**Development and Application of Compact Multi Temperature Phase Change Concrete for Building Structure Thermal Bridges**

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**Background**

A thermal bridge is an area or component of a building which has higher thermal conductivity than the surrounding materials, creating a path of least resistance for heat transfer. Thermal bridges result in heat transfer into or out of conditioned space. Thermal bridges in buildings may led to increase in the amount of energy required to heat and cool a space, cause condensation (moisture) within the building envelope, and result in thermal discomfort. Thermal bridges can occur at several locations within a building envelope; most commonly, they occur at junctions between two or more building elements, include wood, steel or concrete members, such as studs and joists, incorporated in exterior wall, ceiling, or roof construction.

There are strategies to reduce or prevent thermal bridging, such as limiting the number of building members that span from unconditioned to conditioned space and, more commonly, applying continuous insulation materials to create thermal breaks. The use of phase change materials (PCMs) in building elements has gained increasing popularity in recent years because of the potential energy savings that result from the heat stored during variable temperature–time histories. However, pasting PCM insulation onto external side of high-rise building walls, it will cause problems to the decorative structure and crack prevention.

An alternative is to insert PCM filled metal pipes into building structures, especially for beams. metal pipes can also resist loads applied laterally to the beam's axis. However, problems like sub-cooling and low thermal conductivity shall be solved. Also, most of phase change building materials under study are only effective in summer because the materials only have one phase change temperature.

**Aim and Objectives**

This study aims to develop a concrete structure embedded with multi temperature phase change materials to minimize the thermal bridge via structural beams.

The objectives are

1. Review of literature on PCM to understand their physical/chemical properties and limits regarding their applications.
2. Modelling and simulation of multi temperature phase change concrete system. The model should be capable of predicting optimum energy saving potential for variables of PCM, such as melting point, latent heat capacity and layout, etc.
3. Characterization of multi temperature PCMs in order to select appropriate candidate.
4. Experimentally test the load-bearing concrete structures embedded with multi temperature phase change materials

**Task Breakdown**

Bulgarian Team

1. Development and tests of multi temperature phase change materials based on data provided by Chinese Team

Chinese Team:

1. Modelling and simulation of multi temperature phase change concrete system.
2. Development and tests of concrete structures embedded with multi temperature phase change materials

**基于多级相变贮热混凝土结构的房屋结构性冷热桥处理技术**

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**研究背景**

在建筑物保温层不连续的地方,热量会从高温处向低温处扩散,建筑围护结构中的薄弱部位是热量容易通过的桥梁,称为冷热桥。常见的冷热桥有处在外墙周边的钢筋混凝土抗震柱、圈梁、门窗过梁，钢筋混凝土或钢框架梁、柱，钢筋混凝土或金属屋面板中的边肋或小肋等。热桥效应现象，在冬季，会严重降低住宅的保温隔热效果，增加住宅的能源消耗。在夏季，同样也会增加住宅的能源负荷。

目前国内外处理房屋结构性冷热桥方法是用各种保温材料（常用如EPS保温板）将其包裹起来，但是轻质低强的保温材料粘贴在高层房屋外墙后，会给外墙面粘贴装饰结构及防裂渗带来不少问题，房屋结构性冷热桥的问题不解决，建筑节能很难深入。

相变储能材料在混凝土试块、石膏墙板等建筑材料中的研究和应用方兴未艾。相变储能建筑材料兼备普通建材和相变材料两者的优点，能够吸收和释放适量的热能，能够和其他传统建筑材料同时使用。但是目前的相变储能建筑材料的相变温度多集中于28-30℃，夏季节能效果较好，冬季基本不发挥作用。

**研究内容**

课题组将研制多相变温度的多级相变储能材料，并在此基础上开发多级相变贮热混凝土结构,以减少房屋结构性冷热桥。具体目标如下：

1. 多级相变蓄热单元管的开发及基础应用性研究
   1. 多级相变材料体系的配制
   2. 在外传热管储热单元中填充多级相变材料，通过数字模拟技术，对多级相变蓄热单元管的热工性能进行评测
2. 多级相变贮热混凝土的制备及力学性能评估

**计划分工**

1. **宁波工程学院：**
   1. 多级相变蓄热单元管的开发
   2. 多级相变贮热管混凝土的制备及力学性能测试
2. **保加利亚：**
   1. 多级相变蓄热材料研制