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# Transport properties of crushed WEEE plastics waste composites

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# Introduction

- The crushed plastic made from Waste Electrical and Electronic Equipments (WEEE) is a possible alternative of the traditional or artificial lightweight concrete aggregates.
- The crushed plastic waste cement composites can be characterised as the lightweight concretes with water impermeable aggregates in contrast to the classical (e.g. expanded clay aggregates) lightweight concretes.
- Their transport properties like the thermal conductivity, the water permeability, the diffusion resistance factor are determined by the volume portion of aggregate, the dose and properties of binder, water-to-cement ratio and the properties of contact zone between aggregate grains and cement matrix.

# Loose density of particular crushed plastics fractions

| Fraction mm | Mass portion kg/kg | Loose density $kg/m^3$ |
|---|---|---|
| 0/1 | 0.025 | 509 |
| 1/2 | 0.030 | 455 |
| 2/4 | 0.165 | 500 |
| 4/8 | 0.740 | 418 |
| 8/16 | 0.040 | 428 |
| Original mixture | 1.000 | 519 |

# Thermal properties of dominant crushed plastics waste components

| Material | Specific heat capacity J/kg.K | Thermal conductivity W/m.K |
|---|---|---|
| Polyethylene | 2100 – 3000 | 0.26 – 0.40 |
| Polystyrene | 1400 – 1640 | 0.08 – 0.16 |

# Thermal conductivity of the loose crushed material – guided hot plate method

- $k$ = 0.09 W/m.K
- the thermal conductivity of the most frequent fraction 4/8, of lower loose density, equals 0.08 W/m.K.
- The value of 0.09 W/m.K corresponds to the determined voids ratio and the minimum thermal conductivity of the prevailing (77 % volume portion) components with a particle density higher than 1000 kg/m$^3$, mainly the polystyrene.

# Thermophysical properties of crushed cement composites manufactured of various mixtures - monotony heating regime method

| Mixture No: | Bulk density kg/m$^3$ | Thermal diffusivity m$^2$/s | Specific heat capacity J/kg.K | Thermal conductivity W/m.K |
|---|---|---|---|---|
| 1 | 1111 | 1,470.10$^{-7}$ | 1561 | 0.255 |
| 2 | 1109 | 1,717.10$^{-7}$ | 1682 | 0.320 |
| 3 | 1510 | 2,313.10$^{-7}$ | 1424 | 0.504 |
| 4 | 1631 | 4,233.10$^{-7}$ | 1235 | 0.853 |

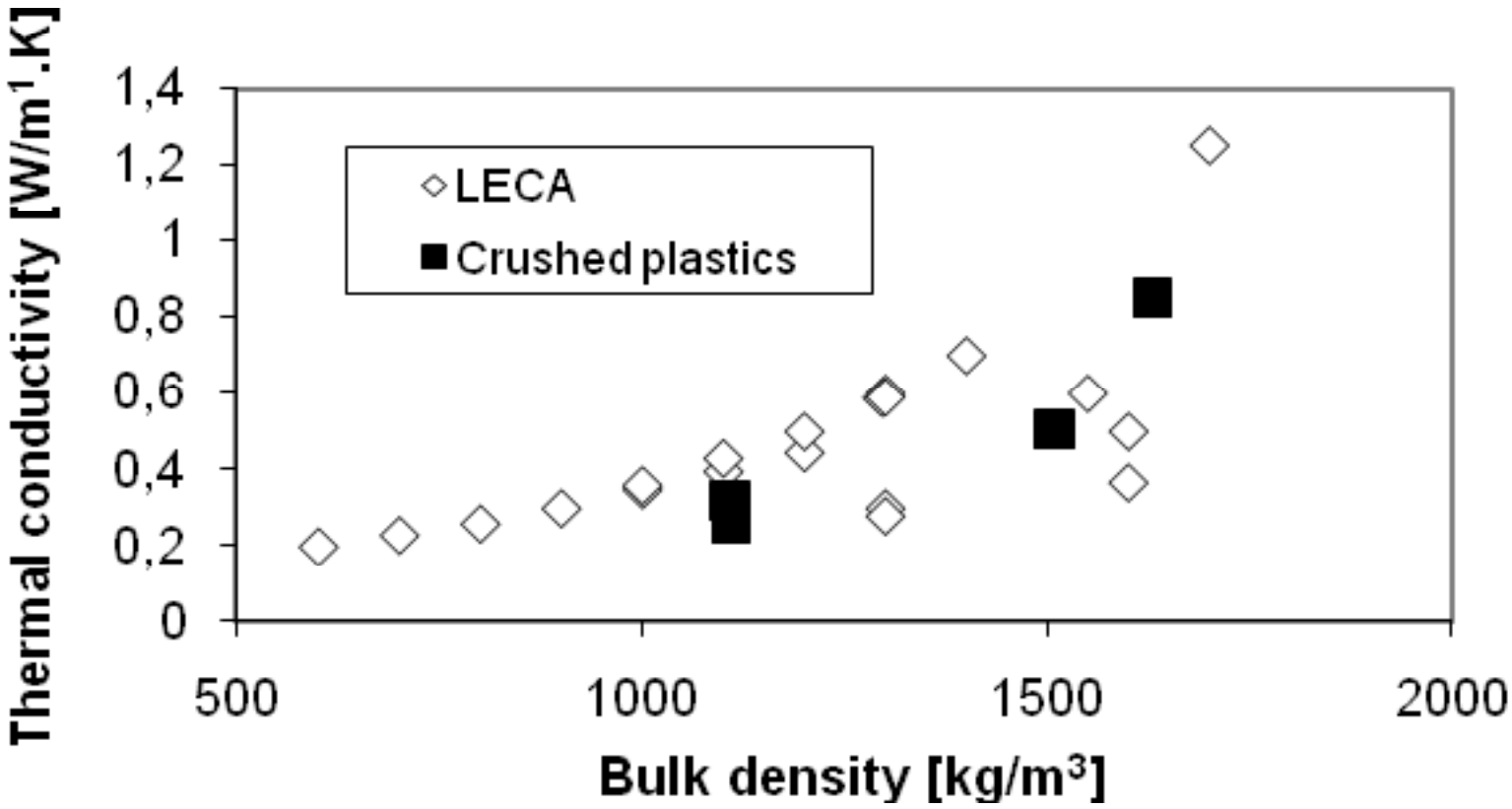
# Diffusion resistance factor for crushed plastics cement composites made of various mixtures - dry cup method

| Mixture No: | Bulk density kg/m$^3$ | Diffusion resistance factor - |
|---|---|---|
| 1 | 916 | 31 |
| 2 | 1112 | 47 |
| 3 | 1423 | 34 |
| 4 | 1602 | 107 |

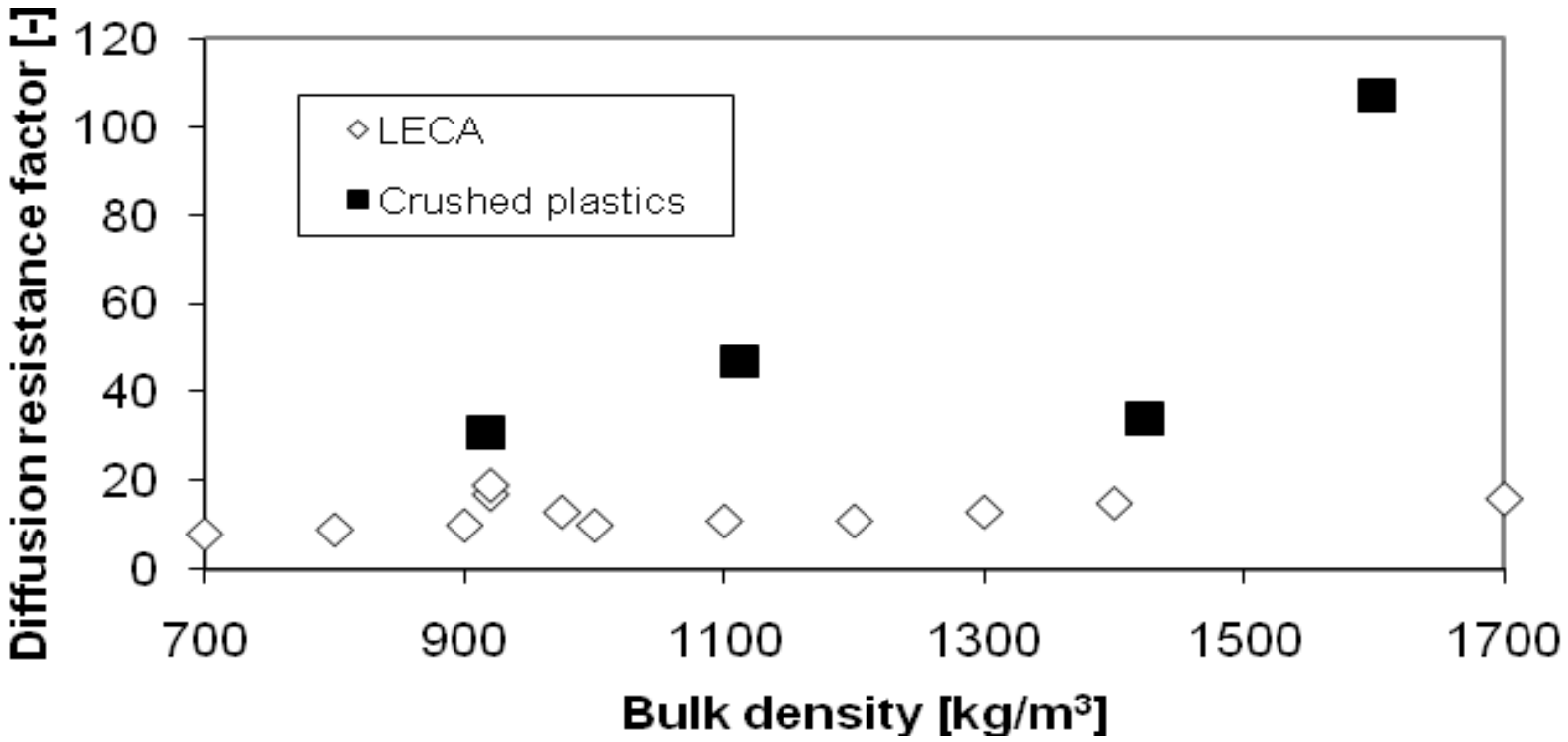
# Water absorption parameters for crushed cement composites manufactured of various mixtures

| Mixture No: | Bulk density $kg/m^3$ | Water absorption coefficient $kg/m^2.s^{0,5}$ | Capillary moisture content $m^3/m^3$ | Water saturation after 14 days $m^3/m^3$ |
|---|---|---|---|---|
| 1 | 1112 | 0.0144 | 0.077 | 0.139 |
| 2 | 1111 | 0.0387 | 0.150 | 0.195 |
| 3 | 1503 | 0.0331 | 0.147 | 0.180 |
| 4 | 1640 | 0.0137 | 0.077 | 0.103 |

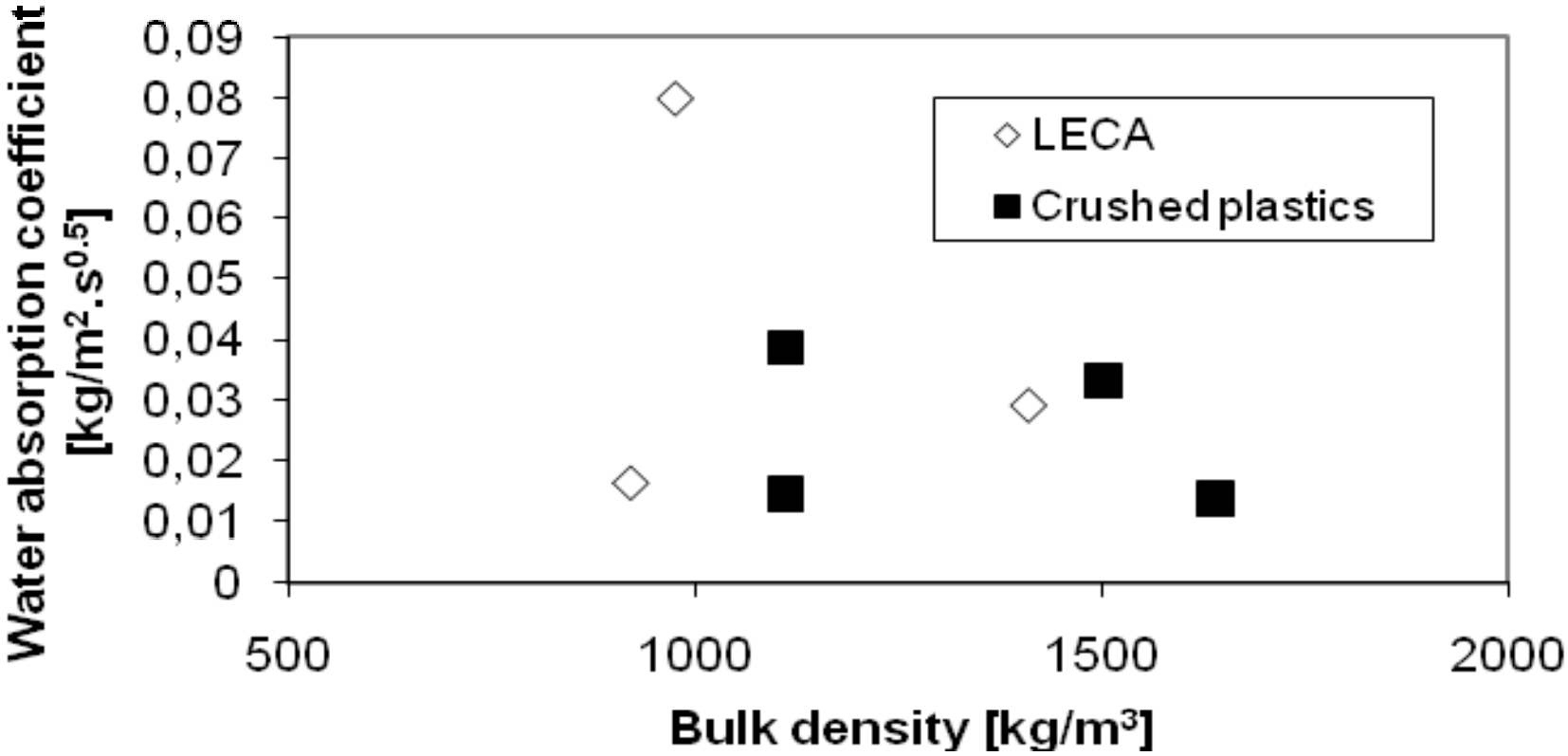
# Comparison of thermal conductivities of LECA and crushed plastics cement composites



# Comparison of diffusion resistance factors of LECA and crushed plastics cement composites



# Comparison of water absorption coefficients of LECA and crushed plastics cement composites



# Conclusions

- The heat and water transport parameters of the cement composites containing the WEEE crushed plastics were compared with the parameters of traditional concretes with lightweight aggregates.
- The comparison of transport properties was made with the data from different sources and with different statistical weight.
- Nevertheless the comparison confirms an assumption that transport parameters of the new materials are comparable with parameters of the traditional products.
- Moreover the comparison indicates higher water transport inertia of the WEEE crushed plastics cement composites and confirms the meaningfulness of their further development.

# Conclusions

- In comparison with the expanded clay aggregate concrete the crushed plastic cement composites can provide lower water vapour and water permeabilities and their thermal conductivities can be less sensitive to the moisture content than in the case of classical lightweight concretes.
- However an achievement these properties  are determined by the shape of the aggregate grains and the quality of the contact zone between the matrix and the aggregate surface.

Thank you for your attention