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Creep and Shrinkage Prediction from Theoretical

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Upon the release of the data from the tragic collapse in 1996 of the record-span segmental box-girder bridge in Palau, it was found that the 18-year deflection was 200 - 400% larger than the predictions based on the American, European and Japanese design codes or recommendations. This finding triggered further studies that led to a collection of deflection histories of 69 large-span segmental bridges, most of which suffered excessive, logarithmically growing, deflections with no sign of an asymptotic bound. It thus became clear that major improvements in design codes and practices are required. Data collection efforts led to a new database of laboratory concrete creep and shrinkage data. With over 3000 test curves, this database more than doubles the size of the previous RILEM database. Unfortunately, the duration of about 94% of the available lab tests is <6 years, 97% ≤12 years, and only 3% attains 30 years, while 100-year lifetimes are generally desired. So it became evident that the only way to develop a realistic multi-decade prediction model was by joint statistical optimization of the fit of the laboratory data and the multi-decade bridge data. Regrettably, most of the bridge data are insufficient for inverse FE analysis. The relative increases of multi-decade deflection after about 1,500 days could be used for calibration. The combination of incomplete multi-decade bridge data with the short-time laboratory database posed a challenge for statistical optimization of the model parameters. Nonlinear least-square regression was used to inform the information of obtained from the database with the bridge deflection measurements. The database of laboratory tests has further been extended to include high-strength concretes (up to 167 MPa strength at 28 days), as well as modern concretes with various admixtures, classified into six classes, some of which decrease and others increase the creep and shrinkage. Through correlation analyses and the incorporation of previously studied trends, new formulas for estimating the model parameters from concrete strength and composition (with admixtures) have been identified.