% air) 13  953 (17% air) 13  947 (22% air) 13  946 (25% air) 13 | 840– 920 (PPCC) 4  1050 (PCC) 4 | 1900 (dry soil subgrade) 8 |
| Volumetric heat capacity\*\**,* |  |  |  |  |
| Min layer thickness |  | 150 (flexible) plus 50 (surface)  100 base  75 - 100 surface airport 14  125 (stabilized base airport, only heavy planes) 14  75 – 150 (crushed agg base airport) 14  75 agg (base airport, only light planes) 14  100 (subbase airport) 14 | 150 (plain concrete)  100 (PCC sidewalk) 15 |  |
| Characteristic Pavement Length, L | m | [5, 50+] |  |  |
|  |  |  |  |  |

\* Thermal diffusivity is equivalent to the ratio of thermal conductivity to volumetric heat capacity: *k* / *pc*

\*\* Volumetric heat capacity is equivalent to the product of density and specific heat: *p \* c*

Example Profiles of Different Pavement Types Based on Typical Functional Class

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| --- | --- | --- | --- | --- | --- |
| **Profile #1: Highway; Asphaltic Concrete (AC)** | | | | | |
|  | Albedo | Thermal Conductivity | Density | Specific heat | Thickness Range |
| *Units* |  |  |  |  |  |
| Layer 1;  Surface, AC | 0.17 | 1.21 | 2,238 | 921 | [40, 130+] |
| Layer 2; Base | NA | 1.21 | 2,238 | 921 | [40, 130+] |
| Layer 3; Subase | NA | 1.00 | 1,500 | 1900 | [100, 500] |

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **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 |

Note on Characteristic Pavement Length:

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“Let us first consider an horizontal flat plate, of width b and infinite length L, hotter than the environment. The flow established by natural convection on the top surface is different from that on the bottom surface. Heated up fluid from the bottom surface comes to the edges of the plate and rises. Colder surrounding fluid is then continuously pulled next to the bottom surface of the plate, to compensate for that fluid escaping at the edges. Due to the symmetry of the horizontal plate problem, the surrounding fluid approaches the bottom of the plate near its centerline and then progresses along half-width of the plate, i.e. along a distance b/2, until it reaches the edge of the plate and is allowed to rise. Therefore, the characteristic length (CL) could be taken as b/2. However, if the plate has an inclination, even a small one, then the symmetry of the problem is disrupted, and one can reason that the surrounding fluid shall approach the plate from its lower edge and then progress along its entire width before it is allowed to rise at the higher edge. Because the fluid is trying to rise, the flow remains attached to the bottom surface of the plate and does not detaches. Hence, CL could be taken as b this time. This example shows that for the same geometry one can have distinct CL, due to inclination. This should answer your question.

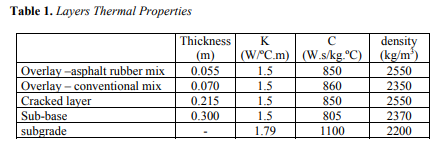
A similar discussion could be made to the top surface of this hotter-than-environment plate and again b and b/2 would appear as possible values for CL. However, in this case I should add that the particular value of b (not to mention L) and inclination can become important in what concerns the exact pattern of the flow that is established on the top surface. This is due to the possibility of formation of structures related to Bénard convection cells. In such case, the typical width of these cells would be a more suitable CL than the whole width b of the plate. Empirical correlations for plates exhibit this effect.”

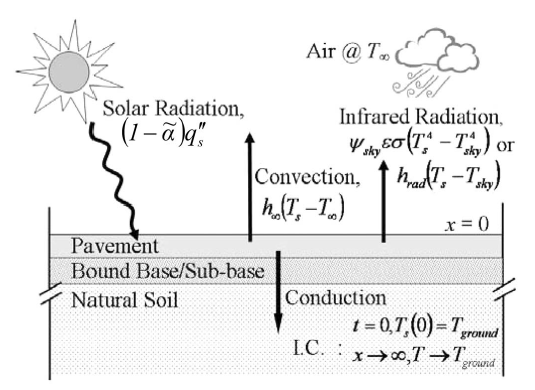
<https://www.researchgate.net/post/Can_anyone_suggest_the_basis_for_choosing_characteristic_length>

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Thickness source (ADOT):

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





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