Dispelling Creep Confusion

“The power to question is the basis for all human progress.”

— Indira Gandhi

Written by: Brian Majeska, Joseph Drbohlav, Joseph Lorenc, Paul Noring, Geoff Rowe, PhD

Introduction

In the concrete and asphalt paving industry, many of the real challenges and cost-effective solutions lie in the nuances of material testing. One such area of focus is *creep*. But no, we’re not talking about a childhood troublemaker who repeatedly mocked others—although the concept of persistence is relevant when discussing the effects of stress over time on materials.

Consider, for example, the repeated loading and unloading on port transfer slabs. It isn’t any single container that causes the concrete to crack or the asphalt to rut; it’s the cumulative effect of countless repetitions. Similarly, we often see more severe fatigue-related cracking in turn lanes from a collector to an arterial road. This occurs due to the increased load and concentration of stress in these areas compared to the ongoing lanes.

Understanding Creep

Creep refers to the slow, continuous deformation of a material under sustained stress. According to Wikipedia, “Creep (sometimes called cold flow) is the tendency of a solid material to undergo slow deformation while subjected to persistent mechanical stresses… Unlike brittle fracture, creep deformation does not occur suddenly upon the application of stress. Instead, strain accumulates as a result of long-term stress.”

Think of creep as the outcome of prolonged stress on a material—whether it be soil, concrete, asphalt, or steel—all of which are integral to road construction.

Types of Creep and Force Considerations

- **Time-Dependent:** Creep is a gradual form of stress that leads to material strain or failure, often manifesting over years in pavements.
- **Material-Specific:** Creep affects different materials—soils, asphalt, concrete, and steel—differently, with varying forces, mechanisms, and rates.
- **Temperature Sensitivity:** Creep, sometimes referred to as cold flow, becomes more pronounced as materials approach or exceed their melting points. This is particularly important for asphalt cement, where temperature impacts were traditionally gauged using methods like the ring and ball softening point before the development of Performance Grade (PG) testing.

Creep essentially describes the long-term consequences of sustained force on a material. Imagine a slow-moving, heavily loaded forklift repeatedly traversing the same pavement segment over years. To contextualize the forces and their effects on creep:

- **Tensile Stress:** Occurs when materials are subjected to a "tug of war" or stretching force. *Example:* A metal cable under constant stress elongates over time.
- **Compressive Stress:** Happens when a material is being squeezed or compressed. *Example:* Concrete columns under constant compressive loads shorten over time.
- **Shear Stress:** Arises when a force is applied parallel to a material, causing layers to slide past each other. *Example:* Truck-only lanes develop ruts over time due to the shear stress imposed by heavy loads on asphalt pavements.

Simplified: Creep is the result of repetitive forces—compressive, shear, and tensile—acting on a pavement over years, leading to cracking and rutting.

Considerations of Creep in Asphalt Pavements

In 2010, the Multiple Stress Creep Recovery (MSCR) test was adopted by the American Association of State Highway and Transportation Officials (AASHTO) for asphalt binder testing. This method assesses four key aspects of an asphalt binder:

- **Load Application:** Repeated loads are applied to the asphalt binder to simulate the stress and eventual strain that lead to deformation, indicative of creep.
- **Non-Recoverable Performance:** The test measures the binder's non-recoverable performance after each loading cycle, known as Non-recoverable Creep Compliance (Jnr).
- **Rutting Prediction:** It evaluates the likelihood of rutting over the lifespan of the asphalt binder within the mixture, taking into account the binder's long-term stiffness performance, which can be validated by increasing temperature.
- **Traffic Simulation:** The MSCR test simulates real-world traffic conditions through repeated loading and unloading.

Types of Distresses in Asphalt Pavements

- **Rutting:** Wheel path depressions that develop over time due to loads exceeding pavement design capacities. This uneven surface poses a significant safety risk, especially during rain or snow events.
- **Asphalt Shoving or Flow:** The lateral movement of pavement under high temperatures and slow-moving traffic, often occurring at intersections or heavy-load terminals, resulting in thinning pavement and the formation of bumps.
- **Fatigue Cracking:** As pavement ages and creep accumulates, fatigue cracking, such as alligator or longitudinal cracks, appears around the wheel path, allowing water intrusion and further pavement deterioration.

Types of Distresses in Concrete Pavements

- **Increased Deflection:** Creep in concrete can cause increasing deflection of pavement slabs over time, leading to structural degradation.
- **Joint Deterioration:** Over time, increased stresses can cause joint spalling, allowing water infiltration and compromising the pavement's ability to carry traffic smoothly.
- **Reduced Load-Bearing Capacity:** As concrete pavements age, they lose their ability to bear traffic loads, potentially leading to premature failure.

Conclusion: "The Power to Question Is the Basis for Progress."

Asking, "How does creep affect pavements?" leads to a deeper understanding of the issue. Creep results from repetitive forces—compressive, shear, and tensile—acting over years, causing cracking and rutting.

Recognizing the role of creep is crucial for effective pavement maintenance. When joint or crack distresses develop, it's essential to have solutions with strong adherence and cohesion to "weld" and waterproof the pavement.

Acknowledgments & Sources

The authors extend gratitude to:

- Ryan Brown, PE
- Dan Wegman, PE
- *Concrete Pavement Preservation Guide (Second Edition) - FHWA Publication No. FHWA-HIF-14-014*
- *Rheological Performance of Non-Asphalt Crack Sealing Materials for Concrete Pavements* - Geoffrey Rowe, et al.
- *Tech Brief - Joint Sealing FHWA-HIF-18-019*
- ChatGPT 4.0

#PublicWorks #Concrete #Asphalt #PavementCracks #PavementPreservation

Connect with us for more insights on pavement engineering and infrastructure development. Let's build stronger, more resilient roadways together!