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**EVALUATION OF CONCRETE SHRINKAGE
AND CREEP PREDICTION MODELS**

A Thesis

Presented to

**The Faculty of the Department of Civil and Environmental Engineering
San Jose State University**

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Jian-Ping Lam

May 2002

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ABSTRACT

EVALUATION OF CONCRETE SHRINKAGE AND CREEP MODELS

by Jian-Ping Lam

Shrinkage and creep are the main types of volume change with time in concrete. These changes may cause stresses, cracking, or deflection that affect the performance of concrete structures. In this study, four shrinkage and creep prediction models are evaluated for their accuracy. Their predicted shrinkage and creep values are compared against the RILEM experimental data bank, and seven statistical methods are used to determine their performance.

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Nomenclature

A. Organizations

ACI The American Concrete Institute

CEB-FIP The Committee Euro-International Du Beton/Federation International de
la Precontrainte-Europe

B. General Abbreviations and Symbols

R = European rapid hardening cement (assumed equivalent to type I
cement)

SL = European slow hardening cement (assumed equivalent to type II
cement)

RS = European rapid hardening high strength cement (assumed
equivalent to type III cement)

Type I = North American normal Portland cement

Type II = North American moderate sulfate resistance cement

Type III = North American high early strength cement

$\epsilon(t)$ = Total strain (instantaneous plus shrinkage plus creep)

σ = Applied stress [MPa] or [psi]

C. Abbreviations and Symbols for Models

C.1 The ACI Model

b	=	Constant in determining shrinkage strain depends on curing method
C_{cu}	=	Ultimate creep coefficient
$C_c(t)$	=	Creep coefficient at time t
E_{cmto}	=	Modulus of elasticity at age of loading [MPa] or [psi]
f_{cm28}	=	Average 28-day concrete compressive strength [MPa] or [psi]
$f_c(t_0)$	=	Mean concrete compressive strength at age of loading [MPa] or [psi]
H	=	Relative humidity [%]
$J(t, t_0)$	=	Creep compliance [$\times 10^{-6}$/MPa] or [$\times 10^{-6}$/psi]
K_{ca}	=	Age at loading correction factor
K_{sh}	=	Relative humidity correction factor for shrinkage
K_{ss}	=	Shape and size correction factor for shrinkage
K_{ch}	=	Relative humidity correction factor for creep
K_{cs}	=	Shape and size correction factor for creep
V/S	=	Volume-to-surface area ratio [mm] or [in.]
t	=	Age of Concrete after casting [days]
t_0	=	Age of concrete at loading [days]
t_c	=	Age of Concrete drying commenced, usually taken as the age at the end of moist curing [days]

$\epsilon(t)$	=	Total strain [mm/mm] or [in./in.]
$\epsilon_s(t)$	=	Shrinkage strain [mm] or [in./in.]
ϵ_{shu}	=	Ultimate shrinkage strain [mm] or [in./in.]
γ	=	Concrete unit weight [kg/m ³] or [lb./yd ³]

C.2 The CEB 90 Model

A_c	=	Cross-section area of concrete member [mm ²] or [in ²]
A_c / u	=	Area-to-Perimeter Ratio [mm] or [in]
E_{cm28}	=	Modulus of elasticity at 28-day [MPa] or [psi]
E_{cmto}	=	Modulus of elasticity at age of loading [MPa] or [psi]
f_{cm28}	=	Average 28-day concrete compressive strength [MPa] or [psi]
f'_{c28}	=	Specified concrete compressive strength at 28-day [MPa] or [psi]
h_e	=	Effective thickness to account of volume/surface ratio [mm] or [in.]
H	=	Relative humidity [%]
$J(t, t_0)$	=	Creep compliance [$\times 10^{-6}$ /MPa] or [$\times 10^{-6}$ /psi]
t	=	Age of concrete after casting [days]
t_0	=	Age of concrete at loading [days]
t_c	=	Age of concrete drying commenced, usually taken as the age at the end of moist curing [days]
u	=	Perimeter of member in contact with atmosphere [mm] or [in.]
ϕ_0	=	Notional creep coefficient

ϕ_H	=	Relative humidity factor on the notional creep coefficient, ϕ_o
$\phi(t, t_o)$	=	Creep coefficient
$\epsilon(t)$	=	Total strain [mm/mm] or [in./in.]
ϵ_{cso}	=	Notional shrinkage coefficient
$\epsilon_s(t)$	=	Shrinkage strain [mm/mm] or [in./in.]
$\epsilon_s(f_{cm28})$	=	Concrete strength factor on shrinkage
$\beta_c(t-t_o)$	=	Coefficient describing development of creep with time after loading
$\beta_s(t-t_c)$	=	Equation describing development of shrinkage with time
$\beta(f_{cm28})$	=	Concrete strength factor on the notional creep coefficient
β_H	=	Relative humidity, H, and Notional member size, h_o factor on creep
β_{RH}	=	Relative humidity, H factor on notional shrinkage coefficient
β_s	=	Coefficient to describe the development of shrinkage with time
β_{sc}	=	Coefficient to describe type of cement
$\beta(t_o)$	=	Age of concrete at loading factor on the notional creep coefficient,
$\phi(t, t_o)$	=	Creep Coefficient

C.3 The B3 Model

a/c	=	Aggregate-to-Cement ratio by weight
c	=	Cement content in concrete [kg/m^3] or [lb/ft^3]
$C_o(t, t_o)$	=	Compliance function for basic creep
$C_d(t, t_o, t_c)$	=	Compliance function for additional creep due to drying
$D = 2(V/S)$	=	Effective cross-section thickness [mm] or [in.]
E_{cm28}	=	Modulus of Elasticity at 28-day [MPa] or [psi]
f_{cm28}	=	Average 28-day concrete compressive strength [MPa] or [psi]
f_{c28}	=	Specified concrete compressive strength at 28-day [MPa] or [psi]
H	=	Relative humidity [%]
$H(t)$	=	Spatial average of pore relative humidity within cross section
$H(t_o)$	=	Spatial average of pore relative humidity within cross section
$J(t, t_o)$	=	Creep compliance function
K_h	=	Humidity function for shrinkage
K_S	=	Cross section shape correction factor
$Q(t, t_o)$	=	Binomial integral
q_1	=	Instantaneous strain due to unit stress
q_2	=	Aging visco-elastic compliance
q_3	=	Non-aging visco-elastic compliance
q_4	=	Flow compliance
q_5	=	Drying creep compliance
$S(t)$	=	Time function for shrinkage

$S(t_0)$	=	Another time function for shrinkage
T_{sh}	=	Shrinkage half-time [days]
t	=	Age of concrete after casting [days]
t_0	=	Age of concrete at loading [days]
t_c	=	Age of concrete drying commenced, usually taken as the age at the end of moist curing [days]
V/S	=	Volume-to-Surface area ratio [mm] or [in.]
w	=	Water content in concrete [kg/m ³] or [lb/ft ³]
w/c	=	Water-to-Cement ratio by weight
$\epsilon(t)$	=	Total strain [mm/mm] or [in./in.]
$\epsilon_s(t)$	=	Shrinkage strain [mm/mm] or [in./in.]
ϵ_{shu}	=	Ultimate shrinkage strain [mm/mm] or [in./in.]
α_1	=	Type of cement correction factor on creep
α_2	=	Curing condition correction factor
$\phi(t, t_0)$	=	Creep Coefficient

C.4 The GL 2000 Model

E_{cm28}	=	Modulus of elasticity at 28-day [MPa] or [psi]
E_{cmto}	=	Modulus of elasticity at age of loading [MPa] or [psi]
f_{cm28}	=	Average 28-day concrete compressive strength [MPa] or [psi]
f_{c28}	=	Specified concrete compressive strength at 28-day [MPa] or [psi]
H	=	Relative humidity [%]

$J(t, t_0)$	=	Creep compliance function
K	=	Function of Cement Type
t	=	Age of concrete after casting [days]
t_0	=	Age of concrete at loading [days]
t_c	=	Age of concrete drying commenced, usually taken as the age at the end of moist curing [days]
V/S	=	Volume-to-Surface Area Ratio [mm] or [in.]
ϵ_{shu}	=	Ultimate shrinkage strain [mm/mm] or [in./in.]
$\epsilon_s(t)$	=	Shrinkage strain
$\beta(H)$	=	Correction term for Effect of Relative Humidity
$\beta(t)$	=	Correction term for Effect of Time
$\phi(t, t_0)$	=	Creep Coefficient
$\Phi(t_c)$	=	Correction term for Effect of Drying before Loading

D. Abbreviations and Symbols for Statistical Methods

D.1 The Average and Standard Deviation Methods

A_j	=	Average of residuals for shrinkage strain or creep compliance for fixed time, j
n	=	Total number of values considered at a fixed time
S_j	=	Standard deviation of residuals for shrinkage strain or creep compliance for fixed time, j

X_j = Residual values for shrinkage strain or creep compliance of i^{th} data point in a fixed time, j

D.2 The B3 Coefficient of Variation (ϖ_{B3} %) Method

n = Number of data points in data set number, j

n_w = Sum of the weights of all data points in a data set

n_k = Number of data points in the k^{th} decade

n_d = Number of decades on the logarithmic scale spanned by measured data in data set number, j

N = Number of data sets in the data bank

J_{ij} = Measured value of the shrinkage strain or creep compliance for the i^{th} data point in data set number, j

Δ_{ij} = Deviation of the shrinkage strain or creep compliance value given by model from the measured value for the i^{th} data point in data set number, j

ϖ_{ij} = Weight assigned to the i^{th} data point in data set number, j

ϖ_j = Coefficient of variation for data set number, j

ϖ_{B3} = Overall coefficient of variation of the deviations of the model from the measured values for all the data sets considered in data bank

D.3 The CEB Coefficient of Variation (V_{CEB} %) Method

n	=	Number of differences (data points) taken
N	=	Total number of data sets considered
S_i	=	Standard error determined from ΔY_{ij} for experiment i
V_i	=	Coefficient of variation of experiment i
V_{CEB}	=	Mean coefficient of variation
Y_i	=	Mean shrinkage strain or creep compliance of experiment i
Y_{ij}	=	Observed shrinkage strain or creep compliance at time j of experiment i
ΔY_{ij}	=	Difference between observed shrinkage strain or creep compliance and predicted values at time j of experiment i

D.4 The CEB Mean Square Error (F_{CEB} %) Method

Cal X_{ij}	=	Predicted shrinkage strain or creep compliance of time j of experiment i
Obs X_{ij}	=	Experimental shrinkage strain or creep compliance of time j of experiment i
f_j	=	Percent difference between calculated and observed data point j
F_{CEB}	=	Mean square error %
n	=	Total number of values j of experiment i considered at a fixed time
N	=	Total number of data sets considered

D.5 The CEB Mean Deviation (M_{CEB}) Method

Cal X_{ij} = Predicted shrinkage strain or creep compliance of time j of experiment i

Obs X_{ij} = Experimental shrinkage strain or creep compliance of time j of experiment i

M_i = Deviation between predicted values and experimental values of experiment i

M_{CEB} = Mean deviation

n = Total number of values j of experiment i considered at a fixed time

N = Total number of data sets considered

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Chapter 1

Introduction

1.1 General

Shrinkage and creep have a significant impact on the performance of concrete structures. They cause deflections in reinforced concrete structures and affect the stress distribution within concrete element. Effects of shrinkage and creep are related to safety against failure, and economic factors such as durability, serviceability, and long-term reliability. Therefore, it is important to find an accurate prediction model for shrinkage and creep. This chapter will cover an overview on shrinkage and creep. Factors that are considered contributing to concrete shrinkage and creep will also be discussed.

1.2 Concrete Shrinkage

Shrinkage occurs on loss of moisture from the concrete. It develops without any action of stresses; it is caused solely by water passing from concrete into the environment and vice versa. There are four definition types of shrinkage: Plastic Shrinkage, Drying Shrinkage, Carbonation Shrinkage, and Autogenous Shrinkage.

Plastic Shrinkage refers to the loss of water from fresh concrete. If this loss is not prevented, it can cause cracking shortly after the concrete is poured. The cracking is mainly due to evaporation of water from the surface, and suction of water from the concrete by form work materials. Plastic shrinkage cracking is common in horizontal

surfaces of pavements and slabs where rapid evaporation occurs. It is aggravated by a combination of high wind velocity, low relative humidity, high air temperature, and high concrete temperatures. The most effective way to prevent plastic shrinkage is to keep the concrete surface wet until the surface has been finished and routine curing begun. Curing methods consist of temporary wet coverings, waterproof sheeting, or fog spraying.

Drying Shrinkage is used to describe the phenomenon of moisture movement from hardened concrete. It is due to the loss of a layer of adsorbed water from the surface of the gel particles. As a result, exterior concrete shrinks more rapidly than the interior. This leads to tensile stresses in the outer skin of the concrete and compressive stresses in the interior. For large members, as the ratio of volume-to-surface area increases, less shrinkage occurs because there is more internal moisture in the concrete that will restrain shrinkage. Insufficient allowance for the effects of drying shrinkage in concrete design and construction can lead to cracking or warping of elements of the structure due to restraints present during shrinkage [1]. Providing shrinkage control joints in pavement and slabs is the most common way to control drying shrinkage crack. These joints prevent random, irregular shrinkage cracking and limit it to a desired path in a form in which the crack can readily be filled with a sealant to prevent the entry of foreign materials.

Carbonation Shrinkage is due to the carbonation process in cement hydration products. It occurs when hydrated cement reacts with atmospheric carbon dioxide. The rate of carbonation depends on the moisture content of the concrete and the relative humidity of the ambient medium. It is roughly proportional to the square root of time;

however, periodic wetting of the concrete significantly slows down the progress of carbonation. Carbonation shrinkage is caused by the dissolving of crystals of $\text{Ca}(\text{OH})_2$ while under a compressive stress (imposed by the drying shrinkage) and depositing of CaCO_3 in spaces free from stress. When concrete is subjected to alternating wetting and drying in air containing CO_2 , shrinkage due to carbonation becomes more obvious. Because total shrinkage is always greater if drying takes place in CO_2 free air, therefore carbonation increases the magnitude of shrinkage cracking of exposed concrete.

Autogenous Shrinkage occurs when a concrete member can self-desiccate during hydration. The self-desiccation phenomenon happens when no additional water beyond that added during mixing is provided. It is possible that the concrete will begin to dry out even if no moisture is lost to the surroundings if concrete has a low water-to-cement ratio and is due to the internal consumption of water during hydration.

In general, parameters affecting concrete shrinkage are the following:

1. Paste parameters
 - a. Water-to-Cement ratio
 - b. Curing temperature
 - c. Cement composition
 - d. Moisture content
 - e. Admixtures
2. Concrete parameters
 - a. Aggregate stiffness
 - b. Aggregate content / Cement content

- c. Volume-to-Surface ratio
 - d. Concrete member thickness
3. Environmental parameters
- a. Relative humidity
 - b. Drying rate

1.3 Concrete Creep

Creep refers to the deformation that *hardened concrete* experiences after live load and dead load is applied to the concrete member. Therefore, creep can be defined as the increase in strain under a sustained stress, and since this increase can be several times as large as the strain on loading, creep is an important parameter in structural mechanics. It is generally to consider creep as a deformation in excess of shrinkage. It is calculated as the difference between the total time-deformation of the loaded specimen and the shrinkage of a similar unloaded specimen stored under the same conditions through the same period. It has been determined that creep deformations are greater if concrete is drying while under loading than concrete is dried prior to loading. Creep also occurs under dynamic loading. It is generally found that dynamic creep is greater than static creep compared under the same maximum stress.

There are two major types of concrete creep: Basic creep and Drying creep. Basic Creep refers to the non-drying component of creep. It is a time dependent increase in strain under a constant stress without any moisture gain or loss.

Drying Creep is sometimes called the Picket effect. It refers to the drying component of creep. It is a time dependent increase in strain under drying condition in

excess of basic creep. If a sustained load is removed, the strain decreases immediately. This instantaneous recovery is followed by a gradual decrease in strain, called creep recovery [2]. The reversal of creep is not complete, and creep is not a simply reversible phenomenon, so that any sustained application of load results in a residual deformation. In fact, only a relatively small proportion of the total creep strain is reversible when concrete is unloaded. The recoverable creep is general in the range of 10%-20% of total creep after loading for 200 days. Therefore, irreversible creep dominates creep behavior. Creep recovery is affected by time, temperature, and relative humidity. The proportion of irreversible creep increases with time under loading.

Creep is greatly influenced by the following parameters:

1. **Water-to-Cement Ratio, w/c**

A change in w/c ratio of concrete implies a change in cement content and concrete strength. In general, specific creep increases with increasing w/c ratio.

2. **Temperature**

Temperature has a two-fold effect on creep. Increases in temperature give increased creep while at the same time resulting in increased concrete strength during hydration [1]. This increased strength has the influence of reducing creep. It has been reported that creep of mature concrete will be 2 to 3 times larger at 50°C than at controlled room temperature [3].

2. **Moisture**

Creep is a function of the evaporable water in the concrete, and falls to zero when no evaporable water is present. The greatest decrease in evaporable water / creep, occurs

on drying to 40% relative humidity. Both basic creep and drying creep depend on changes of relative humidity and are the greatest when concrete is completely re-saturated.

3. Cement Composition

An increase in the content of C_3A or a decrease in the effective content of C_3S , tends to increase creep in concrete.

4. Aggregates

Aggregates act as a restraint to reduce the potential deformations of the paste. It is reported that an increase in the volumetric aggregate content from 65% to 75% can decrease creep by 10%. However, physical properties of aggregate like size, grading, and surface texture have little influence on creep. The modulus of elasticity of the aggregate is probably the most important factor. The higher the modulus the greater the restraint offered by the aggregate to the potential creep of the cement paste.

1.4 Objective

The objective of this study is to determine the accuracy of four shrinkage and creep prediction models. The models namely are the ACI 209 Code Model, the CEB 90 Code Model, the B3 Model, and the GL 2000 Model. The ACI 209 Model and the CEB 90 Model are code models while the other two are being considered as a replacement for the ACI 209 Model. Predicted shrinkage strain and creep compliance values by each individual model will be compared against the RILEM experimental data bank. Seven statistical methods will be utilized to evaluate the performance of each model for

different time ranges. The approach in this study is to analyze the data that are within each model's limitation. For each statistical method, models are identified and ranked according to their accuracy of prediction. The Model that most frequently ranks first or second under each category is considered the best performing model for shrinkage and creep.

1.5 Thesis Outline

This thesis consists of five chapters. Chapter 1 gives an introduction on concrete shrinkage and creep. Chapter 2 presents brief discussion on each model and the RILEM data bank. This chapter also covers the data selection criteria for the approach that is used in this study. Chapter 3 describes the seven statistical methods that are utilized to evaluate the accuracy of each model. Chapter 4 includes the discussion and interpretations of study results. Conclusion and recommendations for future research are presented in Chapter 5.

Chapter 2

Shrinkage and Creep Prediction Models, RILEM Data Bank

2.1 Introduction

Four shrinkage and creep prediction models are presented in this thesis. The discussion is concentrated on evaluating the accuracy of these models. This is accomplished by comparing the theoretical results that obtained by these models and compare them to the RILEM experimental data bank. These four models are the ACI 209 Model, the CEB 90 Model, the B3 Model, and the GL 2000 Model.

2.2 The ACI Model

The ACI 209 Model is the current standard code model recommended by the American Concrete Institute. It has been incorporated in most building codes in the United States and serves as the basis for comparable codes in Canada, New Zealand, Australia, and parts of Latin America. The ACI 209 Model is a purely empirical model based on creep and shrinkage tests performed on 150 mm x 300 mm diameter standard cylinders [4]. The creep and shrinkage formulas given in the model represent the mean behavior of hundreds of test results.

The most current ACI 209 Model is based on the works by Branson et al [4]. The rates of shrinkage and creep are expressed as functions of time. The creep coefficient is used to calculate creep strain and the model accounts for moist and steam cured concrete. In the ACI 209 Model, the following factors are considered for prediction of shrinkage

and creep: relative humidity, concrete member size, concrete compressive strength at loading, cement types, ratio of coarse/fine aggregate, concrete age at loading. This model can be applied for type I and III portland cement concrete with relative humidities ranging between 40% to 100% [5].

2.3 The CEB 90 Model

The CEB 90 Model is recommended by CEB-FIP Model Code 1990 (Euro-International Concrete Committee and International Federation for Prestressing). Earlier models include: CEB-FIP-1970 and CEB-FIP-1978 Models.

In the CEB 90 model, the following factors are considered for prediction of shrinkage and creep: relative humidity, exposure of concrete member to the temperature prior to drying, concrete member size, cement type, cement modulus, concrete age at loading. Neither the effects of curing duration nor method is accounted for in this CEB 90 Model. This model can be applied for concretes with relative humidity ranging between 40% and 100% at a mean temperature ranges from 5 °C to 30 °C. It is valid for normal weight concrete structures having an average 28-day compressive strength ranging from 20 MPa to 90 MPa, curing at normal temperatures not longer than 14 days.

Like ACI 209 Model, CEB 90 calculates a creep coefficient at certain time after loading. However, CEB 90 calculates the creep coefficient based on both the modulus of elasticity at the age of 28-day, E_{cm28} , and the modulus of elasticity at age of loading, E_{cmto} , which is utilized in the ACI 209 Model.

2.4 The B3 Model

The B3 Model is the latest version in a number of shrinkage and creep prediction methods. The model was developed by Bazant and Baweja at North Western University in 1997. An earlier version of this model was proposed in 1978 and was called the BP Model. It was then modified in 1991 and was named the BP-KX Model. The latest B3 Model is a simpler version of the expanded BP-KX Model.

The B3 Model requires more parameters and calculations than the ACI 209 Model, the CEB 90 Model, or the GL 2000 Model. In the B3 Model, the following factors are considered for prediction of shrinkage and creep: relative humidity, exposure of concrete specimen to temperature prior to drying, concrete member size, concrete specimen shape, concrete specimen 28-day strength, water-to-cement ratio, cement content, cement type, cement modulus, fine and coarse aggregate content, cement and sand content, cement and gravel content, concrete density, concrete age at drying, and concrete age at loading. This model has the following restrictions:

1. Average compressive strength from 17.2 MPa to 69 MPa (2500 psi to 10000 psi)
2. Relative humidity between 40 % and 100 %
3. Water-to-Cement ratio between 0.30 to 0.85
4. Cement Contents from 160 kg/m³ to 719 kg/m³ (10 lb/ft³ to 45 lb/ft³)
5. Aggregate-to-Cement ratio between 2.5 to 13.5
6. Age of concrete at loading $\geq$ Age of concrete after casting ($t_0 \geq t_c$)

2.5 The GL 2000 Model

The GL 2000 Model is a modified Atlanta 97 Model which was proposed by Gardner and Zhao in 1993 [6]. GL 2000 Model itself was influenced by the CEB 90 Model, developed to correct the negative relaxation at early ages of loading and the unrealistic creep recovery of the Atlanta 97 Model [6].

In the GL 2000 Model, the following factors are considered for prediction of shrinkage and creep: relative humidity, concrete member size, concrete member 28-day strength, water-to-cement ratio, cement type, modulus of elasticity of concrete at loading, concrete age at drying, and concrete age at loading. This model has the following restrictions:

1. Average compressive strength ranges from 16 MPa to 82 MPa (2320 psi to 11890 psi)
2. Relative humidity between 20% and 100%
3. Water-to-Cement ratio between 0.40 to 0.60
4. Volume-to-Surface ratio larger than 19 mm (0.76 in.)
5. Age of concrete at loading $\geq$ Age of concrete drying commenced $\geq$ 1 day
($t_o \geq t_c \geq 1$ day)

2.6 Summary of Analyzed Models

Table 2.1 summarizes the limitations of each model, and Table 2.2 indicates the factors required to predict shrinkage strain, creep compliance for each model.

Table 2.1 Limitations of Analyzed Models

	ACI 209	CEB 90	B3	GL 2000
f_{cm28} [MPa] f_{cm28} (psi)	–	20-90 (2900-13000)	17.2-69 (2500-10000)	16-82 (2320-11890)
Aggregate-to-Cement Ratio	–	–	2.5-13.5	–
Cement Content [kg/m ³] Cement Content (lb/ft ³)	–	–	160-719 (10-45)	–
Water-to-Cement Ratio	–	–	0.35-0.85	0.40-0.60
Relative Humidity [%]	40-100	40-100	40-100	20-100
Type of Cement [European] Type of Cement (American)	R or RS I or III	R, SL, RS I, II, III	R, SL, RS I, II, III	R, SL, RS I, II, III
t_0 or t_c (Moist Cured)	≥ 7 days	< 14 days	$t_0 \geq t_c$	$t_0 \geq t_c \geq 1$ day
t_0 or t_c (Steam Cured)	≥ 1 day	< 14 days	$t_0 \geq t_c$	$t_0 \geq t_c \geq 1$ day

Table 2.2 Input Factors for Predicting Shrinkage and Creep

	ACI 209	CEB 90	B3	GL 2000
Relative Humidity	(S), (C)	(S), (C)	(S), (C)	(S)
Specimen Size	(S), (C)	(S), (C)	(S)	(S), (C)
Specimen Shape			(S)	
f_{cm28} (compressive strength at 28-day after casting)	(C)	(S), (C)	(S), (C)	(S), (C)
f_{cmto} (compressive strength at age of loading)	(C)			(C)
E_{cm28} (Modulus of Elasticity at 28-day after casting)	(C)	(C)	(C)	(C)
E_{cmto} (Modulus of Elasticity at age of loading)	(C)	(C)		(C)
Cement Types	(C)	(C)	(S), (C)	(S)
w/c (Water-to-Cement ratio)			(C)	
a/c (Aggregate-to-Cement ratio)			(C)	
Curing Types	(S), (C)		(S), (C)	
t_c (Age at end of curing)	(S)	(S)	(S)	(S)
t_o (Age at loading)	(C)	(C)	(C)	(C)
Total Parameters Required for Shrinkage (S)	4	4	7	4
Total Parameters Required for Creep (C)	9	7	8	6

Chapter 3

Methods for Assessments of the Accuracy of Models

3.1 Introduction

In this study, all the shrinkage strain and creep compliance values are calculated by the four different models for each data set in RILEM Data Bank. The calculated values are grouped together and sorted in different time ranges. The different time ranges consist of the following intervals: 0-10 days, 11-99 days, 100-365 days, 366-730 days, 731-1095 days, and above 1095 days are utilized. These time ranges refer to the duration the concrete member experienced shrinkage or creep. In a mathematical expression, for shrinkage, the time range is represented by $(t-t_c)$ and for creep, it is represented by $(t-t_o)$ where 't' is the age of concrete after casting, 't_o' is the age of concrete at loading, and 't_c' is the age of the end of curing. The nomenclature used is consistent for all four analyzed models. The models are compared to the RILEM Data Bank and different graphs are plotted to reflect accuracy of each model. Seven methods for assessments of the model accuracy will be presented in the following sections.

3.2 The Residual Method

The Residual Method is the simplest one among all seven methods. The basic idea for this method is subtracting the predicted values from the experimental values, and then determine how much different those predicted values are away from RILEM data. A positive difference implies that a particular model over-estimates the shrinkage strain or creep compliance values. Under-estimating the values are reflected in a negative difference. Residuals are further classified into over ± 100 microstrain for shrinkage, and within or over ± 33 microstrain/MPa (± 0.23 microstrain/psi for creep). The data are categorized into 3-time ranges, which are 0-1000 days, 1001-9000 days, and 0-9000 days. The purpose of identifying the residuals within certain microstrain for shrinkage and microstrain/psi for creep is to seek out the distribution of those residuals and determine which model predicts the most data that are close to the experimental data. In this study, the residual values are plotted versus the log time 0-9000 days. The residual value is calculated using the following equation:

$$RV = P - E \quad \text{(Eq. 3-1)}$$

where:

RV = Residual Value

P = Model Predicted value

E = RILEM Experimental data value

3.3 The Average and Standard Deviation of

Residuals Methods

The methods consist of calculating the average mean values and standard deviation values for each model's residuals in 2-time ranges, which are 0-1000 days, 1001-9000 days, and 6-time ranges, which are 0-10 days, 11-100 days, 101-365 days, 366-730 days, 731-1095 days, and above 1095 days. The idea of calculating standard deviation for residuals is to determine how widely the residuals deviate from the average value. The following equations are utilized in this statistical method:

$$A_j = \frac{\sum_{i=1}^n X_i}{n} \quad (\text{Eq. 3.2})$$

$$S_j = \sqrt{\frac{n \sum_{i=1}^n X_i^2 - (\sum_{i=1}^n X_i)^2}{n(n-1)}} \quad (\text{Eq. 3.3})$$

A_j = Average of residuals for shrinkage strain or creep compliance for fixed time, j

n = Total number of values considered at a fixed time

S_j = Standard deviation of residuals for shrinkage strain or creep compliance for fixed time, j

X_j = Residual values for shrinkage strain or creep compliance of i^{th} data point in a fixed time, j

3.4 The B3 Coefficient of Variation ($\varpi_{B3}\%$) Method

The B3 Coefficient of Variation Method was developed by Bazant and Baweja [7, 8]. This method involves more complex analysis procedures than the other methods that are utilized in this study. Firstly, the coefficient of variation, ϖ is determined for each single data set shown in Eq. 3.4, 3.5, and 3.6. The overall coefficient of variation (ϖ_{B3}) for all considered data sets is then given as a percentage as calculated by Eq. 3.7. For a single data set, the data points in each decade are considered as one group, and each data point in that group is assigned equal weight. Weight is assigned to a data point based on the decade in which it falls and number of data points in that particular decade. An example of the procedure utilized in this method is given in Appendix C.

There are four decades of creep and shrinkage duration identified in this method:

Decade 1	=	0-10 days
Decade 2	=	10-100 days
Decade 3	=	101-1000 days
Decade 4	=	1001-10000 days

The equations utilized in this method are as follow:

$$\varpi_j = \frac{1}{J_j} \sqrt{\frac{1}{n-1} \sum_{i=1}^n (\varpi_{ij} \Delta_{ij})^2} \quad (\text{Eq. 3.4})$$

$$\overline{J_j} = \frac{1}{n_w} \sum_{i=1}^n (\varpi_{ij} J_{ij}) \quad (\text{Eq. 3.5})$$

$$\varpi_{ij} = \frac{n}{n_d n_k} \quad (\text{Eq. 3.6})$$

$$\varpi_{B3} = \sqrt{\frac{1}{N} \sum_{j=1}^N \varpi_j^2} \quad (\text{Eq. 3.7})$$

The nomenclatures for this method are listed as follow:

n	=	Number of data points in data set number, j
n_w	=	Sum of the weights of all data points in a data set
n_k	=	Number of data points in the k^{th} decade
n_d	=	Number of decades on the logarithmic scale spanned by measured data in data set number, j
N	=	Number of data sets in the data bank
J_{ij}	=	Measured value of the shrinkage strain or creep compliance for the i^{th} data point in data set number, j
Δ_{ij}	=	Deviation of the shrinkage strain or creep compliance value given by the model from the measured value for the i^{th} data point in data set number, j
ϖ_{ij}	=	Weight assigned to the i^{th} data point in data set number, j
ϖ_j	=	Coefficient of variation for data set number, j
ϖ_{B3}	=	Overall coefficient of variation of the deviations of the model from the measured values for all the data sets considered in data bank

3.5 The CEB Coefficient of Variation (V_{CEB} %) Method

The CEB Coefficient of Variation Method was suggested by Muller and Hilsdorf [9, 10]. In this study, the coefficient of variation, V_i for shrinkage and creep compliance is calculated in 6-time ranges which are 0-10 days, 11-100 days, 101-365 days, 366-730 days, 731-1095 days, above 1095 days. And the mean coefficient of variation, V_{CEB} for all six different time ranges, is calculated last. Equations and nomenclatures utilized in this method are as follow:

$$Y_i = \frac{\sum_{j=1}^n Y_{ij}}{n} \quad (\text{Eq. 3.8})$$

$$S_i = \sqrt{\frac{1}{n-1} \sum_{j=1}^n (\Delta Y_{ij})^2} \quad (\text{Eq. 3.9})$$

$$V_i = \frac{S_i}{Y_i} \times 100 \quad (\text{Eq. 3.10})$$

$$V_{CEB} = \sqrt{\frac{1}{N} \sum_{i=1}^N V_i^2} \quad (\text{Eq. 3.11})$$

n = Number of differences (data points) taken

N = Total number of data sets considered

S_i = Standard error determined from ΔY_{ij} for experiment i

V_i = Coefficient of variation of experiment i

V_{CEB} = Mean coefficient of variation

Y_i = Mean shrinkage strain or creep compliance of experiment i

Y_{ij} = Observed shrinkage strain or creep compliance at time j of experiment i

ΔY_{ij} = Difference between observed shrinkage strain or creep compliance and predicted values at time j of experiment i

3.6 The CEB Mean Square Error (F_{CEB} %) Method

The CEB Mean Square Error (F_{CEB} %) Method was also suggested by Muller and Hilsdorf [9, 10]. F_{CEB} is an overall error indication of predicted values. F_i for shrinkage strain and creep compliance is calculated in 6-time ranges which are 0-10 days, 11-100 days, 101-365 days, 366-730 days, 731-1095 days, above 1095 days. Similar to V_{CEB} , the overall F_{CEB} value for all six time ranges are calculated at last, utilizing Eq. 3.14. All equations used to calculate F_i and F_{CEB} in this statistical method are given below.

$$f_j = \frac{(\text{Cal}X_{ij} - \text{Obs}X_{ij})}{\text{Obs}X_{ij}} \times 100 \quad (\text{Eq. 3.12})$$

$$F_i = \sqrt{\frac{1}{n-1} \sum_{j=1}^n f_j^2} \quad (\text{Eq. 3.13})$$

$$F_{CEB} = \sqrt{\frac{1}{N} \sum_{i=1}^N F_i^2} \quad (\text{Eq. 3.14})$$

Cal X_{ij} = Predicted shrinkage strain or creep compliance of time j of experiment i

Obs X_{ij} = Experimental shrinkage strain or creep compliance of time j of experiment i

f_j = Percent difference between calculated and observed data point j

F_{CEB} = Mean square error %

n = Total number of values j of experiment i considered at a fixed time

N = Total number of data sets considered

3.7 The CEB Mean Deviation (M_{CEB}) Method

The CEB Mean Deviation (M_{CEB}) is another statistical method suggested by Muller and Hilsforf [9, 10]. This is a method to indicate the systematic over-estimation or under-estimation of a given model. Similar to the CEB Coefficient of Variation Method and the CEB Mean Square Error Method, M_i is first calculated for a fixed time of shrinkage or creep duration, then the mean deviation M_{CEB} for all six-time ranges is determined. In this study, M_i is calculated for 6-time ranges which are 0-10 days, 11-100 days, 101-365 days, 366-730 days, 731-1095 days, and above 1095 days. Following are the equations and nomenclatures used in this method:

$$M_i = \frac{1}{n} \sum_{j=1}^n \frac{\text{Cal}X_{ij}}{\text{Obs}X_{ij}} \quad (\text{Eq. 3.15})$$

$$M_{\text{CEB}} = \frac{\sum_{i=1}^N M_i}{N} \quad (\text{Eq. 3.16})$$

Cal X_{ij} = Predicted shrinkage strain or creep compliance of time j of experiment i

**Obs X_{ij} = Experimental shrinkage strain or creep compliance of time j of
experiment i**

M_i	=	Deviation between predicted values and experimental values of experiment i
M_{CEB}	=	Mean deviation
n	=	Total number of values j of experiment i considered at a fixed time
N	=	Total number of data sets considered

Chapter 4

Study Results

4.1 Introduction

The ACI 209 Model, the CEB 90 Model, the B3 Model, and the GL 2000 Model, these shrinkage and creep prediction models are evaluated for their accuracy by comparing their predicted results against the RILEM data bank utilizing the seven statistical methods discussed in Chapter 3. The following sections will discuss the data selection criteria and summarize the findings for both shrinkage strain and creep compliance.

4.2 Data Selection Criteria

The RILEM Data Bank as of Year 2001 consists of 7053 shrinkage data points (426 shrinkage data sets) and 8790 creep data points (518 data sets). Some of the data points are excluded in this study because their experimental conditions are beyond the application of the individual prediction model. Table 4.1 lists the individual model's applicable range for different categories.

In addition to the limitations listed in Table 4.1, some other criteria are imposed in the data selection process. Data points with a swelling phenomena (a +ve value) instead of a shrinking phenomena (a -ve value) are excluded from the shrinkage analysis.

Table 4.1 Data Selection Criteria for Each Model

	ACI 209	CEB 90	B3	GL 2000
f_{cm28} [MPa] f_{cm28} (psi)	–	20-90 (2900-13000)	17.2-69 (2500-10000)	16-82
Aggregate-to-Cement Ratio	–	–	2.5-13.5	–
Cement Content [kg/m³] Cement Content (lb/ft³)	–	–	160-719 (10-45)	–
Water-to-Cement Ratio	–	–	0.35-0.85	0.40-0.60
Relative Humidity [%]	40-100	40-100	40-100	20-100
Type of Cement [European] Type of Cement (American)	R or RS I or III	R, SL, RS I, II, III	R, SL, RS I, II, III	R, SL, RS I, II, III
t_o or t_c (Moist Cured)	≥ 7 days	< 14 days	$t_o \geq t_c$	$t_o \geq t_c \geq 1$ day
t_o or t_c (Steam Cured)	≥ 1 day	< 14 days	$t_o \geq t_c$	$t_o \geq t_c \geq 1$ day

The experimental f_{cm28} and E_{cm28} are available for most data sets. However no experimental E_{cm28} values are used directly in the model equations; the values are back calculated by the experimental f_{cm28} . This is a procedure that is useful for practitioners. In the case of data sets with no experimental f_{cm28} value, they are excluded in the analysis.

Data sets with 101% relative humidity implies a sealed curing condition; a value of 98% relative humidity is assigned for those data sets when utilizing the ACI 209 Model, the CEB 90 Model, and the B3 Model. A value of 96% relative humidity is used when the shrinkage strain and creep compliance are predicted by the GL 2000 Model. The GL 2000 Model is designed so that it will have zero shrinkage strain at 96% relative humidity.

Data points with zero experimental values are excluded from the analysis. It is because when calculating the interim values for the $F_i\%$ and M_i , it requires dividing experimental value and since it is zero, the data point is excluded.

Table 4.2 summarizes the number of experimental sets and experimental points utilized in this study for both shrinkage strain and creep compliance prediction after considering the limitations described previously.

Table 4.2 Summary of Analyzed Shrinkage and Creep Data Points

Category	ACI 209	CEB 90	B3	GL 2000
Shrinkage Strain	176 Sets 2642 Points	182 Sets 2749 Points	166 Sets 2388 Points	115 Sets 1677 Points
Creep Compliance	250 Sets 4795 Points	312 Sets 5894 Points	276 Sets 5141 Points	225 Sets 4166 Points
Creep Data with Stress-Strength Ratio >0.4	16 Sets 327 Points *(7%)	21 Sets 462 Points *(8%)	20 Sets 472 Points *(9%)	20 Sets 472 Points *(11%)
Creep Data with Stress-Strength Ratio 0.4 – 0.45	10 Sets 120 Points *(3%)	17 Sets 212 Points *(4%)	5 Sets 63 Points *(1%)	5 Sets 63 Points *(2%)
Creep Data with Stress-Strength Ratio 0.45 - 0.50	5 Sets 62 Points *(1%)	4 Sets 71 Points *(1%)	6 Sets 73 Points *(1%)	6 Sets 73 Points *(2%)

* Percentage is calculated based on the total creep compliance data points analyzed by each model

Table 4.2 also indicates the number of creep data with stress-strength ratio > 0.4 . It can be seen that the number of those data constitute a low percentage of the total creep data points analyzed by each model. The CEB 90 Model is designed for concrete specimen with stress-strength less than 0.4; however, this limitation criteria is not included in this study. It is because in reality concrete specimen with stress-strength

larger than 0.4 does exist; therefore, those data are included for analyzing the CEB 90 Model as well as the other models.

4.3 Analysis of Shrinkage Strain

The results for shrinkage strain are presented in the following sections. Each section covers the results of all the seven statistical methods, in the order of methods discussed in Chapter 3. The shrinkage strain values were calculated by the four analyzed models. Those values were compared against the experimental data. The residual points were then calculated and plotted versus the shrinkage duration. They were also classified into various ranges and the total number in each range could be compared among the four models. In this analysis, the average and standard deviation of the residuals were also determined. The B3 Coefficient of Variation (ω_{B3}), the CEB Coefficient of Variation (V_{CEB}), the CEB Mean Square Error (F_{CEB}), and the CEB Mean Deviation (M_{CEB}) of the analyzed model's calculated shrinkage strain were determined for model accuracy.

4.3.1 Analysis of Shrinkage Strain Residuals

Figures 4.1 to 4.4 show the residuals of shrinkage strain of all four models using the 0-9000 days time interval. Residuals in the positive range imply the model predicted values overestimate the experimental data, whereas the negative range indicates underestimation of the experimental values. Table 4.3 summarizes the distribution of residuals for shrinkage strain.

Figure 4.1 shows the shrinkage strain residuals for the ACI 209 Model. It can be seen from the figure and Table 4.3 that the residuals are mostly distributed on the positive side for short duration, (i.e., 0-1000 days), and on the negative side for long time duration, (i.e., 1001-9000 days). The values predicted by the model over-estimate the shrinkage strain in the overall time range, 0-9000 days with 63% on the positive side and 37% on the negative side.

Figure 4.2 shows the shrinkage strain residuals for the CEB 90 Mode. It can be observed from the figure and Table 4.3 that the residuals are mostly distributed on the negative side for both short and long duration. It can be concluded that this model tends to under-estimate shrinkage strain values. 83% of residuals are on the negative side versus 17% of residuals are on the positive side.

Figure 4.3 shows the shrinkage strain residuals for the B3 Model. It can be observed from the figure and Table 4.3 that the residuals are well balanced on the positive and negative range, 41% and 59% respectively, in the short time range. The negative trend, however, is observed in the long time range. The overall duration, 0-9000 days reflects a 39% of “positive” residuals versus a 61% of “negative” residuals.

Figure 4.4 shows the shrinkage strain residuals for the GL 2000 Model. It can be seen from the figure and Table 4.3 that the residuals are well balanced on the positive and negative range, 57% and 43% respectively, in the 0-1000 days duration. The positive trend becomes more obvious in the 1001-9000 days duration. The overall duration, 0-9000 days indicates a 59% of “positive” residuals versus a 41% of “negative” residuals.

When analyzing the shrinkage strain residuals distribution (± 100 microstrain) for the four models from Table 4.4, the following can be observed; It is evident that the B3 and the GL 2000 models give a better prediction in the short term range (i.e., 0-1000 days), while the ACI 209, the CEB 90, and the B3 models give almost similar prediction accuracy in the long term range (i.e., 1001-9000 days).

In summary, the CEB 90 Model is an under-estimated model for shrinkage strain. The ACI 209 Model, the B3 Model, and the GL 2000 Model are more balanced models with the ACI 209, GL 2000 models tend to over-estimate shrinkage strain while the B3 Model tends to under-estimate.

4.3.2 Statistical Analysis of Shrinkage Strain

In this section the result of the average and standard deviation of shrinkage strain residuals, the B3 coefficient of variation ($\omega_{B3}\%$), the CEB coefficient of variation ($V_{CEB}\%$), the CEB mean square error ($F_{CEB}\%$), and the CEB mean deviation (M_{CEB}) of the shrinkage strain are analyzed.

The average of all positive and negative shrinkage strain residuals for two and six time ranges of a given model are calculated using equation 3.2 and presented in Table 4.5. It can be observed from the table that the results of the ACI 209 Model for the six time intervals under-estimate in the range of 0-10 days, 731-1095 days, above 1095 days, whereas the other ranges over-estimate. It can also be observed that the model has a high negative average value in the long time range, (i.e., 0-9000 days), which leads to a

negative mean average. The overall time range, (i.e., 0-9000 days), however, shows a positive value.

The CEB 90 Model gives the highest negative average of residuals among all models. It shows a consistently trend in under-estimating shrinkage strain residuals average throughout all the time ranges. This result is consistent with Table 4.3 which shows the model produces most of data points in the “- ve” range, i.e. under-estimate the shrinkage strain.

It can be observed from Table 4.5 that the results of the B3 Model for the six time intervals over-estimate in the range of 0-10 days, whereas the other ranges under-estimate. The GL 2000 Model under-estimate in the range of 11-100 days, whereas the other ranges over-estimate.

The standard deviation of all shrinkage strain residuals in both the two and six time range interval groups for each model is calculated using equation 2.2 and summarized in Table 4.6. The GL 2000 Model has the lowest mean standard deviation of residuals for both the two and six time interval groupings followed by the CEB 90 Model, the B3 Model, and the ACI 209 Model. The ACI 209 Model has the highest mean standard deviation of residuals for both time range groupings. The standard deviation value for the overall time range, i.e., 0-9000 days is similar to the mean average standard deviation of both two and six time ranges for all models.

The B3 coefficient of variation ($\omega_{B3}\%$) of the models for all data sets is calculated using equation 3.4 to 3.7 and summarized in Table 4.7 and Table 4.8. The variation percentage appears to be relatively high for the ACI 209, the CEB 90, and the B3 models.

The high $\omega_{B3}\%$ is due to data with high relative humidity ($>98\%$). The list of experimental sets with high $\omega_{B3}\%$ is presented in Appendix H. If these data sets are excluded, as shown in Table 4.8, then the $\omega_{B3}\%$ becomes much less for the ACI 209, the CEB 90, the B3 models. The GL 2000 Model is not affected by this exclusion process.

Table 4.9 gives the results of the CEB statistical values in the six different time ranges for the coefficient of variation ($V_i\%$), the square error ($F_i\%$) and the deviation (M_i) calculated from equation 3.8 to 3.16. The highest coefficient of variation ($V_i\%$), is obtained by the CEB 90 Model for age up to 730 days. For age above 730 days, all models have similar coefficient of variation ($V_i\%$). The values of M_i from the table show that except for age 0-10 days, the CEB 90 Model under-estimates for all other time ranges. The values of $F_i\%$ indicated in Table 4.9 are high for all models at early age. The $F_i\%$ for the B3 and GL 2000 models even show a grossly high % in the 0-10 days, 11-100 days, and 101-365 days time ranges. Appendix I shows a list of data points which have high interim F_i values calculated by equation 3-12 for each individual model.

Table 4.10 summarizes the results of the $V_i\%$, $F_i\%$ and M_i excluding the data points which produce the high interim $F_i\%$ indicated in Appendix I. Most of the data points eliminated are in the short time range, 0-365 days and with a relatively high humidity above 95%. All these eliminated data points have small experimental shrinkage strain values; consequently, these data points produce high interim $F_i\%$ because the equation requires dividing by a small experimental shrinkage strains in the calculation process. The $F_i\%$ indicated in Table 4.10 are much lower than the values shown in Table 4.9. The $V_i\%$ remains essentially the same as Table 4.9.

4.3.3 Discussion of Shrinkage Strain Analysis

Results of the various statistical evaluations using different time range groupings and ratings are summarized in Table 4.11. It is shown from Table 4.11 that predictions of the ACI 209 and GL 2000 models for shrinkage strain residuals over-estimate by 63% and 59% of the total number of data point values analyzed for each model respectively in the overall time duration, i.e. 0-9000 days. The ACI 209 Model over-estimates 31% and under-estimates 12% of the total number of data point values with residuals range beyond ± 100 microstrain. The GL 2000 Model over-estimate 17% and under-estimate 15% of the total number of data point values with residuals greater than ± 100 microstrain.

It can be observed from Table 4.11 that the CEB 90, B3 models under-estimate by 83% and 61% respectively, and over-estimate by 17% and 39% respectively of the total number of data point values. The CEB 90 Model under-estimate 48% and over-estimate 2% of the total number of data points with residual values larger than ± 100 microstrain. The B3 Model under-estimate 23% and over-estimates 6% of the total number of data points with residuals larger than ± 100 microstrain.

It can also be observed from Table 4.11 that GL 2000 Model performs the best for the B3 coefficient of variation ($\omega_{B3}\%$). The GL 2000 and B3 models rank the first and second respectively in the CEB mean coefficient of variation ($V_{CEB}\%$) category, and the ACI 209 and CEB 90 models rank the first and second respectively in both the CEB mean square error ($F_{CEB}\%$) and the CEB mean deviation (M_{CEB}) categories.

In Table 4.11 the rating of each model in a given category is shown in brackets. A rating of [1] or [2] for a given model indicates the model performed best in that given

category. If the model receives a rating of [1] or [2] then that model receives a credit of one point. The credit points are then cumulated to evaluate the best-performed model. Both the B3 Model and the GL 2000 Model receive a credit rating of 4/6. The ACI 209 Model and the CEB 90 Model receive a credit rating of 3/6 and 2/6 respectively.

Table 4.12 is a summary of results and rating for shrinkage strain under categories of $V_{CEB}\%$, $F_{CEB}\%$, M_{CEB} after excluding the data points with $\omega_i^2 > 10$ and interim $F_i\%$ values $> 50\%$ indicated in Appendix H and I respectively for each model. It can be observed that the values of $V_{CEB}\%$ and model rating remains essentially the same for all four models; on the other hand, the values for $F_{CEB}\%$ and M_{CEB} have changed quite noticeably. The $F_{CEB}\%$ are apparently lower and M_{CEB} values are closer to value of 1 comparing to Table 4.11. The ratings for $F_{CEB}\%$ remains the same after data points elimination, but the ratings for M_{CEB} changes. Table 4.12 shows that the B3 Model performs best in the M_{CEB} category followed by the ACI 209 Model, considering the B3 Model ranks third after the CEB 90 and ACI 209 models in Table 4.11. Table 4.12 also shows that the B3 Model receives a total rating of 5/6 followed by the GL 2000 Model with a total rating of 4/6. The ACI 209 Model and the CEB 90 Model scores 3/6 and 1/6 respectively.

4.4 Analysis of Creep Compliance

The creep compliance values of all four models are calculated for all the experimental data points selected from the RILEM data bank. The residuals are then calculated and plotted against time for comparison. The number of residual points in

different residual ranges is also analyzed. The average and standard deviation of residuals is calculated for the two and six time range intervals. In addition, the B3 coefficient of variation ($\omega_{B3}\%$), the CEB coefficient of variation ($V_{CEB}\%$), the CEB mean square error ($F_{CEB}\%$), and the mean deviation (M_{CEB}) of the predicted creep compliance are calculated and analyzed.

4.4.1 Analysis of Creep Compliance Residuals

Figures 4.5 to 4.8 show the residuals of creep compliance of all four models using the 0-9000 days duration. Residuals are the difference between the predicted model compliance values and the experimental compliance values. Positive residuals represents the corresponding model values over-estimate the creep compliance. Negative residuals indicate that corresponding model values under-estimate the creep compliance. The data are summarized in Table 4.13 and 4.14. Table 4.13 shows the distribution of number and percentage of residual points for creep models as a function of time, and Table 4.14 shows the distribution of number and percentage of residuals in various ranges for creep compliance as a function of accuracy range.

Figures 4.5-4.8 and Table 4.13 show that all four models tend to under-estimate most of the data points in the overall time duration, i.e., 0-9000 days. The ACI 209 Model and the GL 2000 Model have a similar percentage distribution between over-estimating and under-estimating values in both 0-1000 days and 1001-9000 days time ranges. They both share a strong tendency to under-estimate creep compliance values.

The CEB 90 Model and the B3 Model, on the other hand, show a relatively well balanced percentage distribution in the 1001-9000 days duration.

Table 4.13 indicates that the ACI 209 Model over-estimates 27% and under-estimate 73% of the creep data point values for the short time duration. For the long time duration, the model over-estimate and under-estimate 22% and 78% respectively. It can be observed from Table 4.14 that for both short time and long time duration, approximately 80% of the total residuals are in the range of 0 to ± 33 microstrain/MPa (0 to ± 0.23 microstrain/psi).

For the CEB 90 Model, Table 4.13 shows that the model over-estimates 33% and under-estimates 67% of the data point values in the short time duration. For the long time duration, approximately 46% calculated values over-estimate the creep compliance and 54% under-estimate the compliance values. It can be observed from Table 4.14 that 84% of the residuals are in the range of 0 to ± 33 microstrain/MPa (0 to ± 0.23 microstrain/psi) for 0-1000 days time range and 86% for 1001-9000 days time range.

For the B3 Model, Table 4.13 shows that the model over-estimate 29% and under-estimate 71% of the data point values in 0-1000 days time range. For 1001-9000 days duration, approximately 54% calculated values over-estimate the compliance values and 46% under-estimate the values. It can be seen from Table 4.14 that 82% of the residuals are in the range of 0 to ± 33 microstrain/MPa (0 to ± 0.23 microstrain/psi) for 0-1000 days time range and 85% for 1001-9000 days time range.

For the GL 2000 Model, it can be observed from Table 4.13 that the model over-estimates 36% of the data point values and under-estimates 64% for 0-1000 days

duration. For 1001-9000 days duration, approximately 39% calculated values over-estimate the compliance values and 61% under-estimate the values. It can be seen from Table 4.14 that 80% of the residuals are in the range of 0 to ± 33 microstrain/MPa (0 to ± 0.23 microstrain/psi) for both 0-1000 days and 1001-9000 days time ranges.

4.4.2 Statistical Analysis of Creep Compliance

In this section the result of the average and standard deviation of shrinkage strain residuals, the B3 coefficient of variation ($\omega_{B3}\%$), the CEB coefficient of variation ($V_{CEB}\%$), the CEB mean square error ($F_{CEB}\%$), and the CEB mean deviation (M_{CEB}) of the shrinkage strain are analyzed. The average of creep compliance residuals of a given model are calculated and summarized in Table 4.15. Table 4.16 shows the standard deviations of the residuals for two and six time range intervals.

It can be observed from Table 4.15 that the B3 Model gives the lowest mean average of creep compliance residuals followed by the GL 2000 Model, the CEB 90 Model, and the ACI Model. It is worth mentioning that only the B3 Model gives slightly a positive average residual values in 1001-9000 days and above 1095 days time ranges, whereas the average residuals in the rest of time ranges by all models indicate a negative trend. Table 4.16 indicates that the CEB 90 Model followed by the B3 Model, the GL 2000 Model, and the ACI 209 Model gives the lowest standard deviation for creep compliance residuals.

Table 4.17 gives the statistical values of creep compliance calculated using the CEB methods in six different time ranges. The coefficient of variation ($V_i\%$), the square

error ($F_i\%$), and the deviation (M_i) for all six time ranges are listed. The CEB 90 Model, the B3 Model, and the GL 2000 Model give the lowest $V_i\%$ values in various time ranges. The value of M_i from Table 4.17 indicates that the ACI 209, CEB 90, GL 2000 models under-estimate creep compliance in all time ranges. For the B3 Model, it over-estimates in the above 1095 days time range, whereas it under-estimates in all the other time ranges. For the square error ($F_i\%$), the table shows that the CEB 90 Model and the GL 2000 Model gives the values closest to 1.

The overall mean B3 coefficient of variation ($\omega_{B3}\%$) of all analyzed data sets for creep compliance is given in Table 4.18. The GL 2000 Model performed the best for this method with the lowest coefficient of 47% followed by the B3 Model, the CEB 90 Model, and the ACI 209 Model.

4.4.3 Discussion of Creep Compliance Analysis

Table 4.19 summarizes the results of various statistical evaluations of creep compliance and creep compliance residuals. It is evident from Table 4.19 that the predictions of the ACI 209 Model over-estimates and under-estimates the creep compliance data by 27% and 73% respectively in the overall duration, i.e. 0-9000 days. Approximately 20% of the total number of residuals are beyond the ± 33 microstrain/MPa (± 0.23 microstrain/psi).

The CEB 90 Model over-estimates and under-estimates 34% and 66% of the total number of data point values respectively for the 0-9000 days duration. Approximately

16% of the total number of residuals are outside the range of ± 33 microstrain/MPa (± 0.23 microstrain/psi).

The B3 Model over-estimates 31% and under-estimates 69% of the total number of data point values for the overall duration. Approximately 18% of the total number of residuals are beyond the range of ± 33 microstrain/MPa (± 0.23 microstrain/psi).

The GL 2000 Model over-estimate and under-estimate 36% and 64% of the total number of data point values respectively for 0-9000 days duration. Approximately 20% of the total number of residuals are beyond the range of ± 33 microstrain/MPa (± 0.23 microstrain/psi).

Table 4.19 shows that the GL 2000 Model ranks the first and second in the $V_{CEB}\%$ and M_{CEB} categories respectively. The CEB Model ranks the first and second in the $F_{CEB}\%$ and M_{CEB} categories respectively. The B3 Model ranks the first and second in the M_{CEB} and $V_{CEB}\%$ categories respectively. The table also indicates that the GL 2000 Model performs the best under the $\omega_{B3}\%$ category.

The rating of each model in a given category is shown in brackets in Table 4.19. A rating of [1] or [2] for a given model indicates the model performed best in that given category. If a model receives a rating of [1] or [2] then that model receives a credit of one point. The credit points are added to evaluate the best model. It can be observed from Table 4.19 that the B3 Model earns highest accumulated rating of 6/6, while the CEB 90 Model, the GL 2000 Model, and the ACI 209 Model receive a rating of 5/6, 5/6, and 1/6 respectively. It is clear that the CEB 90, the B3, the GL 2000 Models are very good models to predict creep based on the data bank.

**Table 4.3: Distribution of Number and Percentage of Residual Points
for Shrinkage Models**

Time Range	Residual Range	ACI 209	CEB 90	B3	GL 2000
0-1000 days	Data Points	2499	2593	2203	1561
	Model Over-estimated "+"	1633 (65%)	431 (17%)	895 (41%)	893 (57%)
	Model Under-estimated "-"	866 (35%)	2162 (83%)	1308 (59%)	668 (43%)
1001-9000 days	Data Points	143	156	185	116
	Model Over-estimated "+"	39 (27%)	32 (21%)	30 (16%)	94 (81%)
	Model Under-estimated "-"	104 (73%)	124 (79%)	155 (84%)	22 (19%)
0-9000 days	Data Points	2642	2749	2388	1677
	Model Over-estimated "+"	167 (63%)	463 (17%)	925 (39%)	987 (59%)
	Model Under-estimated "-"	970 (37%)	2286 (83%)	1463 (61%)	690 (41%)

Note 1: Values in the brackets indicates the percentage of residuals in that particular range to the total number of residual points for each model.

Note 2: The CEB 90 Model is an under-estimated model for shrinkage strain. The ACI 209 Model, the B3 Model, and the GL 2000 Model are more balanced models with the ACI 209, GL 2000 models tend to over-estimate shrinkage strain while the B3 Model tends to under-estimate.

Table 4.4: Distribution of Number and Percentage of Residuals in Various Ranges for Shrinkage Strain

Residual Range in Microstrain	Number of Residual Points (Percentage)			
	0-1000 days			
	ACI 209	CEB 90	B3	GL 2000
Total Data Points	2499	2593	2203	1561
0 to +100	818 (33%)	392 (15%)	751 (34%)	668 (43%)
0 to -100	605 (24%)	914 (35%)	839 (38%)	412 (26%)
Over +100	815 (33%)	39 (2%)	144 (7%)	225 (14%)
Over -100	261 (10%)	1248 (48%)	469 (21%)	256 (16%)
0 to $\pm$ 100	1423 (57%)	1306 (50%)	1590 (72%)	1080 (69%)
Over $\pm$ 100	1076 (43%)	1287 (50%)	613 (28%)	481 (31%)
Residual Range in Microstrain	Number of Residual Points (Percentage)			
	1001-9000 days			
	ACI 209	CEB 90	B3	GL 2000
Total Data Points	143	156	185	116
0 to +100	22 (15%)	28 (18%)	25 (13%)	28 (24%)
0 to -100	56 (39%)	60 (38%)	79 (43%)	20 (17%)
Over +100	17 (12%)	4 (3%)	5 (3%)	66 (57%)
Over -100	48 (34%)	64 (41%)	76 (41%)	2 (2%)
0 to $\pm$ 100	78 (54%)	88 (56%)	104 (56%)	48 (41%)
Over $\pm$ 100	65 (46%)	68 (44%)	81 (44%)	68 (59%)

Note: Values in the brackets indicates the percentage of residuals in that particular range to the total number of residual points for each model.

**Table 4.5: Average of Shrinkage Strain Residuals for Four Models
Grouped into Two and Six Time Ranges**

	Average of Residuals for Models in Microstrain			
Two Time Ranges	ACI 209	CEB 90	B3	GL 2000
0-1000 days	48	-107	-33	8
1001-9000 days	-77	-95	-106	105
Mean Average	-15	-101	-69	57
0-9000 days	41	-106	-38	15
Six Time Ranges	ACI 209	CEB 90	B3	GL 2000
0-10 days	-11	-38	6	11
11-100 days	61	-107	-29	-6
101-365 days	81	-140	-45	8
366-730 days	62	-149	-76	65
731-1095 days	-47	-102	-98	56
Above 1095 days	-94	-105	-117	102
Mean Average	9	-107	-60	39

Table 4.6: Standard Deviation of Shrinkage Strain Residuals for Four Models Grouped into Two and Six Time Ranges

	Standard Deviation of Residuals for Models in Microstrain			
Two Time Ranges	ACI 209	CEB 90	B3	GL 2000
0-1000 days	138	112	118	104
1001-9000 days	158	130	125	105
Mean Average	148	121	122	105
0-9000 days	142	113	120	107
Six Time Ranges	ACI 209	CEB 90	B3	GL 2000
0-10 days	60	65	49	49
11-100 days	135	105	106	98
101-365 days	170	113	139	127
366-730 days	143	143	154	132
731-1095 days	149	133	153	141
Above 1095 days	158	131	127	110
Mean Average	136	115	121	109

Table 4.7: The B3 Coefficient of Variation for Shrinkage Strain
(All Data Points Within Individual Model's Limitations)

ACI 209	CEB 90	B3	GL 2000
151 %	563%	115%	46%

Table 4.8: The B3 Coefficient of Variation for Shrinkage Strain
(Exclude Data Sets with $\omega_i^2 > 10$)

Model	ACI 209	CEB 90	B3	GL 2000
$\omega_{B3}\%$	102%	90%	55%	46%
No. of Original Data Sets Analyzed	176	182	166	155
No. of Excluded Data Sets	8	34	5	0

Note: List of Data Sets excluded is given in Appendix H

Table 4.9: CEB Statistical Methods for Shrinkage Strain (Include All Data Points Within Individual Model's Limitations)

		ACI 209	CEB 90	B3	GL 2000
0-10 days	V_i %	73%	83%	62%	64%
	F_i %	122%	143%	572%	582%
	M_i	1.23	1.00	2.08	2.16
11-100 days	V_i %	56%	60%	41%	34%
	F_i %	198%	60%	308%	64%
	M_i	1.56	0.61	1.27	1.11
101-365 days	V_i %	44%	49%	37%	28%
	F_i %	152%	59%	1091%	70%
	M_i	1.55	0.58	1.71	1.16
366-730 days	V_i %	30%	41%	35%	30%
	F_i %	77%	42%	187%	97%
	M_i	1.25	0.71	1.21	1.34
731-1095 days	V_i %	27%	32%	33%	27%
	F_i %	86%	33%	29%	33%
	M_i	1.07	0.85	0.89	1.16
Above 1095 days	V_i %	26%	28%	29%	27%
	F_i %	22%	24%	23%	33%
	M_i	0.92	0.86	0.84	1.22

**Table 4.10: CEB Statistical Methods for Shrinkage Strain (Exclude
Data Points with Interim $F_i\%$ > 50%)**

		ACI 209	CEB 90	B3	GL 2000
0-10 days	$V_i\%$	73%	83%	59%	62%
	$F_i\%$	91%	106%	131%	148%
	M_i	1.17	0.91	1.51	1.55
11-100 days	$V_i\%$	55%	60%	39%	34%
	$F_i\%$	96%	60%	72%	64%
	M_i	1.47	0.61	1.02	1.11
101-365 days	$V_i\%$	44%	49%	36%	28%
	$F_i\%$	116%	59%	96%	70%
	M_i	1.48	0.58	1.06	1.16
366-730 days	$V_i\%$	30%	41%	34%	30%
	$F_i\%$	53%	42%	94%	97%
	M_i	1.21	0.71	1.06	1.34
731-1095 days	$V_i\%$	27%	32%	33%	27%
	$F_i\%$	86%	33%	29%	33%
	M_i	1.07	0.85	0.89	1.16
Above 1095 days	$V_i\%$	26%	28%	29%	27%
	$F_i\%$	22%	24%	23%	33%
	M_i	0.92	0.86	0.84	1.22

Table 4.11: Summary of Results and Rating for Shrinkage Strain**(Include All Data Points Within Model Limitations)**

Category	Time Range	ACI 209	CEB 90	B3	GL 2000
1. Distribution of Residuals “+” Range “-” Range	0-9000 days	63% 37% [2]	17% 83% [3]	39% 61% [1]	59% 41% [1]
2. Residual Range Outside + 100 microstrain - 100 microstrain	0-9000 days	31% 12% [3]	2% 48% [4]	6% 23% [1]	17% 15% [2]
3. Mean Coefficient of Variation, V_{CEB} %	6	46% [3]	52% [4]	41% [2]	37% [1]
4. Mean Square Error, F_{CEB} %	6	123% [2]	72% [1]	524% [4]	245% [3]
5. Mean Deviation, M_{CEB}	6	1.26 [2]	0.77 [1]	1.34 [3]	1.36 [4]
6. Coefficient of Variation, ω_{B3} %	-	151% [3]	563% [4]	115% [2]	46% [1]
Number of Categories with Rating [1] or [2]		3/6	2/6	4/6	4/6

Note 1: Rating of Model is given in brackets

[1] – Best Performed

[5] – Least Performed

Table 4.12: Summary of Results and Rating for Shrinkage Strain**(With Exclusion Indicated in Table 4.8 and Table 4.11 for****Data with $\omega_i^2 > 10$, Interim $F_i\% > 50\%$)**

Category	Time Range	ACI 209	CEB 90	B3	GL 2000
1. Distribution of Residuals “+” Range “-“ Range	0-9000 days	63% 37% [2]	17% 83% [3]	39% 61% [1]	59% 41% [1]
2. Residual Range Outside + 100 microstrain - 100 microstrain	0-9000 days	31% 12% [3]	2% 48% [4]	6% 23% [1]	17% 15% [2]
3. Mean Coefficient of Variation, $V_{CEB}\%$	6	46% [3]	52% [4]	40% [2]	37% [1]
4. Mean Square Error, $F_{CEB}\%$	6	83% [2]	60% [1]	84% [3]	84% [3]
5. Mean Deviation, M_{CEB}	6	1.22 [2]	0.75 [3]	1.07 [1]	1.26 [4]
6. Coefficient of Variation, $\omega_{B3}\%$	-	102 [4]	90% [3]	55% [2]	46% [1]
Number of Categories with Rating [1] or [2]		3/6	1/6	5/6	4/6

Note 1: Rating of Model is given in brackets**[1] – Best Performed****[5] – Least Performed****Note 2: Excluded Data Sets for $\omega_i^2 > 10$ are listed in Appendix H****Excluded Data Points for Interim $F_i\% > 50\%$ are listed in Appendix I**

**Table 4.13: Distribution of Number and Percentage of Residual Points
for Creep Models**

Time Range	Residual Range	ACI 209	CEB 90	B3	GL 2000
0-1000 days	Data Points	4515	5581	4838	4014
	Model Over-estimated "+"	1222 (27%)	1848 (33%)	1412 (29%)	1460 (36%)
	Model Under-estimated "-"	3293 (73%)	3733 (67%)	3426 (71%)	2554 (64%)
1001-9000 days	Data Points	280	313	303	152
	Model Over-estimated "+"	62 (22%)	144 (46%)	165 (54%)	59 (39%)
	Model Under-estimated "-"	218 (78%)	169 (54%)	138 (46%)	93 (61%)
0-9000 days	Data Points	4795	5894	5141	4166
	Model Over-estimated "+"	1284 (27%)	1992 (34%)	1577 (31%)	1519 (36%)
	Model Under-estimated "-"	3511 (73%)	3902 (66%)	3564 (69%)	2647 (64%)

Note 1: Values in the brackets indicates the percentage of residuals in that particular range to the total number of residual points for each model.

**Table 4.14: Distribution of Number and Percentage of Residuals in
Various Ranges for Creep Compliance**

Residual Range in Microstrain/MPa (Microstrain/psi)	Number of Residual Points (Percentage) 0-1000 days			
	ACI 209	CEB 90	B3	GL 2000
Total Data Points	4515	5581	4838	4014
0 to +33 (0 to +0.23)	1213 (27%)	1777 (32%)	1288 (27%)	1346 (34%)
0 to -33 (0 to -0.23)	2406 (53%)	2898 (52%)	2676 (55%)	1880 (47%)
Over +33 (Over +0.23)	9 (0.2%)	71 (1%)	124 (3%)	114 (3%)
Over -33 (Over -0.23)	887 (20%)	835 (15%)	750 (16%)	674 (17%)
0 to $\pm$ 33 (0 to $\pm$ 0.23)	3619 (80%)	4675 (84%)	3964 (82%)	3226 (80%)
Over $\pm$ 33 (Over $\pm$ 0.23)	896 (20%)	906 (16%)	874 (18%)	788 (20%)
Residual Range in Microstrain/MPa	Number of Residual Points (Percentage) 1001-9000 days			
	ACI 209	CEB 90	B3	GL 2000
Total Data Points	280	313	303	152
0 to +33 (0 to +0.23)	61 (22%)	136 (43%)	142 (47%)	47 (31%)
0 to -33 (0 to -0.23)	162 (58%)	134 (43%)	117 (39%)	74 (49%)
Over +33 (Over +0.23)	1 (0.4%)	8 (3%)	23 (8%)	12 (8%)
Over -33 (Over -0.23)	56 (20%)	35 (11%)	21 (7%)	19 (13%)
0 to $\pm$ 33 (0 to $\pm$ 0.23)	223 (80%)	270 (86%)	259 (85%)	121 (80%)
Over $\pm$ 33 (Over $\pm$ 0.23)	57 (20%)	43 (14%)	44 (15%)	31 (20%)

**Table 4.15: Average of Creep Compliance Residuals for Four Models
Grouped into Two and Six Time Ranges**

	Average of Residuals for Models in Microstrain/MPa			
Two Time Ranges	ACI 209	CEB 90	B3	GL 2000
0-1000 days	-18	-12	-12	-11
1001-9000 days	-18	-7	2	-6
Mean Average	-18	-9	-5*	-8
0-9000 days	-18	-12	-11	-11
Six Time Ranges	ACI 209	CEB 90	B3	GL 2000
0-10 days	-13	-9	-8	-4
11-100 days	-20	-14	-13	-10
101-365 days	-17	-10	-12	-13
366-730 days	-26	-17	-16	-23
731-1095 days	-23	-11	-9	-21
Above 1095 days	-20	-8	0.4	-8
Mean Average	-20	-12	-10	-13

**Table 4.16: Standard Deviation of Creep Compliance Residuals for
Four Models Grouped into Two and Six Time Ranges**

	Standard Deviation of Residuals for Models in Microstrain			
Two Time Ranges	ACI 209	CEB 90	B3	GL 2000
0-1000 days	35	26	26	26
1001-9000 days	27	24	26	29
Mean Average	31	25	26	28
0-9000 days	35	26	27	26
Six Time Ranges	ACI 209	CEB 90	B3	GL 2000
0-10 days	27	19	17	15
11-100 days	41	27	25	24
101-365 days	35	26	30	29
366-730 days	33	34	37	37
731-1095 days	33	33	36	40
Above 1095 days	27	24	26	29
Mean Average	33	27	28	29

Table 4.17: CEB Statistical Methods for Creep Compliance

		ACI 209	CEB 90	B3	GL 2000
0-10 days	V_i %	56%	44%	38%	32%*
	F_i %	28%	28%	33%	26%*
	M_i	0.87	0.89	0.85	0.97*
11-100 days	V_i %	61%	43%	40%	36%*
	F_i %	32%*	33%	35%	32%*
	M_i	0.86	0.89	0.87	0.93*
101-365 days	V_i %	48%	35%*	37%	36%
	F_i %	34%*	36%	41%	36%
	M_i	0.90	0.95*	0.94	0.92
366-730 days	V_i %	43%	37%*	39%	41%
	F_i %	36%	35%*	39%	41%
	M_i	0.82	0.91*	0.90	0.84
731-1095 days	V_i %	39%	34%*	36%	40%
	F_i %	35%	31%*	35%	41%
	M_i	0.87	0.96*	0.96*	0.88
Above 1095 days	V_i %	32%	25%*	25%*	26%
	F_i %	28%	22%*	25%	27%
	M_i	0.87	0.95	1.03*	0.97*

Table 4.18: The B3 Coefficient of Variation for Creep Compliance

ACI 209	CEB 90	B3	GL 2000
87%	75%	61%	47%

Table 4.19: Summary of Results and Rating for Creep Compliance

Category	Time Range	ACI 209	CEB 90	B3	GL 2000
1. Distribution of Residuals “+” Range “-” Range	0-9000 days	27% 73% [3]	34% 66% [1]	31% 69% [2]	36% 64% [1]
2. Residual Range Outside + 33 microstrain/MPa - 23 microstrain/MPa	0-9000 days	0.2% 20% [3]	1% 15% [1]	3% 15% [2]	3% 17% [3]
3. Mean Coefficient of Variation, V_{CEB} %	6	48% [3]	37% [2]	36% [1]	35% [1]
4. Mean Square Error, F_{CEB} %	6	32% [1]	31% [1]	35% [2]	34% [2]
5. Mean Deviation, M_{CEB}	6	0.86 [3]	0.92 [1]	0.93 [2]	0.92 [1]
6. Coefficient of Variation, ω_{B3} %	-	87% [4]	75% [3]	61% [2]	47% [1]
Number of Categories with Rating [1] or [2]		1/6	5/6	6/6	5/6

Note: Rating of Model is given in brackets

[1] – Best Performed

[5] – Least Performed

Figure 4.1: Shrinkage Strain Residuals for the ACI 209 Model for 0-9000 days

Figure 4.2: Shrinkage Strain Residuals for the CEB 90 Model for 0-9000 days

Figure 4.3: Shrinkage Strain Residuals for the B3 Model for 0-9000 days

Figure 4.4: Shrinkage Strain Residuals for the GL 2000 Model for 0-9000 days

Figure 4.5: Creep Compliance Residuals for the ACI 209 Model for 0-9000 days

Figure 4.6: Creep Compliance Residuals for the CEB 90 Model for 0-9000 days

Figure 4.7: Creep Compliance Residuals for the B3 Model for 0-9000 days

Figure 4.8: Creep Compliance Residuals for the GL 2000 Model for 0-9000 days

Chapter 5

5.1 Conclusions

Four different shrinkage and creep models are compared with the RILEM experimental data bank to determine the level of their accuracy. The studied models are the ACI 209 code Model, the CEB 90 code Model, the B3 Model, and the GL 2000 Model. The calculated shrinkage strains and creep compliance from each model are evaluated by the residual method, the average and standard deviation methods, the coefficient of variation method ($\omega_{B3}\%$), the CEB mean coefficient of variation method ($V_{CEB}\%$), the CEB mean square error method ($F_{CEB}\%$), and the CEB mean deviation method (M_{CEB}). Each model is rated on its performance for a given statistical method. A model scoring as first or second in a given statistical method is considered to perform best in that category and receives one point. The addition of ratings in all categories is used as an indicator for evaluating each model. The following conclusions are made from the results of this study.

1. The B3 Model and the GL 2000 Model performed best for predicting shrinkage strain. Both models receive a score of 4/6 followed by the ACI 209 Model and the CEB 90 Model with a rating of 3/6 and 2/6 respectively.
2. Rating is conducted on the four shrinkage models but by removing data sets with $\omega_i^2 > 10$ and data points with interim $F_i\% > 50\%$. In this case, the B3 and the GL 2000 models also remain to perform the best.

3. For creep compliance prediction, the B3, CEB 90 and the GL 2000 Models performs similarly. The B3 Model receives a rating of 6/6 while both the CEB 90 Model and the GL 2000 Model receive a rating of 5/6. The ACI 209 Model receives a rating of 1/6.
4. In all shrinkage models, over 50% of the residuals data are within the range of – 100 and +100 microstrain. In all creep models, over 80% of creep compliance residuals data are within the range of –33 and +33 microstrain/MPa (-0.23 and +0.23 microstrain/psi).
5. The distribution of shrinkage strain residuals for all models is summarized in Table 5.1. It can be observed from the table that the distribution of residual points for the ACI 209 Model, the B3 Model, and the GL 2000 Model show a more balanced distribution than the CEB 90 Model. The distribution of residual points in the range outside ± 100 microstrain is the lowest for the B3 Model followed by the GL 2000 Model.

Table 5.1: Results of Distribution of Shrinkage Strain Residuals for Models

Model	Distribution of all Residual Points		Distribution of Residual Points in the Range Outside ± 100 microstrain		
	Overestimate	Underestimate	Overestimate	Underestimate	Total
ACI 209	63%*	37%*	31%	12%	43%
CEB 90	17%	83%	2%	48%	50%
B3	39%*	61%*	6%*	23%*	29%*
GL 2000	59%*	41%*	17%	15%	33%

Note: * indicates best performance

6. The distribution of residuals for creep compliance is summarized in Table 5.2. It can be observed from the table that the distribution of all residual points for the CEB 90, the B3, the GL 2000 models are within a close range. The distribution of residual points in the range outside ± 33 microstrain/MPa (± 0.23 microstrain/psi) is the lowest for the CEB 90 Model.

Table 5.2: Results of Distribution of Creep Compliance Residuals for Models

Model	Distribution of all Residual Points		Distribution of Residual Points in the Range Outside ± 33 microstrain/MPa		
	Overestimate	Underestimate	Overestimate	Underestimate	Total
ACI 209	27%	73%	0.2%	20%	20%
CEB 90	34%	66%	1%*	15%*	16%*
B3	31%	69%	3%	15%	18%
GL 2000	36%*	64%*	3%	17%	20%

Note: * indicates best performance

7. Results of the average and standard deviation of the residuals for shrinkage and creep are summarized in Table 5.3. It can be observed from the table that the ACI 209 Model has a fluctuation between the mean average of two time range and six time range for the shrinkage strain. It has a -ve value in the two time range and a +ve value in the six time range while the other models are consistent with the sign for these time ranges.

For the creep compliance, the B3 Model has the lowest mean average residuals.

For the mean standard deviation, the CEB 90 Model has the lowest value for shrinkage and creep compliance prediction.

Table 5.3: Results of the Average and Standard Deviation for Models

Mean Average	Time Range	ACI 209	CEB 90	B3	GL 2000
Shrinkage Strain Residuals in microstrain	2	-15	-101	-69	57
	6	9	-107	-60	39
Creep Compliance Residuals in microstrain/MPa (microstrain/psi)	2	-18 (-0.12)	-9 (-0.06)	-5 (-0.03)	-8 (-0.06)
	6	-20 (-0.14)	-12 (-0.08)	-10 (-0.07)	-13 (-0.09)
Mean Standard Deviation	Time Range	ACI 209	CEB 90	B3	GL 2000
Shrinkage Strain Residuals in microstrain	2	148	121	122	105
	6	136	115	121	109
Creep Compliance Residuals in microstrain / MPa (microstrain/psi)	2	31	25	26	28
	6	33 (0.23)	27 (0.19)	28 (0.19)	29 (0.20)

8. Results of the B3 coefficient of variation ($\omega_{B3}\%$) are summarized in Table 5.4. It can be observed that $\omega_{B3}\%$ decreases in a significant way for shrinkage strain after excluding the data points with $\omega_i^2 > 10$. The CEB 90 Model has the highest number of data sets (34 sets) excluded among all the models, followed by the ACI Model, and the B3 Model. The rating for the models changes after exclusion of the data points. The GL 2000 Model still performs the best for both approaches without excluding any data sets.

Table 5.4: Results of the B3 coefficient of variation ($\omega_{B3}\%$) for Models

Category	ACI 209	CEB 90	B3	GL 2000
Shrinkage Strain (Note 1)	151 %	563%	115%	46%*
Shrinkage Strain (Note 2)	102%	90%	55%	46%*
No. of Excluded Data Sets (Note 3)	8	34	5	0
Creep Compliance	87%	75%	61%	47%*

Note: (1) % calculations include all data points within individual model's limitations

(2) % calculations exclude data points with $\omega_i^2 > 10$

(3) Detailed list of excluded data sets is in Appendix H

(4) *indicates best performance

9. Results of mean coefficient of variation ($V_{CEB}\%$) are summarized in Table 5.5. It can be observed that $V_{CEB}\%$ for the B3 and the GL 2000 models perform best for shrinkage. The $V_{CEB}\%$ in the case of creep compliance is close for the CEB 90, the B3, and the GL 2000 models.

Table 5.5: Results of the CEB mean coefficient of variation ($V_{CEB}\%$)

Category	ACI 209	CEB 90	B3	GL 2000
Shrinkage Strain (Note 1)	46%	52%	41%	*37%
Shrinkage Strain (Note 2)	46%	52%	40%	*37%
No. of Data Points Excluded (Note 3)	14	4	32	10
Creep Compliance	48%	37%	36%	*35%

Note: (1) % calculations include all data points within individual model's limitations

(2) % calculations exclude data points with interim $F_i\% > 50\%$

(3) Detailed list of excluded data points is in Appendix I

(4) *indicates best performance

10. Results of the CEB mean square error ($F_{CEB}\%$) are summarized in Table 5.6. It can be observed that $F_{CEB}\%$ decreases in a significant way after excluding the data points with interim $F_i\% > 50\%$. The B3 Model excludes the highest number of data points and is most sensitive to the exclusion. The rating for the models, however, remains the same for these two different approaches. The CEB 90 Model performs best in the shrinkage strain category. The $F_{CEB}\%$ for creep compliance is similar in value for all models.

Table 5.6: Results of the CEB mean square error ($F_{CEB}\%$)

Category	ACI 209	CEB 90	B3	GL 2000
Shrinkage Strain (Note 1)	123%	72%*	524%	245%
Shrinkage Strain (Note 2)	83%	60%*	84%	84%
No. of Data Points Excluded (Note 3)	14	4	32	10
Creep Compliance	32%	31%*	35%	34%

Note: (1) % calculations include all data points within individual model's limitations

(2) % calculations exclude data points with interim $F_i\% > 50\%$

(3) Detailed list of excluded data points is in Appendix I

(4) *indicates best performance

11. Results of the CEB mean deviation (M_{CEB}) for creep and shrinkage are summarized in Table 5.7. It can be observed that the B3 Model is the most sensitive model for shrinkage when excluding $F_i\% > 50\%$. For the creep compliance all models are not sensitive to the M_{CEB} calculations. The B3 Model performs best for shrinkage. The M_{CEB} is similar in values for the CEB 90, the B3, and the GL 2000 models.

Table 5.7: Results of the CEB mean deviation (M_{CEB})

Category	ACI 209	CEB 90	B3	GL 2000
Shrinkage Strain (Note 1)	1.26	0.77*	1.34	1.36
Shrinkage Strain (Note 2)	1.22	0.75	1.07*	1.26
No. of Data Points Excluded (Note 3)	14	4	32	10
Creep Compliance	0.86	0.92	0.93*	0.92

Note: (1) % calculations include all data points within individual model's limitations

(2) % calculations exclude data points with interim $F_i\% > 50\%$

(3) Detailed list of excluded data points is in Appendix I

(4) *indicates best performance

12. **High ω_i^2 values above 10 can cause misleading statistical results for shrinkage (Appendix H). Data sets of specimens cured above 95% relative humidity is causing this error. The B3 Model and the GL 2000 Model show a higher degree of sensitivity to this factor than the other two models.**
13. **High interim $F_i\%$ values can cause misleading statistical results. These high values obtained from data points with time duration varying up to 365 days (Appendix I). The CEB 90 Model is the most sensitive model to this factor.**

5.2 Recommendations for Future Research

It is recommended that real life environment conditions should be simulated when determining the experimental shrinkage strain and creep compliance values. This will help to develop a model that can be used to reflect the possible realistic physical phenomena. Further studies based on different types of concrete mix design parameters, various methods of curing and different ranges of relative humidity should be conducted. In addition to that, a standard statistical method should be developed for the evaluation of model accuracy. It can be seen from this study that different statistical methods are performed, and they provide different rankings of each model. The B3 coefficient of variation ($\omega_{B3}\%$) is very sensitive to relative humidity. The CEB mean square error ($F_{CEB}\%$) is very sensitive to the experimental duration and large error percentages can occur for early time range measurements.

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APPENDIX A Summary of Equations Describing Shrinkage and Creep Models

A.1 The ACI Model (Units in lb. and in. unless specified)

A.1.1 Calculate Compressive Strength

$$f'_c(t_0) = f_{cm28} (t_0 / (b + c t_0))$$

Type of cement	Moist cured concrete		Steam cured concrete	
I	b = 4	c = 0.85	b = 1	c = 0.95
III	b = 2.30	c = 0.92	b = 0.70	c = 0.98

A.1.2 Calculate Modulus of Elasticity

$$E_{cmto} = 33(\gamma)^{3/2} (f'_c(t_0))^{1/2} \quad \text{where } \gamma \text{ in [lb/ft}^3\text{]}$$

A.1.3 Calculate Shrinkage Strain

$$\epsilon_s(t) = \frac{(t - t_c)}{b + (t - t_c)} K_{ss} K_{sh} \epsilon_{shu}$$

Curing Method	Humidity, H	b	K_{sh}	K_{ss}	ϵ_{shu} [in./in.]
Moist Cured	40% ≤ 80%	35	1.40 – 0.01H	1.14 – 0.09(V/S)	780 x 10 ⁻⁶
	81% ≤ 100%	35	3.00 – 0.03H	1.14 – 0.09(V/S)	780 x 10 ⁻⁶
Steam Cured	40% ≤ 80%	55	1.40 – 0.01H	1.14 – 0.09(V/S)	780 x 10 ⁻⁶
	81% ≤ 100%	55	3.00 – 0.03H	1.14 – 0.09(V/S)	780 x 10 ⁻⁶

$$K_{sh} = 1.40 - 0.01H$$

$$K_{ss} = 1.14 - 0.09(V/S)$$

$$\epsilon_{shu} = 780 \times 10^{-6} \text{ in./in.} \quad (\text{For both moist and steam cured concrete})$$

A.1.4 Calculate Creep Strain

$$\text{Creep Strain} = \frac{\sigma}{E_{cmto}} C_c(t)$$

$$C_c(t) = \frac{t^{0.60}}{10 + t^{0.60}} C_{cu} K_{ch} K_{ca} K_{cs}$$

$$C_{cu} = 2.35$$

Curing Method	t_0 [days]	H	K_{ca}	K_{ch}	K_{cs}
Moist Cured	≥ 1 day	$\geq 40\%$	N/A	N/A	N/A
	≥ 7 days	$\geq 40\%$	$1.25(t_0)^{-0.118}$	$1.27 - 0.0067H$	$1.14 - 0.09(V/S)$
Steam Cured	≥ 1 day	$\geq 40\%$	$1.13(t_0)^{-0.095}$	$1.27 - 0.0067H$	$1.14 - 0.09(V/S)$
	≥ 7 days	$\geq 40\%$	N/A	N/A	N/A

A.1.5 Calculate Total Strain

$$\epsilon(t) = \epsilon_s(t) + \frac{\sigma}{E_{cmto}} (1 + C_c(t))$$

I.1.6 Calculate of Creep Compliance

$$J(t, t_0) = \frac{(1 + C_c(t))}{E_{cmto}}$$

A.2 The CEB 90 Model (Units in lb. and in. unless specified)

A.2.1 Calculate Mean Concrete Strength

$$f_{cm28} = f_{c28} + 1200$$

A.2.2 Calculate Tangent Modulus of Elasticity

Original Recorded Equation:

$$(E_{cm28} = 21500 \times (f_{cm28})^{1/3}$$

where f_{cm28} and E_{cm28} are in unit of $[N/mm^2]$)

A.2.3 Calculate Modulus of Elasticity at Age t_0

$$E_{cmto} = (E_{cm28}) \{ \exp[0.5S (1 - ((28 / t)^{0.5}))] \}$$

Type of Cement	European Type	American Type	S
Slow Hardening	SL	II	0.38
Normal / Rapid Hardening	R	I	0.25
Rapid Hardening High Strength	RS	III	0.20

A.2.4 Calculate Shrinkage Strain

$$\epsilon_s(t-t_c) = (\epsilon_{cso}) \beta_s(t-t_c)$$

$$\epsilon_{cso} = \epsilon_s(f_{cm28})(\beta_{RH})$$

$$\epsilon_s(f_{cm28}) = [160 + 10(\beta_{sc})(9 - \frac{f_{cm28}}{1450})] \times 10^{-6}$$

Type of Cement	European Type	American Type	β_{sc}
Slow Hardening	SL	II	4
Normal / Rapid Hardening	R	I	5
Rapid Hardening High Strength	RS	III	8

Humidity	β_{RH}
$40\% \leq H < 99\%$	$-1.55 \times \beta_{arh}$
$H \geq 99\%$	0.25

Note: For sealed cured specimen, $H = 98\%$

$$\beta_{RH} = -1.55 \times \beta_{arh}$$

$$\beta_{arh} = 1 - (H/100)^3$$

$$h_c = 2A_c/u$$

$$\beta_s(t-t_c) = \sqrt{\frac{(t-t_c)}{350(h_c/4)^2 + (t-t_c)}}$$

A.2.5 Calculate Creep Strain

$$\text{Creep Strain} = \varphi(t, t_o) \frac{\sigma}{E_c}$$

$$\phi(t, t_o) = (\phi_o)\beta_c(t, t_o)$$

$$\phi_o = (\phi_{RH})\beta(f_{cm28})\beta(t_w)$$

$$\phi_{RH} = 1 + \frac{(1 - H/100)}{0.46(h_e/4)^{1/3}}$$

$$\beta(f_{cm28}) = \frac{5.3}{\sqrt{f_{cm28}/1450}}$$

$$\beta(t_0) = \frac{1}{0.1 + t_0^{0.2}}$$

$$\beta_c(t, t_0) = \frac{(t - t_0)^{0.3}}{[\beta_H + (t - t_0)]^{0.3}}$$

$$\beta_H = 150[1 + (0.012H)^{18}](h_e/4) + 250 \leq 1,500 \text{ days}$$

A.2.6 Calculate Total Strain

$$\varepsilon(t) = \varepsilon_s(t) + \left[\frac{\varphi(t, t_0)}{E_{cm28}} + \frac{1}{E_{cmto}} \right]$$

A.2.7 Calculate Creep Compliance

$$J(t, t_0) = \frac{\varphi(t, t_0)}{E_{cm28}} + \frac{1}{E_{cmto}}$$

A.3 The B3 Model (Units in lb. and in. unless specified)

A.3.1 Calculate Mean Concrete Compressive Strength

$$f_{cm28} = f_{c28} + 1200$$

A.3.2 Calculate Shrinkage Strain

$$\epsilon_s(t) = (\epsilon_{shu})(K_h)S(t)$$

A.3.2.1 Ultimate Shrinkage Strain

$$\epsilon_{shu} = -\alpha_1\alpha_2[(26(w)^{2.1}(f_{cm28})^{-0.28}) + 270] \times 10^{-6}$$

Type of cement	α_1
I	1.00
II	0.85
III	1.10

Type of curing	α_2
Steam Cured	0.75
Water Cured or H =100%	1.00
Sealed During Curing	1.20

A.3.2.2 Time Dependence

$$S(t) = \tanh \sqrt{\frac{t - t_c}{T_{sh}}}$$

$$S(t_0) = \tanh \sqrt{\frac{t_0 - t_c}{T_{sh}}}$$

$$T_{sh} = K_t (K_s D)^2$$

$$K_t = 190.8(t_0)^{-0.08} (f_{cm28})^{-0.25}$$

Cross-section Shape	K_s
Infinite slab	1.00
Infinite cylinder	1.15
Infinite square prism	1.25
Sphere	1.30
Cube	1.55

K_s can be assumed to be 1 if type of member is not defined

A.3.2.3 Humidity Dependence

Humidity (H)	K_h
$H \leq 98$	$1 - (H/100)^3$
$H = 100$	-0.2
$98 \leq H \leq 100$	Linear Interpolation

A.3.3 Calculate Creep Strain

A.3.3.1 Calculate Creep Compliance

$$J(t, t_0) = q_1 + C_0(t, t_0) + C_d(t, t_0, t_c)$$

$$q_1 = \frac{0.6 \times 10^6}{E_{cm28}}$$

$$E_{cm28} = 57000 (f_{cm28})^{1/2}$$

A.3.3.2 Calculate Basic Creep

$$C_0(t, t_0) = q_2 Q(t, t_0) + q_3 \ln[1 + (t - t_0)^{0.1}] + q_4 \ln(t / t_0)$$

$$Q(t, t_0) = Q_f(t_0) \left[1 + \frac{(Q_f(t_0))^{r(t_0)}}{Z(t, t_0)^{r(t_0)}} \right]^{-1/r(t_0)}$$

$$Q_f(t_0) = [0.086(t_0)^{2/9} + 1.21(t_0)^{4/9}]^{-1}$$

$$Z(t, t_0) = (t_0)^{-0.5} \ln[1 + (t - t_0)^{0.1}]$$

$$m = 0.5$$

$$n = 0.1$$

$$r(t_0) = 1.7(t_0)^{0.12} + 8$$

$$q_1 = \frac{0.6 \times 10^6}{E_{cm28}}$$

$$q_2 = 451.1(c)^{0.5}(f_{cm28})^{-0.9}$$

$$q_3 = 0.29(w/c)^4(q_2)$$

$$q_4 = 0.14(a/c)^{-0.7}$$

A.3.3.3 Calculate Drying Creep

$$C_d(t, t_0, t_s) = q_5 \{ \exp[-8H(t)] - \exp[-8H(t_0)] \}^{1/2}$$

$$H(t) = 1 - \left[\left(1 - \frac{H}{100} \right) S(t) \right]$$

$$H(t_0) = 1 - \left[\left(1 - \frac{H}{100} \right) S(t_0) \right]$$

$$q_5 = 7.57 \times 10^5 (f_{cm28})^{-1} | \epsilon_{sh\infty} |^{-0.6}$$

A.3.4 Calculate Total Strain

$$\epsilon(t) = J(t, t_0) \sigma + \epsilon_s(t)$$

A.4 The GL 2000 Model (Units in lb. and in. unless specified)

A.4.1 Calculate Mean Concrete Strength

$$f_{cm28} = 1.1(f_{ck28}) + 725$$

Original Recorded Equation:

$$f_{cm28} = 1.1(f_{ck28}) + 5.0$$

where f_{cm28} and E_{cm28} are in unit of $[N/mm^2]$)

A.4.2 Calculate Mean Modulus of Elasticity

$$E_{cmto} = 500,000 + 52,000(f_{cmto})^{1/2}$$

$$E_{cm28} = 500,000 + 52,000(f_{cm28})^{1/2}$$

Original Recorded Equations:

$$E_{cmto} = 3500 + 4300(f_{cmto})^{1/2} \text{ where } f_{cmto} \text{ and } E_{cmto} \text{ are in [MPa]}$$

$$E_{cm28} = 3500 + 4300(f_{cm28})^{1/2} \text{ where } f_{cm28} \text{ and } E_{cm28} \text{ are in [MPa]}$$

A.4.3 Calculate Shrinkage Strain

$$\varepsilon_s(t) = \varepsilon_{shu}\beta(h)\beta(t)$$

$$\beta(H) = 1 - 1.18\left(\frac{H}{100}\right)^4$$

$$\varepsilon_{shu} = (1000)K\left(\frac{4350}{f_{cm28}}\right)^{1/2} (10^{-6})$$

Type of Cement	K
I	1.00
II	0.70
III	1.15

$$\beta(t) = \left(\frac{t - t_c}{t - t_c + 97(V/S)^2} \right)^{0.5}$$

A.4.4 Calculate Creep Coefficient

$$\phi(t, t_0) = \Phi(t_c) \left[2 \left(\frac{(t - t_c)^{0.3}}{(t - t_c)^{0.3} + 14} \right) + \left(\frac{7}{t_0} \right)^{0.5} \left(\frac{t - t_c}{t - t_c + 7} \right)^{0.5} + 2.5(1 - 1.086h^2) \left(\frac{t - t_0}{t - t_0 + 97(V/S)^2} \right)^{0.5} \right]$$

$$\text{If } t_0 = t_c \quad \text{then } \Phi(t_c) = 1$$

$$\text{If } t_0 > t_c \quad \text{then } \Phi(t_c) = \left[1 - \left(\frac{t - t_c}{t - t_c + 97(V/S)^2} \right)^{0.5} \right]^{0.5}$$

A.4.5 Calculate Creep Compliance

$$J(t, t_0) = \frac{1}{E_{cm(t_0)}} + \frac{\varphi(t, t_0)}{E_{cm28}}$$

APPENDIX B Examples of Shrinkage and Creep Calculations

Utilizing all Four Models

Shrinkage Data Set (Author: Keeton [15] File no. e_015_02)

Given:

Cement Type III, Moist Cured

$$f_{cm28} = 45.2 \text{ MPa} \quad (6554 \text{ psi})$$

$$2A/u = 38 \text{ mm} \quad (1.52 \text{ in.})$$

$$H = 50\%$$

$$t = 9 \text{ days}$$

$$t_c = 8 \text{ days}$$

Creep Data Set (Author: Keeton [15] File no. e_015_07)

Given:

Cement Type III

Moist Cured

$$f_{cm28} = 45.2 \text{ MPa} \quad (6554 \text{ psi})$$

$$2A/u = 76 \text{ mm} \quad (3.04 \text{ in.})$$

$$H = 50\%$$

$$E_{cm28} = 25860 \text{ MPa} \quad (3749700 \text{ psi})$$

$$t = 15 \text{ days}$$

$$t_o = 8 \text{ days}$$

B.1 The ACI Model (Units in lb. and in. unless specified)

Shrinkage Strain

$$b = 35$$

$$K_{sh} = 1.40 - 0.01(50) = 0.90$$

$$K_{ss} = 1.14 - 0.09(0.984) = 1.05$$

$$\epsilon_{shu} = 780 \times 10^{-6}$$

$$\epsilon_s(t) = -[(9-8) / (35 + 9-8)](1.05)(0.90)(780 \times 10^{-6})$$

$$\underline{\epsilon_s(t) = -21 \times 10^{-6}} \quad (\text{Negative sign implies shrinkage})$$

Creep Compliance

Calculate E_{cmto}

$$f_{cmto} = 6554 (8 / (2.3 + 0.92(8))) = 5248$$

$$E_{cmto} = 33(145)^{2/3} \times (5248)^{1/2} = 4174100$$

$$C_c(t) = [(t-t_0)^{0.60} / (10 + (t-t_0)^{0.60})](C_{cu})(K_{ch})(K_{ca})(K_{cs})$$

where

$$C_{cu} = 2.35$$

$$K_{ca} = 1.25(8)^{-0.118} = 0.9780$$

$$K_{ch} = 1.27 - 0.0067(50) = 0.9350$$

$$K_{cs} = 1.14 - 0.09(3.04/2) = 1.0032$$

$$C_c(t) = [7^{0.60} / (10 + 7^{0.60})](2.35)(0.9350)(0.9780)(1.0032) = 0.5244$$

$$J(t, t_0) = [1 + 0.5244] / 4.17 \times 10^6 \text{ psi}$$

$$\underline{J(t, t_0) = 0.3656 \times 10^{-6} / \text{psi} \quad (53 \times 10^{-6} / \text{MPa})}$$

B.2 The CEB 90 Model (Units in lb. and in. unless specified)

Shrinkage Strain

$$\beta_{sc} = 8 \quad \text{for Normal Type III Concrete}$$

$$\epsilon_s(f_{cm28}) = [160 + 10(8)(9 - \frac{6554}{1450})] \times 10^{-6} = 518 \times 10^{-6}$$

$$\beta_{RH} = -1.55 \times \beta_{arh}$$

where

$$\beta_{arh} = 1 - (50/100)^3 = 0.875$$

$$\beta_{RH} = -1.55 \times 0.875 = -1.356$$

$$\epsilon_{cso} = (518 \times 10^{-6})(-1.356) = -702 \times 10^{-6}$$

$$h_c = 2A/u = 1.52 \text{ in.}$$

$$\beta_s(t-t_c) = \sqrt{\frac{(9-8)}{350(1.52/4)^2 + (9-8)}} = 0.1393$$

$$\epsilon_s(t-t_c) = -702 \times 10^{-6} \times 0.1393$$

$$\underline{\epsilon_s(t-t_c) = -98 \times 10^{-6}} \quad \text{(Negative sign implies shrinkage)}$$

Creep Compliance

Calculate E_{cm28}

$$E_{cm28} = 21500(45.2 \text{ MPa})^{1/3} = 35548 \text{ MPa} = 5154460 \text{ psi}$$

$$E_{cmto} = (35548)\exp[0.20/2)(1-(28/8)^{0.5})]$$

$$E_{cmto} = 32584 \text{ MPa} = 4724680 \text{ psi}$$

$$\phi_{RH} = 1 + \frac{(1-50/100)}{0.46(3.04/4)^{1/3}} = 2.1802$$

$$\beta(f_{cm28}) = \frac{5.3}{\sqrt{6554/1450}} = 2.4929$$

$$\beta(t_0) = \frac{1}{0.1+8^{0.2}} = 0.6189$$

$$\phi_o = (2.1802)(2.4929)(0.6189) = 3.3637$$

$$\begin{aligned}\beta_H &= 150[1 + (0.012 \times 50)^{18}](3.04/4) + 250 \leq 1,500 \text{ days} \\ &= 364\end{aligned}$$

$$\beta_c(t, t_0) = \frac{(15-8)^{0.3}}{[364 + (15-8)]^{0.3}} = 0.3039$$

$$\phi(t, t_0) = 3.3637 \times 0.3039 = 1.0222$$

$$J(t, t_0) = \frac{1.0222}{5.15 \times 10^6} + \frac{1}{4.72 \times 10^6}$$

$$\underline{J(t, t_0) = 0.410 \times 10^{-6} / \text{psi} \quad (60 \times 10^{-6} / \text{MPa})}$$

B.3 The B3 Model (Units in lb. and in. unless specified)

Shrinkage Strain

$$\alpha_1 = 1.10$$

$$\alpha_2 = 1.00$$

$$f_{cm28} = 6554 \text{ psi}$$

$$\epsilon_{sh\infty} = -(1.10)(1.00)[(26(12.98)^{2.1}(6554)^{-0.28}) + 270] \times 10^{-6}$$

$$\epsilon_{sh\infty} = -829 \times 10^{-6}$$

$$K_h = 1 - (50/100)^3 = 0.875$$

$$K_t = 190.8(8)^{-0.08}(6554)^{-0.25} = 17.96$$

$$K_s = 1 \quad \text{since type of member is not defined}$$

$$D = 2A/u = 1.52 \text{ in.}$$

$$T_{sh} = 17.96(1 \times 1.52)^2 = 41.49$$

$$S(t) = \tanh \sqrt{\frac{9-8}{41.49}} = 0.1540$$

$$\epsilon_s(t-t_c) = (-829 \times 10^{-6})(0.875)(0.1540)$$

$$\epsilon_s(t-t_c) = \underline{-112 \times 10^{-6}} \quad (\text{Negative sign implies shrinkage})$$

Creep Compliance

Calculate E_{cm28}

$$E_{cm28} = 57000(6554)^{1/2} = 4614536$$

Solve for Instantaneous strain due to unit stress, q_1

$$q_1 = \frac{0.6 \times 10^6}{4.61 \times 10^6} = 0.1302$$

Solve for Aging visco-elastic compliance, q_2

$$\begin{aligned} q_2 &= 451.1(5.97 \text{ lb/ft}^3)^{0.5}(6554 \text{ psi})^{-0.9} \\ &= 0.4050 \end{aligned}$$

Solve for Non-aging visco-elastic compliance, q_3

$$q_3 = 0.29(0.46)^4(0.4050) = 0.00526$$

Solve for Flow compliance, q_4

$$q_4 = 0.14(3.73)^{-0.7} = 0.0557$$

Solve for is a Binomial integral $Q(t, t_0)$

$$Q(t, t_0) = [0.086(8)^{2/9} + 1.21(8)^{4/9}]^{-1} = 0.3139$$

$$Z(t, t_0) = (8)^{-0.5} \ln[1 + (15-8)^{0.1}] = 0.2811$$

$$r(t_0) = 1.7(8)^{0.12} + 8 = 10.1818$$

$$Q(t, t_0) = 0.3139 \left[1 + \frac{0.3139^{10.1818}}{0.2811^{10.1818}} \right]^{-1/10.1818}$$

$$Q(t, t_0) = 0.2734$$

$$\begin{aligned} C_o(t, t_0) &= (0.4050 \times 0.2734) + \{0.00526 \times \ln[1 + (15-8)^{0.1}]\} + (0.0557 \times \ln(15/8)) \\ &= 0.1499 \end{aligned}$$

$$\alpha_1 = 1.10$$

$$\alpha_2 = 1.00$$

$$\begin{aligned}\epsilon_{shu} &= -(1.10)(1.00) [26(12.97)^{2.1} (6554)^{-0.28} + 270] \\ &= -827.78\end{aligned}$$

$$\begin{aligned}q_5 &= 7.57 \times 10^5 \times (6554)^{-1} |-827.78|^{-0.6} \\ &= 2.0504\end{aligned}$$

$$K_t = 190.8(1)^{-0.08}(6554)^{-0.25} = 21.20$$

Solve for Cross section shape correction factor, K_s

$$K_s = 1 \quad \text{since type of member is not defined}$$

Solve for another variable, Effective cross-section thickness, D

$$\begin{aligned}D &= 2(V/S) \\ &= 3.04 \text{ in.}\end{aligned}$$

$$T_{sh} = 21.20(1 \times 3.04)^2 = 195.92$$

$$S(t) = \tanh \sqrt{\frac{15-1}{195.92}} = 0.2611$$

$$H(t) = 1 - [(1 - \frac{50}{100}) \times 0.2611] = 0.8694$$

Solve for Time function for shrinkage, $S(t_0)$

$$S(t_0) = \tanh \sqrt{\frac{8-1}{195.92}} = 0.1868$$

Solve for $H(t_0)$, another Spatial average of pore relative humidity, which depends on the age of concrete at loading, t_0

$$H(t_0) = 1 - \left[\left(1 - \frac{50}{100} \right) \times 0.1868 \right] = 0.9066$$

$$\begin{aligned} C_d(t, t_0, t_c) &= 2.0504 \{ \exp[-8(0.8694)] - \exp[-8(0.9066)] \}^{1/2} \\ &= 0.1682 \end{aligned}$$

$$J(t, t_0) = (0.1302 + 0.1499 + 0.1682) \times 10^{-6} / \text{psi}$$

$$\underline{J(t, t_0) = 0.4483 \times 10^{-6} / \text{psi} \quad (65 \times 10^{-6} / \text{MPa})}$$

B.4 The GL 2000 Model (Units in lb. and in. unless specified)

Shrinkage Strain

$$K = 1.15 \quad \text{for Type III Cement}$$

$$\epsilon_{shu} = 1000 \times 1.15 \times \left(\frac{4350}{6554} \right)^{1.2} \times 10^{-6} = 937 \times 10^{-6}$$

Solve for Correction term for Effect of Relative Humidity, $\beta(H)$

$$\beta(H) = \left(1 - 1.18 \left(\frac{50}{100} \right)^4 \right) = 0.9263$$

Solve for last variable, Correction term for Effect of Time, $\beta(t)$ in Eq. 2.59

$$\beta(t) = \sqrt{\frac{9-8}{9-8+97(0.76)^2}} = 0.1324$$

$$\epsilon_s(t) = -(937 \times 10^{-6})(0.9263)(0.1324)$$

$$\underline{\epsilon_s(t) = -115 \times 10^{-6}}$$

Creep Compliance

Calculate E_{cm28} and E_{cmto}

$$E_{cm28} = 3500 + 4300(45.2 \text{ MPa})^{0.5} = 32409 \text{ MPa} = 4699305 \text{ psi}$$

$$f_{cmto} = 6554 \left(\frac{8^{3/4}}{1.0 + 0.92(8^{3/4})} \right) = 5800 \text{ psi}$$

$$E_{cmto} = 3500 + 4300(5800)^{0.5} = 330978 \text{ MPa} = 47991845 \text{ psi}$$

In this case, $t_o > t_c$; therefore,

$$\Phi(t_c) = \left[1 - \left(\frac{8-1}{8-1+97(3.04/2)^2} \right)^{0.5} \right]^{0.5} = 0.9072$$

$$\begin{aligned} \phi_{28} = (0.9072) & \left[2 \left(\frac{(15-8)^{0.3}}{(15-8)^{0.3}+14} \right) + \left(\frac{7}{8} \right)^{0.5} \left(\frac{15-8}{15-8+7} \right)^{0.5} + \right. \\ & \left. 2.5(1-1.086\left(\frac{50}{100}\right)^2) \left(\frac{15-8}{15-8+97(3.04/2)^2} \right)^{0.5} \right] \end{aligned}$$

$$\begin{aligned} \phi_{28} &= (0.9072)(0.23 + 0.66 + 0.32) \\ &= 1.0977 \end{aligned}$$

$$J(t, t_o) = \frac{1}{4.8 \times 10^6} + \frac{1.0977}{4.7 \times 10^6}$$

$$\underline{J(t, t_o) = 0.44 \text{ microstrain/psi} \quad (65 \times 10^{-6} / \text{MPa})}$$

APPENDIX C Example of Calculating the Coefficient of Variation for a Model as Suggested by the B3 Method

An experimental data set, j (Series: Brooks, 74/C/60/05) was taken out from the RILEM data bank and coefficient of variation was calculated for shrinkage strain for ACI Model.

Data Point Number (i)	Decade in which the data point falls	Shrinkage Duration, (t-t _c) days	Experimental Data	Model Value
1	1	7	330	112
2	2	14	450	191
3	2	28	610	297
4	3	365	865	611
5	4	1825	890	657
6	4	3650	900	663

Number of data set selected =1 = Data set number, j

Total number of points in this data set, n = 6

Number of points in decade 1 (0-10 days), n₁ = 1

Number of points in decade 2 (10-100 days), n₂ = 2

Number of points in decade 3 (101-1000 days), n₃ = 1

Number of points in decade 4 (1001-10000 days), n₄ = 2

Total number of decades in this data set, n_d =4 (Decade 1, 2, 3, 4)

Weight assigned to data point in decade 1 is calculated with Eq. 4.16:

$$w_{ij} = \frac{n}{n_d n_k}$$

$$= \frac{6}{4 \times 1}$$

$$w_{ij} = 1.5 \quad (\text{for } i = 1, j = 1)$$

Weight assigned to the data points in decade 2 is calculated as follow:

$$w_{ij} = \frac{6}{4 \times 2}$$

$$= 0.75 \quad (\text{for } i = 2 \text{ and } 3, j = 1)$$

w_{41}, w_{51}, w_{61} are calculated in the similar manner,

$$w_{41} = 1.5$$

$$w_{51} = 0.75$$

$$w_{61} = 0.75$$

Weights assigned to each data point (w_{ij})	Model Values (J_{ij})	Difference between Experimental and Predicated Values (Δ_{ij})	($w_{ij} J_{ij}$)	($w_{ij} \Delta_{ij}$) ²
$w_{11} = 1.50$	112	-218	168	106,929
$w_{21} = 0.75$	191	-259	144	37,733
$w_{31} = 0.75$	297	-313	223	55,108
$w_{41} = 1.50$	611	-254	917	145,161
$w_{51} = 0.75$	657	-233	493	30,538
$w_{61} = 0.75$	663	-237	497	31,595
$\sum w_{ij} = n_w = 6$		Total	= 2,442	= 407,064

For data set, $j = 1$, J_1 is calculated using Eq. 4.15

$$J_j = \frac{1}{n_w} \sum_{i=1}^n (\varpi_{ij} J_{ij})$$

$$J_j = \frac{1}{6} \times 2442$$

$$= 407$$

And the coefficient variation for this particular data set, $j = 1$ is calculated with Eq. 4.14

$$\varpi_j = \frac{1}{J_j} \sqrt{\frac{1}{n-1} \sum_{i=1}^n (\varpi_{ij} \Delta_{ij})^2} \times 100$$

$$\varpi_1 = \frac{1}{407} \sqrt{\frac{1}{6-1} \times 407064} \times 100$$

$$= 70 \%$$

Coefficient of variation (ϖ_1) for data set $j = 1$, is 70%

APPENDIX D														
Shrinkage Experimental Data Sets from the RILEM Data Bank														
Utilized for the ACI 209 Model Analysis														
RILEM File No. and Author Record			Environment Condition	Concrete Properties				Time Data			Ultimate Experimental Shrinkage Strain	ACI 209 Interim Values		
Serial no	File	Author	Humidity [%]	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t_c (Days)	$t - t_c$ (Days)	$\epsilon_{sh}(t_c)$ (b10-5)	b	Kah	Kas
1	e 005 01	Trossel [5]	50	0.59	5.669	R	1	16.5	28	8900	-1140	35	0.9	1.05
2	e 005 02	Trossel [5]	70	0.59	5.669	R	1	16.5	28	7088	-780	35	0.7	1.05
13	e 011 05	Mummel [11]	65	0.55	5.368	R	1	41.9	7	1455	-520	35	0.75	0.98
21	e 015 02	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	897	-1055	35	0.8	1.07
22	e 015 03	Keeton [15]	75	0.46	3.732	RS	3	45.2	8	897	-775	35	0.65	1.07
23	e 015 04	Keeton [15]	97	0.46	3.732	RS	3	45.2	8	897	-30	35	0.09	1.07
24	e 015 05	Keeton [15]	99	0.46	3.732	RS	3	45.2	8	897	-300	55	0.03	1.07
26	e 015 07	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	897	-1030	35	0.8	1.05
27	e 015 08	Keeton [15]	75	0.46	3.732	RS	3	45.2	8	897	-745	35	0.65	1.05
29	e 015 10	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	897	-885	35	0.9	1.01
30	e 015 11	Keeton [15]	75	0.46	3.732	RS	3	45.2	8	897	-655	35	0.65	1.01
31	e 015 12	Keeton [15]	99	0.46	3.732	RS	3	45.2	8	897	-80	55	0.03	1.01
35	e 015 16	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	385	-615	35	0.8	1.07
36	e 015 17	Keeton [15]	75	0.46	3.732	RS	3	45.2	8	385	-450	35	0.65	1.07
37	e 015 18	Keeton [15]	75	0.46	3.732	RS	3	45.2	8	385	-435	35	0.65	1.01
41	e 015 22	Keeton [15]	50	0.46	3.732	RS	3	45.2	24	385	-835	35	0.8	1.07
42	e 015 23	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	730	-1015	35	0.9	1.09
43	e 015 24	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	730	-880	35	0.9	1.07
44	e 015 25	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	730	-795	35	0.9	1.01
45	e 015 26	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	730	-545	35	0.9	0.87
46	e 015 27	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	720	-480	35	0.9	0.82
56	e 017 12	Marmilan [17]	50	0.49	4.814	R	1	33.9	625	744	-325	35	0.9	1.08
59	e 017 13	Marmilan [17]	75	0.49	4.814	R	1	33.9	625	744	-227	35	0.65	1.08
61	e 019 01	Wallo [19]	50	0.45	6	R	1	k.A.	7	157	-454	35	0.9	1.07
62	e 019 02	Wallo [19]	50	0.45	6	R	1	k.A.	7	157	-482	35	0.9	1.05
63	e 019 03	Wallo [19]	50	0.45	6	R	1	k.A.	7	157	-418	35	0.9	1.01
64	e 019 04	Wallo [19]	50	0.45	6	R	1	k.A.	14	157	-500	35	0.9	1.07
65	e 019 05	Wallo [19]	50	0.45	6	R	1	k.A.	14	157	-438	35	0.9	1.05
66	e 019 06	Wallo [19]	50	0.45	6	R	1	k.A.	14	157	-448	35	0.9	1.01
67	e 019 07	Wallo [19]	50	0.45	6	R	1	k.A.	28	100	-372	35	0.9	1.05
68	e 019 08	Wallo [19]	50	0.45	6	R	1	k.A.	28	100	-300	35	0.9	1.01
69	e 019 09	Wallo [19]	50	0.75	10.7	R	1	k.A.	7	156	-420	35	0.9	1.07
70	e 019 10	Wallo [19]	50	0.75	10.7	R	1	k.A.	7	156	-373	35	0.9	1.05
71	e 019 11	Wallo [19]	50	0.75	10.7	R	1	k.A.	7	156	-310	35	0.9	1.01
72	e 019 12	Wallo [19]	50	0.75	10.7	R	1	k.A.	14	157	-371	35	0.9	1.07
73	e 019 13	Wallo [19]	50	0.75	10.7	R	1	k.A.	14	157	-358	35	0.9	1.05
74	e 019 14	Wallo [19]	50	0.75	10.7	R	1	k.A.	14	157	-321	35	0.9	1.01
75	e 019 15	Wallo [19]	50	0.75	10.7	R	1	k.A.	28	157	-321	35	0.9	1.07
76	e 019 16	Wallo [19]	50	0.75	10.7	R	1	k.A.	28	100	-329	35	0.9	1.05
77	e 019 17	Wallo [19]	50	0.75	10.7	R	1	k.A.	28	100	-250	35	0.9	1.01
78	e 019 18	Wallo [19]	50	0.45	6	R	1	k.A.	7	156	-380	35	0.9	1.07
79	e 019 19	Wallo [19]	50	0.45	6	R	1	k.A.	7	156	-380	35	0.9	1.05
80	e 019 20	Wallo [19]	50	0.45	6	R	1	k.A.	7	156	-329	35	0.9	1.01
81	e 019 21	Wallo [19]	50	0.45	6	R	1	k.A.	14	157	-372	35	0.9	1.07
82	e 019 22	Wallo [19]	50	0.45	6	R	1	k.A.	14	157	-352	35	0.9	1.05
83	e 019 23	Wallo [19]	50	0.45	6	R	1	k.A.	14	157	-312	35	0.9	1.01
84	e 019 24	Wallo [19]	50	0.45	6	R	1	k.A.	28	100	-280	35	0.9	1.07
85	e 019 25	Wallo [19]	50	0.45	6	R	1	k.A.	28	100	-300	35	0.9	1.05
86	e 019 26	Wallo [19]	50	0.45	6	R	1	k.A.	28	100	-251	35	0.9	1.01
87	e 020 01	Hanson [20]	50	0.71	6	RS	3	41.3	8	1485	-830	35	0.9	1.05
88	e 020 02	Hanson [20]	50	0.71	6	RS	3	41.3	8	1780	-880	35	0.9	1.01
89	e 020 03	Hanson [20]	50	0.71	6	RS	3	41.3	8	1785	-800	35	0.9	0.98
90	e 020 04	Hanson [20]	50	0.71	6	RS	3	41.3	8	1730	-715	35	0.9	0.87
91	e 020 05	Hanson [20]	50	0.71	6	RS	3	41.3	8	1720	-610	35	0.9	0.78
92	e 020 06	Hanson [20]	50	0.71	6	RS	3	41.3	8	1775	-585	35	0.9	0.89
93	e 020 07	Hanson [20]	50	0.71	6	RS	3	41.3	8	1745	-470	35	0.9	0.80
94	e 020 08	Hanson [20]	50	0.71	6	RS	3	41.3	8	1705	-580	35	0.9	0.78
95	e 020 09	Hanson [20]	50	0.71	6	RS	3	41.3	8	1880	-700	35	0.9	0.88
96	e 020 10	Hanson [20]	50	0.71	6	RS	3	41.3	8	1822	-788	35	0.9	1.05
97	e 022 01	Wallo [22]	50	0.5	4.4	R	1	46.2	28	157	-885	35	0.9	1.07
98	e 022 02	Wallo [22]	50	0.5	4.4	R	1	46.2	28	157	-539	35	0.9	1.05
99	e 022 03	Wallo [22]	50	0.5	4.4	R	1	46.2	28	157	-539	35	0.9	1.01
100	e 022 04	Wallo [22]	50	0.5	4.4	R	1	46.2	28	157	-579	35	0.9	1.07
101	e 022 05	Wallo [22]	50	0.5	4.4	R	1	46.2	28	157	-635	35	0.9	1.05
102	e 022 06	Wallo [22]	50	0.5	4.4	R	1	46.2	28	157	-484	35	0.9	1.01
103	e 022 07	Wallo [22]	50	0.8	9	R	1	24.6	28	190	-439	35	0.9	1.07
104	e 022 08	Wallo [22]	50	0.8	9	R	1	24.6	28	190	-489	35	0.9	1.05
105	e 022 09	Wallo [22]	50	0.8	9	R	1	24.6	28	190	-480	35	0.9	1.01
106	e 022 10	Wallo [22]	50	0.8	9	R	1	24.6	28	190	-478	35	0.9	1.07
107	e 022 11	Wallo [22]	50	0.8	9	R	1	24.6	28	190	-488	35	0.9	1.05
108	e 022 12	Wallo [22]	50	0.8	9	R	1	24.6	28	190	-448	35	0.9	1.01
109	e 022 13	Wallo [22]	50	0.8	9	R	1	24.6	28	190	-477	35	0.9	1.07

RILEM File No. and Author Record			Environment Condition	Concrete Properties				Time Data			Ultimate Experimental Shrinkage Strain	ACI 209 Interim Values		
Serial no.	File	Author	Humidity (%)	w/c	s/c	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t_c (Days)	$t - t_c$ (Days)	$E_{cm}(t,c)$ (x10 ⁻⁶)	b	K _{sp}	K _{ss}
110	e 022 14	Wallo [22]	50	0.8	9	R	1	24.6	28	150	-457	35	0.9	1.05
111	e 022 15	Wallo [22]	50	0.8	9	R	1	24.6	28	150	-418	35	0.9	1.01
112	e 026 01	[26] Hannat	98	0.47	4.5	R	1	54.7	180	743	-7	35	0.1	1.05
113	e 026 02	[26] Hannat	98	0.47	4.5	R	1	54.7	180	743	-79	35	0.1	1.05
114	e 026 03	[26] Hannat	98	0.47	4.5	R	1	54.7	180	743	-87	35	0.1	1.05
115	e 030 01	Roach	65	0.65	7.69	R	1	16.8	7	1083	-379	35	0.75	1.03
116	e 030 02	Hummel [30]	65	0.55	5.35	R	1	28.3	7	1083	-480	35	0.75	1.03
117	e 030 03	R + H [30]	65	0.49	5.34	R	1	47.8	7	693	-480	35	0.75	1.03
120	e 030 06	R + H [30]	65	0.87	8.13	RS	3	k.A.	7	693	-565	35	0.75	1.03
121	e 030 07	R + H [30]	65	0.49	4.39	RS	3	43.8	7	693	-430	35	0.75	1.03
177	e 061 02	Wascher [81]	65	0.48	5.862	R	1	50.3	8	2190	-455	35	0.75	1.01
178	e 061 03	Wascher [81]	65	0.48	5.862	R	1	50.3	28	2190	-440	35	0.75	1.01
180	e 061 05	Wascher [81]	65	0.48	4.239	R	1	46.4	10	2190	-545	35	0.75	1.01
181	e 061 06	Wascher [81]	65	0.48	4.239	R	1	46.4	28	2190	-575	35	0.75	1.01
184	e 061 09	Wascher [81]	65	0.48	5.862	RS	3	56.3	28	2190	-479	35	0.75	1.01
187	e 061 12	Wascher [81]	65	0.48	4.239	RS	3	50.8	28	2190	-593	35	0.75	1.01
190	e 061 15	Wascher [81]	65	0.4	4.533	RS	3	60.3	28	2190	-344	35	0.75	1.01
192	e 063 02	Wesche [83] A	65	0.55	5.387	R	1	33.2	7	549	-452	35	0.75	0.98
195	e 063 05	Wesche [83] C	65	0.55	5.355	RS	3	46.5	7	780	-420	35	0.75	0.98
219	e 072 06	Brooks [72]	65	0.36	3.3	R	1	70.9	28	350	-530	35	0.75	1.07
220	e 072 07	Brooks [72]	65	0.27	3.3	R	1	85.5	28	337.5	-500	35	0.75	1.07
221	e 072 08	Brooks [72]	65	0.34	2.6	R	1	69.1	28	337.5	-735	35	0.75	1.07
222	e 072 09	Brooks [72]	65	0.27	2.6	R	1	80.9	28	337.5	-560	35	0.75	1.07
223	e 072 10	Brooks [72]	65	0.3	2.08	R	1	67.3	28	337.5	-620	35	0.75	1.07
224	e 074 01	Brooks [74]	60	0.8	4.75	R	1	k.A.	14	3650	-980	35	0.8	1.07
226	e 074 03	Brooks [74]	60	0.67	4.75	R	1	k.A.	14	3650	-840	35	0.8	1.07
228	e 074 05	Brooks [74]	60	0.58	4.75	R	1	k.A.	14	3650	-900	35	0.8	1.07
230	e 074 07	Brooks [74]	60	0.54	4.75	R	1	k.A.	14	3650	-720	35	0.8	1.07
232	e 074 09	Brooks [74]	60	0.5	4.75	R	1	k.A.	14	3650	-720	35	0.8	1.07
234	e 074 11	Brooks [74]	60	0.8	4.75	R	1	k.A.	14	3650	-1385	35	0.8	1.07
236	e 074 13	Brooks [74]	60	0.67	4.75	R	1	k.A.	14	3650	-1270	35	0.8	1.07
238	e 074 15	Brooks [74]	60	0.56	4.75	R	1	k.A.	14	3650	-980	35	0.8	1.07
240	e 074 17	Brooks [74]	60	0.48	4.75	R	1	k.A.	14	3650	-470	35	0.8	1.07
242	e 074 19	Brooks [74]	60	0.4	4.75	R	1	k.A.	14	3650	-750	35	0.8	1.07
245	e 076 02	[76] Schwesinger	65	0.68	6.047	R	1	15.5	28	188.7	-380	35	0.75	1.01
246	e 076 03	[76] Schwesinger	98	0.68	6.047	R	1	15.5	28	188.7	-237	35	0.1	1.01
252	e 076 09	[76] Schwesinger	98	0.68	6.047	R	1	15.5	385	1.4	-1.9	35	0.1	1.01
258	e 078 01	Russel [78]	50	0.432	4.04	R	1	52.4	7	6342	-733	35	0.9	1.01
259	e 078 02	Russel [78]	50	0.39	3.34	R	1	63	7	8789	-772	35	0.9	1.01
260	e 079 01	Shrinthan [79]	60	0.47	5.09	R	1	50.1	8	3492	-740	35	0.8	1.05
261	e 079 02	Shrinthan [79]	60	0.47	5.09	R	1	50.1	8	3492	-719	35	0.8	1.01
262	e 079 03	Shrinthan [79]	60	0.47	5.09	R	1	50.1	8	3492	-488	35	0.8	0.98
263	e 079 04	Shrinthan [79]	60	0.47	5.09	R	1	50.1	8	3492	-598	35	0.8	0.87
264	e 079 05	Shrinthan [79]	60	0.47	5.09	R	1	50.1	8	3492	-585	35	0.8	0.79
265	e 079 06	Shrinthan [79]	98	0.47	5.09	R	1	50.1	8	384	-24	35	0.1	1.01
270	e 081 05	Pentala [81]	60	0.31	3.612	R	1	87	7	370	-340	35	0.8	1.05
271	e 081 06	Pentala [81]	45	0.31	3.612	R	1	87	7	370	-430	35	0.95	1.05
272	e 081 07	Pentala [81]	60	0.52	5.246	R	1	59.1	7	380	-368	35	0.8	1.05
273	e 081 08	Pentala [81]	45	0.52	5.246	R	1	59.1	7	380	-465	35	0.95	1.05
274	e 082 01	[82] Budelmann	65	7.54	k.A.	R	1	44.1	90	60	-144	35	0.75	1.10
275	e 082 02	[82] Budelmann	65	7.54	k.A.	R	1	44.1	150	60	-134	35	0.75	1.10
276	e 082 03	[82] Budelmann	65	7.54	k.A.	R	1	44.1	150	60	-255	35	0.75	1.10
277	e 082 04	[82] Budelmann	65	7.54	k.A.	R	1	44.1	150	60	-341	35	0.75	1.10
278	e 082 05	[82] Budelmann	95	7.54	k.A.	R	1	44.1	90	60	-50	35	0.15	1.10
279	e 082 06	[82] Budelmann	95	7.54	k.A.	R	1	44.1	150	60	-52	35	0.15	1.10
280	e 082 07	[82] Budelmann	95	7.54	k.A.	R	1	44.1	150	60	-149	35	0.15	1.10
281	e 082 08	[82] Budelmann	95	7.54	k.A.	R	1	44.1	150	60	-280	35	0.15	1.10
292	e 084 01	Witzmann [84]	65	0.48	5.428	R	1	33.2	7	1105	-720	35	0.75	1.07
293	e 084 02	Witzmann [84]	65	0.48	5.428	R	1	33.2	7	1105	-683	35	0.75	1.00
294	e 084 03	Witzmann [84]	65	0.48	5.428	R	1	33.2	7	1105	-535	35	0.75	0.87
295	e 085 01	Burg [85]	50	0.281	3.041	R	1	78.6	28	617	-487	35	0.9	1.07
296	e 085 02	Burg [85]	50	0.338	3.635	R	1	88.5	28	617	-580	35	0.9	1.07
297	e 085 03	Burg [85]	50	0.32	3.581	RS	3	91.9	28	617	-543	35	0.9	1.07
298	e 085 04	Burg [85]	50	0.255	2.945	RS	3	118.9	28	617	-480	35	0.9	1.07
299	e 085 05	Burg [85]	50	0.318	3.496	RS	3	107	28	617	-483	35	0.9	1.07
300	e 085 06	Burg [85]	50	0.281	3.041	R	1	78.6	28	617	-447	35	0.9	1.01
301	e 085 07	Burg [85]	50	0.338	3.635	R	1	88.5	28	617	-508	35	0.9	1.01
302	e 085 08	Burg [85]	50	0.32	3.581	RS	3	91.9	28	617	-543	35	0.9	1.01
303	e 085 09	Burg [85]	50	0.255	2.945	RS	3	118.9	28	617	-415	35	0.9	1.01
304	e 085 10	Burg [85]	50	0.318	3.496	RS	3	107	28	617	-483	35	0.9	1.01
307	e 086 03	De Larrard [86]	98	0.267	4.556	R	1	101	28	240	-88	35	0.1	1.00
308	e 086 04	De Larrard [86]	98	0.441	4.522	R	1	k.A.	28	240	-146	35	0.1	1.00
309	e 086 05	De Larrard [86]	50	0.267	4.556	R	1	101	28	240	-150	35	0.9	1.00
310	e 086 06	De Larrard [86]	50	0.441	4.522	R	1	k.A.	28	240	-316	35	0.9	1.00
317	e 089 01	Hooton [89]	50	0.361	4.838	R	1	55.6	28	448	-376	35	0.9	1.06
318	e 089 02	Hooton [89]	50	0.405	5.346	R	1	70.7	28	448	-391	35	0.9	1.06
319	e 089 03	Hooton [89]	50	0.428	5.616	R	1	75.2	28	448	-430	35	0.9	1.06

RILEM File No. and Author Record			Environment Condition	Concrete Properties				Time Data			Ultimate Experimental Shrinkage Strain	ACI 208 Interim Values		
Serial no.	File	Author	Humidity (%)	w/c	s/c	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t_c (Days)	$t - t_c$ (Days)	$\epsilon_{cs}(t, t_c)$ ($\times 10^{-6}$)	b	K _{sh}	K _{sa}
320	e 088 04	Hooton [89]	50	0.465	3.96	R	1	74.2	28	448	-446	35	0.9	1.08
321	e 088 05	Hooton [89]	50	0.488	5.342	R	1	85	28	448	-464	35	0.9	1.08
322	e 088 01	Oh [80]	50	0.385	3.283	RS	3	46	28	229	-487	35	0.9	1.01
323	e 088 02	Oh [80]	98	0.385	3.283	RS	3	46	28	229	-383	35	0.1	1.01
325	e 081 02	A af 1C	65	0.3	4.217	R	1	70.9	30	238	-158.3	35	0.75	1.05
329	e 081 08	B af 3C	65	0.3	3.825	R	1	75.6	28	238	-303.3	35	0.75	1.05
332	e 081 09	C af 4C	65	0.271	4.373	R	1	82.9	28	209	-128.3	35	0.75	1.05
335	e 081 12	D af 2C	65	0.239	4.556	R	1	97	28.5	350.5	-82	35	0.75	1.05
340	e 081 17	F af 7C	65	0.38	3.984	R	1	57.7	32	328	-128	35	0.75	1.05
348	e 081 25	I af 27/28T	98	0.3	4.168	R	1	68.3	7	212	-85	35	0.1	1.08
353	e 081 30	N af 5C	65	0.239	4.173	R	1	104.7	29	302	-118.3	35	0.75	1.05
355	e 081 32	O af 11C	65	0.271	4.017	R	1	89.1	29	139	-131.7	35	0.75	1.05
358	e 081 35	N af 29T	98	0.239	4.175	R	1	104.7	7	212	-17	35	0.1	1.05
365	e 083 01	Chem [93]	50	0.28	3.331	R	1	53.5	28	681.8	-555	35	0.9	1.05
368	e 084 04	Rawndarajah [94] A	65	0.3	3.87	R	1	75	480	101	-383	35	0.75	1.07
370	e 084 05	Rawndarajah [94] B	65	0.38	3.848	R	1	72.7	480	100	-360	35	0.75	1.07
371	e 084 06	Rawndarajah [94] C	65	0.271	3.553	R	1	89.5	480	100	-283	35	0.75	1.07
374	e 084 09	Rawndarajah [94] D	65	0.311	3.878	R	1	85.6	480	100	-248	35	0.75	1.07
381	e 085 01	Han [95]	65	0.316	3.78	R	1	106.2	28	218	-233.9	35	0.75	1.05
383	e 085 03	Han [95]	65	0.316	3.779	R	1	100.3	28	208.2	-284.8	35	0.75	1.05
384	e 085 04	Han [95]	65	0.316	3.783	R	1	92.8	28	202.4	-248.8	35	0.75	1.05
416	e 088 03	[98] Däger	99	0.3405	4.33	R	1	80	1	58.1	-25	55	0.03	1.05
419	e 088 06	[98] Däger	98	0.3405	4.33	R	1	80	7	745.3	-270	35	0.1	1.05
420	e 088 07	[98] Däger	50	0.3405	4.33	R	1	80	7	745.3	-845	35	0.9	1.05
423	e 089 03	Hisdorf [99]	65	0.55	5.401	RS	3	40.3	7	1088	-545	35	0.75	0.98
424	e 089 04	Hisdorf [99]	65	0.55	5.401	RS	3	40.3	28	1087	-540	35	0.75	0.98
425	e 089 05	Hisdorf [99]	65	0.55	5.401	RS	3	40.3	90	1735	-478	35	0.75	0.98

APPENDIX E

Shrinkage Experimental Data Sets from the RILEM Data Bank Utilized for the CEB 90 Model Analysis

RILEM File and Author Record		Environment Condition	Concrete Properties						Time Data	Ultimate Experimental Shrinkage Strain	CEB 90 Interim Values		
File	Author	Humidity (%)	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t_c (Days)	$\epsilon_{cs}(t_c)$ [x10-6]	S_{RH}	$E_c(t_{cm})$	S_{RH}	
9 e 011 01	Hummel [11]	65	0.55	5.388	SL	2	28.9	7	-430	4	0.0004124	-1.1243	
10 e 011 02	Hummel [11]	65	0.38	5.381	SL	2	43.1	7	-325	4	0.0003478	-1.1243	
11 e 011 03	Hummel [11]	65	0.45	5.392	SL	2	35.3	7	-340	4	0.0003788	-1.1243	
12 e 011 04	Hummel [11]	65	0.65	5.383	SL	2	18.7	7	-405	4	0.0004452	-1.1243	
13 e 011 05	Hummel [11]	65	0.55	5.388	R	1	41.9	7	-520	5	0.0004005	-1.1243	
14 e 014 01	Rosch [14]	65	0.55	5.384	SL	2	24.4	7	-360	4	0.0004224	-1.1243	
15 e 014 02	Rosch [14]	65	0.55	5.469	SL	2	25.8	7	-313	4	0.0004168	-1.1243	
16 e 014 03	Rosch [14]	65	0.55	5.397	SL	2	26.4	7	-498	4	0.0004144	-1.1243	
17 e 014 04	Rosch [14]	65	0.55	5.588	SL	2	23.4	7	-374	4	0.0004254	-1.1243	
18 e 014 05	Rosch [14]	65	0.55	5.504	SL	2	27.8	7	-536	4	0.0004088	-1.1243	
19 e 014 06	Rosch [14]	65	0.55	6.281	SL	2	28.4	7	-370	4	0.0004084	-1.1243	
21 e 015 02	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	-1056	8	0.0005184	-1.3563	
22 e 015 03	Keeton [15]	75	0.46	3.732	RS	3	45.2	8	-775	8	0.0005184	-0.8961	
23 e 015 04	Keeton [15]	97	0.46	3.732	RS	3	45.2	8	-30	8	0.0005184	-0.1354	
26 e 015 07	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	-1030	8	0.0005184	-1.3563	
27 e 015 08	Keeton [15]	75	0.46	3.732	RS	3	45.2	8	-745	8	0.0005184	-0.8961	
29 e 015 10	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	-965	8	0.0005184	-1.3563	
30 e 015 11	Keeton [15]	75	0.46	3.732	RS	3	45.2	8	-655	8	0.0005184	-0.8961	
35 e 015 16	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	-615	8	0.0005184	-1.3563	
36 e 015 17	Keeton [15]	75	0.46	3.732	RS	3	45.2	8	-450	8	0.0005184	-0.8961	
37 e 015 18	Keeton [15]	75	0.46	3.732	RS	3	45.2	8	-435	8	0.0005184	-0.8961	
40 e 015 21	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	-1120	8	0.0005184	-1.3563	
42 e 015 23	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	-1015	8	0.0005184	-1.3563	
43 e 015 24	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	-960	8	0.0005184	-1.3563	
44 e 015 25	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	-795	8	0.0005184	-1.3563	
45 e 015 26	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	-490	8	0.0005184	-1.3563	
46 e 015 27	Keeton [15]	50	0.46	3.732	RS	3	45.2	8	-490	8	0.0005184	-1.3563	
47 e 017 01	Marmilan [17]	50	0.49	4.814	R	1	33.9	1	-463	5	0.0004405	-1.3563	
51 e 017 05	Marmilan [17]	75	0.49	4.814	R	1	33.9	1	-371	5	0.0004405	-0.8961	
52 e 017 06	Marmilan [17]	50	0.49	4.814	R	1	33.9	1	-565	5	0.0004405	-1.3563	
54 e 017 08	Marmilan [17]	50	0.49	4.814	R	1	33.9	1	-507	5	0.0004405	-1.3563	
55 e 017 09	Marmilan [17]	50	0.49	4.814	R	1	33.9	1	-491	5	0.0004405	-1.3563	
56 e 017 10	Marmilan [17]	50	0.49	4.814	R	1	33.9	1	-467	5	0.0004405	-1.3563	
87 e 020 01	Hanson [20]	50	0.71	6	RS	3	41.3	8	-930	8	0.0005496	-1.3563	
88 e 020 02	Hanson [20]	50	0.71	6	RS	3	41.3	8	-890	8	0.0005496	-1.3563	
89 e 020 03	Hanson [20]	50	0.71	6	RS	3	41.3	8	-800	8	0.0005496	-1.3563	
90 e 020 04	Hanson [20]	50	0.71	6	RS	3	41.3	8	-715	8	0.0005496	-1.3563	
91 e 020 05	Hanson [20]	50	0.71	6	RS	3	41.3	8	-610	8	0.0005496	-1.3563	
92 e 020 06	Hanson [20]	50	0.71	6	RS	3	41.3	8	-585	8	0.0005496	-1.3563	
93 e 020 07	Hanson [20]	50	0.71	6	RS	3	41.3	8	-470	8	0.0005496	-1.3563	
94 e 020 08	Hanson [20]	50	0.71	6	RS	3	41.3	8	-560	8	0.0005496	-1.3563	
95 e 020 09	Hanson [20]	50	0.71	6	RS	3	41.3	8	-700	8	0.0005496	-1.3563	
96 e 020 10	Hanson [20]	50	0.71	6	RS	3	41.3	8	-765	8	0.0005496	-1.3563	
115 e 030 01	Rosch [14]	65	0.65	7.69	R	1	16.8	7	-370	5	0.0005290	-1.1243	
116 e 030 02	Hummel [30]	65	0.55	5.35	R	1	28.3	7	-490	5	0.0004665	-1.1243	
117 e 030 03	R + H [30]	65	0.49	5.34	R	1	47.8	7	-480	5	0.0003710	-1.1243	
118 e 030 04	R + H [30]	65	0.6	6.1	RS	3	36.5	1	-520	8	0.0006720	-1.1243	
119 e 030 05	R + H [30]	65	0.45	5.41	RS	3	50.4	1	-480	8	0.0024768	-1.1243	
121 e 030 07	R + H [30]	65	0.49	4.39	RS	3	43.8	7	-630	8	0.0006296	-1.1243	
172 e 059 01	Lambotte [59]	60	0.55	6.51	R	1	30.6	1	-375	5	0.0004570	-1.2152	
173 e 059 02	Lambotte [59]	60	0.5	6.3	R	1	29.2	1	-561	5	0.0004640	-1.2152	
174 e 059 03	Lambotte [59]	60	0.445	5.27	R	1	41.9	1	-539	5	0.0004005	-1.2152	
175 e 059 04	Lambotte [59]	60	0.47	5.23	R	1	39	1	-461	5	0.0004150	-1.2152	
176 e 061 01	Wischer [61]	65	0.48	5.862	R	1	50.3	4.54	-432	5	0.0003565	-1.1243	
177 e 061 02	Wischer [61]	65	0.48	5.862	R	1	50.3	8	-456	5	0.0003565	-1.1243	
179 e 061 04	Wischer [61]	65	0.48	4.239	R	1	46.4	4.92	-575	5	0.0003780	-1.1243	
180 e 061 05	Wischer [61]	65	0.48	4.239	R	1	46.4	10	-545	5	0.0003780	-1.1243	
182 e 061 07	Wischer [61]	65	0.48	5.862	RS	3	56.3	0.83	-424	8	0.0004296	-1.1243	
183 e 061 08	Wischer [61]	65	0.48	5.862	RS	3	56.3	2.92	-508	8	0.0004296	-1.1243	
185 e 061 10	Wischer [61]	65	0.48	4.239	RS	3	50.6	1.42	-601	8	0.0004736	-1.1243	
186 e 061 11	Wischer [61]	65	0.48	4.239	RS	3	50.6	2.92	-677	8	0.0004736	-1.1243	
188 e 061 13	Wischer [61]	65	0.4	4.533	RS	3	60.3	0.42	-641	8	0.0003876	-1.1243	
189 e 061 14	Wischer [61]	65	0.4	4.533	RS	3	60.3	1.5	-614	8	0.0003876	-1.1243	
191 e 063 01	Wesche [63] A	65	0.55	5.367	R	1	33.2	3	-442	5	0.0004440	-1.1243	
192 e 063 02	Wesche [63] A	65	0.55	5.367	R	1	33.2	7	-452	5	0.0004440	-1.1243	
193 e 063 03	Wesche [63] C	65	0.56	5.365	RS	3	46.5	1	-638	8	0.0006080	-1.1243	
194 e 063 04	Wesche [63] C	65	0.55	5.365	RS	3	46.5	3	-629	8	0.0006080	-1.1243	
195 e 063 05	Wesche [63] C	65	0.55	5.365	RS	3	46.5	7	-620	8	0.0006080	-1.1243	
196 e 063 06	Wesche [63] H	65	0.55	5.366	SL	2	33.9	3	-547	4	0.0003844	-1.1243	
197 e 063 07	Wesche [63] H	65	0.55	5.366	SL	2	33.9	7	-474	4	0.0003844	-1.1243	
198 e 063 08	Wesche [63] I	65	0.55	5.366	SL	2	33.1	7	-482	4	0.0003876	-1.1243	
199 e 063 09	Wesche [63] J	65	0.55	5.366	SL	2	30.5	7	-530	4	0.0003880	-1.1243	
202 e 069 01	Stöckl [69]	65	0.601	5.02	SL	2	17.7	7	-613	4	0.0004482	-1.1243	
203 e 069 02	Stöckl [69]	65	0.598	6.32	SL	2	19	7	-366	4	0.0004440	-1.1243	
204 e 069 03	Stöckl [69]	65	0.45	5.405	SL	2	23.9	7	-469	4	0.0004244	-1.1243	
205 e 069 04	Stöckl [69]	65	0.8	7.78	SL	2	10.8	7	-466	4	0.0004768	-1.1243	
206 e 071 01	Wegler [71]	65	9.5	n.A.	SL	2	41.3	3	-526	4	0.0003548	-1.1243	
207 e 071 02	Wegler [71]	65	10.5	n.A.	R	1	40.7	3	-498	5	0.0004065	-1.1243	

RILEM File and Author Record		Environment Condition	Concrete Properties					Time Data	Ultimate Experimental Shrinkage Strain	CEB 98 Interim Values		
File	Author	Humidity (%)	w/c	slc	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t _c (Days)	$\epsilon_{cs}(t_c)$ [x10-6]	β_{cs}	$E_{cs}(t_{max})$	β_{cs}
208 e 071 03	Wegler (71)	65	9.5	LA	SL	2	37.5	3	-263	4	0.0003700	-1.1243
208 e 071 04	Wegler (71)	65	10.5	LA	R	1	44.7	3	-480	5	0.0003865	-1.1243
210 e 071 05	Wegler (71)	65	10.5	LA	RS	3	59.4	3	-526	8	0.0004048	-1.1243
211 e 071 06	Wegler (71)	65	10.6	LA	SL	2	34.2	3	-536	4	0.0003632	-1.1243
212 e 071 07	Wegler (71)	65	10.6	LA	R	1	38.4	3	-498	5	0.0004180	-1.1243
213 e 071 08	Wegler (71)	65	10.65	LA	RS	3	40.3	3	-527	8	0.0005578	-1.1243
257 e 077 01	Espen (77)	60	LA	LA	R	1	36	1	-568	5	0.0004000	-1.2152
258 e 078 01	Russel (78)	50	0.432	4.04	R	1	52.4	7	-733	5	0.0003480	-1.3563
259 e 078 02	Russel (78)	50	0.39	3.34	R	1	63	7	-772	5	0.0002950	-1.3563
280 e 079 01	Shrinanan (79)	60	0.47	5.08	R	1	50.1	8	-740	5	0.0003595	-1.2152
281 e 079 02	Shrinanan (79)	60	0.47	5.08	R	1	50.1	8	-719	5	0.0003595	-1.2152
282 e 079 03	Shrinanan (79)	60	0.47	5.08	R	1	50.1	8	-686	5	0.0003595	-1.2152
283 e 079 04	Shrinanan (79)	60	0.47	5.09	R	1	50.1	8	-596	5	0.0003595	-1.2152
284 e 079 05	Shrinanan (79)	60	0.47	5.09	R	1	50.1	8	-585	5	0.0003595	-1.2152
285 e 079 06	Shrinanan (79)	98	0.47	5.09	R	1	50.1	8	-24	5	0.0003595	-0.912
286 e 081 01	Pentala (81)	60	0.297	3.524	SL	2	111.3	7	-295	4	0.0000748	-1.2152
287 e 081 02	Pentala (81)	45	0.297	3.524	SL	2	111.3	7	-355	4	0.0000748	-1.4068
288 e 081 03	Pentala (81)	60	0.305	3.624	SL	2	90.9	7	-220	4	0.0001564	-1.2152
289 e 081 04	Pentala (81)	45	0.305	3.624	SL	2	90.9	7	-268	4	0.0001564	-1.4068
270 e 081 05	Pentala (81)	60	0.31	3.612	R	1	87	7	-340	5	0.0001750	-1.2152
271 e 081 06	Pentala (81)	45	0.31	3.612	R	1	87	7	-430	5	0.0001750	-1.4068
272 e 081 07	Pentala (81)	60	0.52	5.246	R	1	59.1	7	-368	5	0.0003145	-1.2152
273 e 081 08	Pentala (81)	45	0.52	5.246	R	1	59.1	7	-485	5	0.0003145	-1.4068
282 e 083 01	De Larrard (83)	50	0.332	3.787	R	1	94.5	1	-436	5	0.0001375	-1.3563
284 e 083 03	De Larrard (83)	50	0.388	3.77	R	1	83.3	1	-421	5	0.0001935	-1.3563
285 e 083 04	De Larrard (83)	98	0.388	3.77	R	1	83.3	1	-205	5	0.0001935	-0.912
286 e 083 05	De Larrard (83)	50	0.416	3.77	R	1	73.8	1	-473	5	0.0002410	-1.3563
287 e 083 06	De Larrard (83)	98	0.416	3.77	R	1	73.8	1	-157	5	0.0002410	-0.912
288 e 083 07	De Larrard (83)	50	0.385	3.77	R	1	72.5	1	-412	5	0.0002475	-1.3563
289 e 083 08	De Larrard (83)	98	0.385	3.77	R	1	72.5	1	-147	5	0.0002475	-0.912
290 e 083 09	De Larrard (83)	50	0.411	3.769	R	1	64	1	-534	5	0.0002900	-1.3563
291 e 083 10	De Larrard (83)	98	0.411	3.769	R	1	64	1	-113	5	0.0002900	-0.912
292 e 084 01	Witzmann (84)	65	0.48	5.428	R	1	33.2	7	-720	5	0.0004440	-1.1243
293 e 084 02	Witzmann (84)	65	0.48	5.428	R	1	33.2	7	-683	5	0.0004440	-1.1243
294 e 084 03	Witzmann (84)	65	0.48	5.428	R	1	33.2	7	-535	5	0.0004440	-1.1243
305 e 086 01	De Larrard (86)	50	0.267	4.566	R	1	101	1	-271	5	0.0001050	-1.3563
311 e 088 01	Hammer (88)	50	0.533	5.306	R	1	54.3	1	-623	5	0.0003285	-1.3563
312 e 088 02	Hammer (88)	50	0.394	4.413	R	1	79.4	1	-538	5	0.0002130	-1.3563
313 e 088 03	Hammer (88)	50	0.309	3.841	R	1	96.2	1	-550	5	0.0001290	-1.3563
314 e 088 04	Hammer (88)	98	0.533	5.306	R	1	54.3	1	-432	5	0.0003285	-0.912
315 e 088 05	Hammer (88)	98	0.394	4.413	R	1	79.4	1	-390	5	0.0002130	-0.912
324 e 091 01	(81) af 1A	98	0.3	4.217	R	1	70.9	1	-187	5	0.0002566	-0.912
328 e 091 03	A af 1B	65	0.3	4.217	R	1	70.9	1	-425	5	0.0002566	-1.1243
327 e 091 04	A af 19AT	98	0.3	4.217	R	1	65.1	6	-132	5	0.0002845	-0.912
328 e 091 05	B af 3A	98	0.3	3.625	R	1	75.6	1	-138	5	0.0002320	-0.912
330 e 091 07	B af 3B	65	0.3	3.625	R	1	75.6	1	-415	5	0.0002320	-1.1243
331 e 091 08	C af 4A	98	0.271	4.375	R	1	82.9	1	-148	5	0.0001965	-0.912
332 e 091 10	C af 4B	65	0.271	4.375	R	1	82.9	1	-265	5	0.0001965	-1.1243
336 e 091 13	D af 2B	65	0.239	4.569	R	1	97	1	-372	5	0.0001250	-1.1243
338 e 091 15	D af 20A	98	0.239	4.569	R	1	66.8	6	-73	5	0.0002770	-0.912
339 e 091 16	F af 7A	98	0.38	3.994	R	1	57.7	1	-148	5	0.0003215	-0.912
341 e 091 18	F af 7B	65	0.38	3.994	R	1	57.7	1	-465	5	0.0003215	-1.1243
342 e 091 19	G af 6A	98	0.3	4.193	SL	2	55.9	1	-197	4	0.0002964	-0.912
344 e 091 21	G af 6B	65	0.3	4.193	SL	2	55.9	1	-523	4	0.0002964	-1.1243
345 e 091 22	H af 8A	98	0.239	4.535	SL	2	67.6	1	-425	4	0.0002498	-0.912
348 e 091 23	I af 27A	98	0.3	4.166	R	1	75.9	1	-162	5	0.0002305	-0.912
347 e 091 24	J af 26A	98	0.239	4.504	R	1	68.1	1	-245	5	0.0001895	-0.912
348 e 091 25	I af 27/28T	98	0.3	4.166	R	1	66.3	7	-65	5	0.0002785	-0.912
349 e 091 26	K af 14A	98	0.3	4.213	R	1	75	3	-163	5	0.0002350	-0.912
351 e 091 28	M af 16A	98	0.3	3.151	R	1	83.4	1	-217	5	0.0001930	-0.912
354 e 091 31	N af 5B	65	0.239	4.175	R	1	104.7	1	-257	5	0.0000885	-1.1243
356 e 091 33	O af 11B	65	0.271	4.017	R	1	89.1	1	-300	5	0.0001645	-1.1243
358 e 091 36	O af 13A	98	0.3	3.845	SL	2	61.9	1	-383	4	0.0002724	-0.912
360 e 091 37	R af 9A	98	0.239	4.156	SL	2	71.1	1	-363	4	0.0002356	-0.912
361 e 091 38	O af 30A	98	0.271	4.017	R	1	69.1	1	-132	5	0.0001645	-0.912
362 e 091 39	S af 23A	98	0.48	3.723	R	1	48.7	1	-207	5	0.0003885	-0.912
363 e 091 40	S af 23C(8)?	65	0.48	3.723	R	1	48.7	1	-445	5	0.0003885	-1.1243
364 e 092 01	Yus (92)	60	0.323	4.875	RS	3	80.5	1	-435	8	0.0002380	-1.2152
366 e 094 011	Ravndorssah (94) A	65	0.3	3.67	R	1	75	3	-653	5	0.0002350	-1.1243
367 e 094 02	Ravndorssah (94) B	65	0.38	3.848	R	1	72.7	3	-778	5	0.0002485	-1.1243
368 e 094 03	Ravndorssah (94) C	65	0.271	3.553	R	1	89.5	3	-680	5	0.0001625	-1.1243
372 e 094 07	Ravndorssah (94) D	65	0.311	3.878	R	1	85.6	3	-647	5	0.0001820	-1.1243
373 e 094 08	Ravndorssah (94) E	65	0.3	3.67	SL	2	67.6	3	-689	4	0.0002488	-1.1243
382 e 095 02	Hen (95)	50	0.318	3.779	R	1	100.3	0.67	-406.7	5	0.0001085	-1.3563
385 e 095 05	Hen (95)	50	0.318	3.779	R	1	100.3	0.67	-391.9	5	0.0001085	-1.3563
386 e 095 08	Hen (95)	50	0.318	3.783	R	1	92.8	0.67	-349.4	5	0.0001480	-1.3563
387 e 096 01	Eichschen (96) A	60	0.45	5.308	R	1	72.1	3	-481	5	0.0002745	-1.2152
388 e 096 02	Eichschen (96) B	60	0.45	5.308	R	1	67.1	3	-568.4	5	0.0002745	-1.2152
389 e 096 03	Eichschen (96) C	60	0.4	5.44	R	1	77.9	3	-569	5	0.0002206	-1.2152
390 e 096 04	Eichschen (96) D	60	0.5	5.177	R	1	63.3	3	-648	5	0.0002835	-1.2152
391 e 096 05	Eichschen (96) E	60	0.45	6.527	R	1	73.7	3	-643	5	0.0002415	-1.2152
392 e 096 06	Eichschen (96) F	60	0.45	5.051	R	1	60.4	3	-682	5	0.0003080	-1.2152
393 e 096 07	Eichschen (96) G	60	0.45	5.84	R	1	71.7	3	-451.5	5	0.0002515	-1.2152

RILEM File and Author Record		Environment Condition	Concrete Properties					Time Date	Ultimate Experimental Strain/age Strain	CEB 98 Interim Values		
File	Author	Humidity (%)	w/c	slc	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t_c (Days)	$E_{cs}(L)$ (x10-6)	B_{sp}	$E_c(f_{cm})$	B_{sp}
3841 • 086 06	Eckstein (RS) H	80	0.45	5.374	R	1	88.6	3	-501	5	0.0002970	-1.2152
3851 • 086 08	Eckstein (RS) I	80	0.473	5.374	R	1	84.6	3	-438	5	0.0002870	-1.2152
4051 • 086 19	Eckstein (RS) A	98	0.45	5.309	R	1	72.1	1	-88	5	0.0002486	-0.0812
4061 • 086 20	Eckstein (RS) B	98	0.45	5.309	R	1	87.1	1	-175	5	0.0002746	-0.0812
4071 • 086 21	Eckstein (RS) C	98	0.4	5.44	R	1	77.9	1	-178	5	0.0002208	-0.0812
4081 • 086 22	Eckstein (RS) O	98	0.5	5.177	R	1	83.3	1	-124	5	0.0002908	-0.0812
4091 • 086 23	Eckstein (RS) E	98	0.45	6.527	R	1	73.7	1	-148	5	0.0002419	-0.0812
4101 • 086 24	Eckstein (RS) F	98	0.45	5.051	R	1	80.4	1	-128	5	0.0003080	-0.0812
4111 • 086 25	Eckstein (RS) G	98	0.45	5.84	R	1	71.7	1	-175.5	5	0.0002515	-0.0812
4121 • 086 26	Eckstein (RS) H	98	0.45	5.374	R	1	88.6	1	-68	5	0.0002970	-0.0812
4131 • 086 27	Eckstein (RS) I	98	0.473	5.374	R	1	84.6	1	-84	5	0.0002870	-0.0812
4141 • 086 01	(RS) Däger	98	0.3405	4.33	R	1	80	1	-195	5	0.0002100	-0.0812
4151 • 086 02	(RS) Däger	50	0.3405	4.33	R	1	80	1	-710	5	0.0002100	-1.3563
4171 • 086 04	(RS) Däger	98	0.3405	4.33	R	1	80	3	-260	5	0.0002100	-0.0812
4181 • 086 05	(RS) Däger	50	0.3405	4.33	R	1	80	3	-700	5	0.0002100	-1.3563
4191 • 086 06	(RS) Däger	98	0.3405	4.33	R	1	80	7	-270	5	0.0002100	-0.0812
4201 • 086 07	(RS) Däger	50	0.3405	4.33	R	1	80	7	-645	5	0.0002100	-1.3563
4211 • 086 01	Hilsdorf (RS)	65	0.55	5.401	RS	3	40.3	1	-498	8	0.0005576	-1.1243
4221 • 086 02	Hilsdorf (RS)	65	0.55	5.401	RS	3	40.3	3	-543	8	0.0005576	-1.1243
4231 • 086 03	Hilsdorf (RS)	65	0.55	5.401	RS	3	40.3	7	-545	8	0.0005576	-1.1243
4261 • 086 06	Hilsdorf (RS)	65	0.55	5.401	RS	3	40.3	1	-605	8	0.0005576	-1.1243

APPENDIX F														
Shrinkage Experimental Data Sets from the RILEM Data Bank														
Utilized for the B3 Model Analysis														
RILEM File no. and Author Record			Environment Condition	Concrete Properties					Time Data	Ultimate Experiment of Shrinkage Strain	B3 Interim Values			
Serial no.	File	Author	Humidity [%]	w/c	a/c	European Cement Type	Equivalent American Type	f _{cm} [N/mm ²]	t _c [Days]	E _{cm} (t _c) [x10-6]	ε _{s1}	ε _{s2}	K _s	D
1	e 005 01	Trostel [5]	50	0.59	5.668	R	1	16.5	28	-1140	1	1.00	0.875	20.98
2	e 005 02	Trostel [5]	70	0.59	5.668	R	1	16.5	28	-780	1	1.00	0.667	20.98
9	e 011 01	Hummel [11]	65	0.55	5.398	SL	2	26.9	7	-430	0.85	1.00	0.725	20.66
10	e 011 02	Hummel [11]	65	0.38	5.381	SL	2	43.1	7	-325	0.85	1.00	0.725	18.37
11	e 011 03	Hummel [11]	65	0.45	5.392	SL	2	35.3	7	-340	0.85	1.00	0.725	19.31
12	e 011 04	Hummel [11]	65	0.65	5.393	SL	2	18.7	7	-405	0.85	1.00	0.725	22.43
13	e 011 05	Hummel [11]	65	0.55	5.398	R	1	41.9	7	-520	1	1.00	0.725	18.50
14	e 014 01	Rösch [14]	65	0.55	5.394	SL	2	24.4	7	-380	0.85	1.00	0.725	21.17
15	e 014 02	Rösch [14]	65	0.55	5.480	SL	2	25.8	7	-313	0.85	1.00	0.725	20.88
16	e 014 03	Rösch [14]	65	0.55	5.397	SL	2	26.4	7	-488	0.85	1.00	0.725	20.76
17	e 014 04	Rösch [14]	65	0.55	5.586	SL	2	23.4	7	-374	0.85	1.00	0.725	21.40
18	e 014 05	Rösch [14]	65	0.55	5.504	SL	2	27.8	7	-538	0.85	1.00	0.725	20.49
19	e 014 06	Rösch [14]	65	0.55	6.261	SL	2	28.4	7	-370	0.85	1.00	0.725	20.38
21	e 015 02	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-1055	1.1	0.75	0.875	17.96
22	e 015 03	Keaton [15]	75	0.46	3.732	RS	3	45.2	8	-775	1.1	0.75	0.578	17.96
23	e 015 04	Keaton [15]	97	0.46	3.732	RS	3	45.2	8	-301	1.1	0.75	0.087	17.96
26	e 015 07	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-1030	1.1	0.75	0.875	17.96
27	e 015 08	Keaton [15]	75	0.46	3.732	RS	3	45.2	8	-745	1.1	0.75	0.578	17.96
29	e 015 10	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-985	1.1	0.75	0.875	17.96
30	e 015 11	Keaton [15]	75	0.46	3.732	RS	3	45.2	8	-655	1.1	0.75	0.578	17.96
35	e 015 16	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-815	1.1	0.75	0.875	17.96
36	e 015 17	Keaton [15]	75	0.46	3.732	RS	3	45.2	8	-450	1.1	0.75	0.578	17.96
37	e 015 18	Keaton [15]	75	0.46	3.732	RS	3	45.2	8	-435	1.1	0.75	0.578	17.96
40	e 015 21	Keaton [15]	50	0.46	3.732	RS	3	45.2	3	-1120	1.1	0.75	0.875	19.42
41	e 015 22	Keaton [15]	50	0.46	3.732	RS	3	45.2	24	-935	1.1	0.75	0.875	16.45
42	e 015 23	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-1015	1.1	0.75	0.875	17.96
43	e 015 24	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-980	1.1	0.75	0.875	17.96
44	e 015 25	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-795	1.1	0.75	0.875	17.96
45	e 015 26	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-545	1.1	0.75	0.875	17.96
46	e 015 27	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-490	1.1	0.75	0.875	17.96
47	e 017 01	Mamillon [17]	50	0.49	4.814	R	1	33.9	1	-463	1	1.0	0.875	22.79
51	e 017 05	Mamillon [17]	75	0.49	4.814	R	1	33.9	1	-371	1	1.0	0.578	22.79
52	e 017 06	Mamillon [17]	50	0.49	4.814	R	1	33.9	1	-565	1	1.0	0.875	22.79
54	e 017 08	Mamillon [17]	50	0.49	4.814	R	1	33.9	1	-507	1	1.0	0.875	22.79
55	e 017 09	Mamillon [17]	50	0.49	4.814	R	1	33.9	1	-481	1	1.0	0.875	22.79
56	e 017 10	Mamillon [17]	50	0.49	4.814	R	1	33.9	1	-467	1	1.0	0.875	22.79
58	e 017 12	Mamillon [17]	50	0.49	4.814	R	1	33.9	625	-325	1	1.0	0.875	13.61
59	e 017 13	Mamillon [17]	75	0.49	4.814	R	1	33.9	625	-227	1	1.0	0.578	13.61
67	e 020 01	Hanson [20]	50	0.71	6	RS	3	41.3	8	-630	1.1	0.75	0.875	18.37
68	e 020 02	Hanson [20]	50	0.71	6	RS	3	41.3	8	-680	1.1	0.75	0.875	18.37
69	e 020 03	Hanson [20]	50	0.71	6	RS	3	41.3	8	-800	1.1	0.75	0.875	18.37
90	e 020 04	Hanson [20]	50	0.71	6	RS	3	41.3	8	-715	1.1	0.75	0.875	18.37
91	e 020 05	Hanson [20]	50	0.71	6	RS	3	41.3	8	-810	1.1	0.75	0.875	18.37
92	e 020 06	Hanson [20]	50	0.71	6	RS	3	41.3	8	-585	1.1	0.75	0.875	18.37
93	e 020 07	Hanson [20]	50	0.71	6	RS	3	41.3	8	-470	1.1	0.75	0.875	18.37
94	e 020 08	Hanson [20]	50	0.71	6	RS	3	41.3	8	-580	1.1	0.75	0.875	18.37
95	e 020 09	Hanson [20]	50	0.71	6	RS	3	41.3	8	-700	1.1	0.75	0.875	18.37
98	e 020 10	Hanson [20]	50	0.71	6	RS	3	41.3	8	-785	1.1	0.75	0.875	18.37
97	e 022 01	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-565	1	1.0	0.875	16.15
98	e 022 02	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-538	1	1.0	0.875	16.15
99	e 022 03	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-528	1	1.0	0.875	16.15
100	e 022 04	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-578	1	1.0	0.875	16.15
101	e 022 05	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-525	1	1.0	0.875	16.15
102	e 022 06	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-484	1	1.0	0.875	16.15
103	e 022 07	Wallo [22]	50	0.8	9	R	1	24.6	28	-438	1	1.0	0.875	18.91
104	e 022 08	Wallo [22]	50	0.8	9	R	1	24.6	28	-488	1	1.0	0.875	18.91
105	e 022 09	Wallo [22]	50	0.8	9	R	1	24.6	28	-450	1	1.0	0.875	18.91
106	e 022 10	Wallo [22]	50	0.8	9	R	1	24.6	28	-478	1	1.0	0.875	18.91
107	e 022 11	Wallo [22]	50	0.8	9	R	1	24.6	28	-468	1	1.0	0.875	18.91
108	e 022 12	Wallo [22]	50	0.8	9	R	1	24.6	28	-448	1	1.0	0.875	18.91
109	e 022 13	Wallo [22]	50	0.8	9	R	1	24.6	28	-477	1	1.0	0.875	18.91
110	e 022 14	Wallo [22]	50	0.8	9	R	1	24.6	28	-467	1	1.0	0.875	18.91
111	e 022 15	Wallo [22]	50	0.8	9	R	1	24.6	28	-418	1	1.0	0.875	18.91
115	e 030 01	Rösch	65	0.65	7.68	R	1	18.8	7	-370	1	1.0	0.725	23.24
116	e 030 02	Hummel [30]	65	0.55	5.35	R	1	28.3	7	-480	1	1.0	0.725	28.48
117	e 030 03	R + H [30]	65	0.49	5.34	R	1	47.8	7	-480	1	1.0	0.725	17.98
118	e 030 04	R + H [30]	65	0.6	6.1	RS	3	38.5	1	-520	1.1	1.0	0.725	22.07
119	e 030 05	R + H [30]	65	0.45	5.41	RS	3	50.4	1	-480	1.1	1.0	0.725	28.64
121	e 030 07	R + H [30]	65	0.49	4.39	RS	3	43.8	7	-430	1.1	1.0	0.725	18.29
130	e 037 03	[37] York	98	0.426	4.624	SL	2	44.2	90	-0.3	0.85	1.20	0.050	14.88
138	e 051 05	[51] McDonald	98	0.425	4.645	SL	2	51.2	90	-1	0.85	1.20	0.050	14.34
137	e 051 06	[51] McDonald	98	0.425	4.645	SL	2	51.2	90	-1.5	0.85	1.20	0.050	14.34
138	e 051 07	[51] McDonald	50	0.425	4.645	SL	2	51.2	90	-78.3	0.85	1.0	0.875	14.34
140	e 051 09	[51] McDonald	98	0.434	3.671	SL	2	46.1	90	-2	0.85	1.20	0.050	14.72

RILEM File no. and Author Record			Environment Condition	Concrete Properties					Time Date	Ultimate Experiment at Shrinkage Strain	BS Interim Values				
Serial no.	File	Author	Humidity (%)	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t_c (Days)	$E_{cm}(t_c)$ (x10-6)	α_{sh}	α_{sh}	K_1	K_2	D
141	e 051 10	[51] McDonald	98	0.434	3.671	SL	2	48.1	90	-40.5	0.88	1.20	0.059	14.72	2.999
142	e 051 11	[51] McDonald	90	0.434	3.671	SL	2	48.1	90	-152	0.88	1.0	0.875	14.72	2.999
172	e 059 01	Lambotte [59]	60	0.55	6.51	R	1	30.6	1	-375	1	1.0	0.784	23.38	1.968
173	e 059 02	Lambotte [59]	60	0.5	8.3	R	1	29.2	1	-551	1	1.0	0.784	23.63	1.968
174	e 059 03	Lambotte [59]	60	0.445	5.27	R	1	41.9	1	-539	1	1.0	0.784	21.61	1.968
175	e 059 04	Lambotte [59]	60	0.47	5.23	R	1	39	1	-481	1	1.0	0.784	22.08	1.968
176	e 061 01	Wiescher [61]	65	0.48	5.862	R	1	50.3	4.54	-432	1	1.0	0.725	18.29	2.912
177	e 061 02	Wiescher [61]	65	0.48	5.862	R	1	50.3	8	-455	1	1.0	0.725	17.48	2.912
178	e 061 03	Wiescher [61]	65	0.48	5.862	R	1	50.3	28	-440	1	1.0	0.725	13.82	2.912
179	e 061 04	Wiescher [61]	65	0.48	4.239	R	1	46.4	4.92	-575	1	1.0	0.725	18.33	2.912
180	e 061 05	Wiescher [61]	65	0.48	4.239	R	1	46.4	10	-545	1	1.0	0.725	17.32	2.912
181	e 061 06	Wiescher [61]	65	0.48	4.239	R	1	46.4	28	-575	1	1.0	0.725	16.14	2.912
182	e 061 07	Wiescher [61]	65	0.48	5.862	RS	3	56.3	0.83	-424	1	1.0	0.725	20.37	2.912
183	e 061 08	Wiescher [61]	65	0.48	5.862	RS	3	56.3	2.92	-508	1	1.0	0.725	18.42	2.912
184	e 061 09	Wiescher [61]	65	0.48	5.862	RS	3	56.3	28	-479	1	1.0	0.725	13.28	2.912
185	e 061 10	Wiescher [61]	65	0.48	4.239	RS	3	50.8	1.42	-601	1	1.0	0.725	20.03	2.912
186	e 061 11	Wiescher [61]	65	0.48	4.239	RS	3	50.8	2.92	-677	1	1.0	0.725	18.90	2.912
187	e 061 12	Wiescher [61]	65	0.48	4.239	RS	3	50.8	28	-593	1	1.0	0.725	15.78	2.912
188	e 061 13	Wiescher [61]	65	0.4	4.533	RS	3	60.3	0.42	-441	1	1.0	0.725	21.15	2.912
189	e 061 14	Wiescher [61]	65	0.4	4.533	RS	3	60.3	1.5	-414	1	1.0	0.725	19.10	2.912
190	e 061 15	Wiescher [61]	65	0.4	4.533	RS	3	60.3	28	-344	1	1.0	0.725	13.11	2.912
191	e 063 01	Wesche [63] A	65	0.55	5.387	R	1	33.2	3	-442	1	1.0	0.725	20.48	3.916
192	e 063 02	Wesche [63] A	65	0.55	5.387	R	1	33.2	7	-452	1	1.0	0.725	19.60	3.916
193	e 063 03	Wesche [63] C	65	0.55	5.395	RS	3	46.5	1	-638	1	1.0	0.725	21.08	3.916
194	e 063 04	Wesche [63] C	65	0.55	5.395	RS	3	46.5	3	-629	1	1.0	0.725	19.28	3.916
195	e 063 05	Wesche [63] C	65	0.55	5.395	RS	3	46.5	7	-620	1	1.0	0.725	18.02	3.916
196	e 063 06	Wesche [63] H	65	0.55	5.386	SL	2	33.9	3	-547	0.85	1.0	0.725	20.87	3.916
197	e 063 07	Wesche [63] H	65	0.55	5.386	SL	2	33.9	7	-474	0.85	1.0	0.725	19.30	3.916
198	e 063 08	Wesche [63] I	65	0.55	5.386	SL	2	33.1	7	-492	0.85	1.0	0.725	19.62	3.916
199	e 063 09	Wesche [63] J	65	0.55	5.386	SL	2	30.5	7	-530	0.85	1.0	0.725	20.02	3.916
202	e 069 01	Stoick [69]	65	0.601	5.02	SL	2	17.7	7	-613	0.85	1.0	0.725	22.94	2.912
203	e 069 02	Stoick [69]	65	0.599	8.32	SL	2	19	7	-366	0.85	1.0	0.725	22.14	2.912
204	e 069 03	Stoick [69]	65	0.45	5.405	SL	2	23.9	7	-469	0.85	1.0	0.725	21.28	2.912
205	e 069 04	Stoick [69]	65	0.8	7.76	SL	2	10.8	7	-466	0.85	1.0	0.725	23.96	2.912
219	e 072 06	Brooks [73]	65	0.36	3.3	R	1	70.9	28	-530	1	1.0	0.725	14.31	1.968
245	e 076 02	[76] Schwesinger	65	0.68	6.047	R	1	15.5	28	-390	1	1.0	0.725	21.23	2.912
253	e 076 10	[76] Schwesinger	65	0.68	6.047	R	1	15.5	365	-260	1	1.0	0.725	17.29	2.912
258	e 078 01	Russel [78]	50	0.432	4.04	R	1	52.4	7	-733	1	0.75	0.875	17.69	2.991
259	e 078 02	Russel [78]	50	0.39	3.34	R	1	63	7	-772	1	0.75	0.875	16.78	2.981
260	e 079 01	Shrinthan [79]	60	0.47	5.09	R	1	50.1	8	-740	1	1.2	0.784	17.30	1.968
261	e 079 02	Shrinthan [79]	60	0.47	5.09	R	1	50.1	8	-719	1	1.2	0.784	17.30	2.912
262	e 079 03	Shrinthan [79]	60	0.47	5.09	R	1	50.1	8	-686	1	1.2	0.784	17.30	3.916
263	e 079 04	Shrinthan [79]	60	0.47	5.09	R	1	50.1	8	-596	1	1.2	0.784	17.30	3.904
264	e 079 05	Shrinthan [79]	60	0.47	5.09	R	1	50.1	8	-585	1	1.2	0.784	17.30	3.872
265	e 079 06	Shrinthan [79]	98	0.47	5.09	R	1	50.1	8	-24	1	1.20	0.059	17.30	2.912
272	e 081 07	Pentata [81]	60	0.52	5.246	R	1	59.1	7	-388	1	1.0	0.784	16.97	2.925
273	e 081 08	Pentata [81]	45	0.52	5.246	R	1	59.1	7	-485	1	1.0	0.909	16.97	2.925
284	e 083 03	De Larrard [83]	50	0.368	3.77	R	1	63.3	1	-421	1	1.2	0.875	18.29	3.149
286	e 083 05	De Larrard [83]	50	0.416	3.77	R	1	73.8	1	-473	1	1.2	0.875	18.76	3.149
288	e 083 07	De Larrard [83]	50	0.385	3.77	R	1	72.5	1	-412	1	1.2	0.875	18.84	3.149
290	e 083 09	De Larrard [83]	50	0.411	3.769	R	1	64	1	-534	1	1.2	0.875	19.44	3.149
291	e 083 10	De Larrard [83]	98	0.411	3.769	R	1	64	1	-113	1	1.20	0.059	19.44	3.149
292	e 084 01	Witmann [84]	65	0.48	5.428	R	1	33.2	7	-720	1	1.2	0.725	19.60	1.633
293	e 084 02	Witmann [84]	65	0.48	5.428	R	1	33.2	7	-663	1	1.2	0.725	19.60	3.149
294	e 084 03	Witmann [84]	65	0.48	5.428	R	1	33.2	7	-535	1	1.2	0.725	19.60	3.904
311	e 088 01	Hammer [88]	50	0.533	5.306	R	1	54.3	1	-623	1	1.2	0.875	20.26	1.968
312	e 088 02	Hammer [88]	50	0.394	4.413	R	1	79.4	1	-538	1	1.2	0.875	18.42	1.968
314	e 088 04	Hammer [88]	98	0.533	5.306	R	1	54.3	1	-432	1	1.20	0.059	20.26	1.968
317	e 089 01	Hooton [89]	50	0.361	4.638	R	1	55.6	28	-378	1	1.0	0.875	15.42	1.714
318	e 089 02	Hooton [89]	50	0.405	5.348	R	1	70.7	28	-391	1	1.0	0.875	14.32	1.714
319	e 089 03	Hooton [89]	50	0.428	5.616	R	1	75.2	28	-430	1	1.0	0.875	14.30	1.714
320	e 089 04	Hooton [89]	50	0.455	5.96	R	1	74.2	28	-445	1	1.0	0.875	14.33	1.714
321	e 089 05	Hooton [89]	50	0.486	5.342	R	1	65	28	-454	1	1.0	0.875	13.87	1.714
322	e 090 01	Oh [90]	50	0.395	3.283	RS	3	46	28	-467	1	1.2	0.875	16.17	2.912
323	e 090 02	Oh [90]	98	0.395	3.283	RS	3	46	28	-383	1	1.20	0.059	16.17	2.912
339	e 091 16	F af 7A	98	0.38	3.994	R	1	57.7	1	-148	1	1.20	0.059	19.95	1.968
340	e 091 17	F af 7C	65	0.38	3.994	R	1	57.7	32	-128	1	1.2	0.725	13.12	1.968
341	e 091 18	F af 7B	65	0.38	3.994	R	1	57.7	1	-463	1	1.2	0.725	19.95	1.968
382	e 091 39	S af 23A	98	0.48	3.723	R	1	48.7	1	-307	1	1.20	0.059	20.81	1.968
383	e 091 40	S af 23C(8)?	65	0.48	3.723	R	1	48.7	1	-445	1	1.2	0.725	20.81	1.968
387	e 094 02	Ravindran [94] B	65	0.38	3.848	R	1	72.7	3	-778	1	1.0	0.725	17.23	1.476
370	e 094 03	Ravindran [94] B	65	0.38	3.848	R	1	72.7	480	-350	1	1.0	0.725	11.33	1.476
387	e 096 01	Eckchen [96] A	60	0.45	5.309	R	1	72.1	3	-481	1	1.2	0.784	17.39	1.968
388	e 096 02	Eckchen [96] B	60	0.45	5.309	R	1	67.1	3	-558.4	1	1.2	0.784	17.39	1.968
389	e 096 03	Eckchen [96] C	60	0.4	5.44	R	1	77.9	3	-588	1	1.2	0.784	16.95	1.968
390	e 096 04	Eckchen [96] D	60	0.5	5.177	R	1	63.3	3	-646	1	1.2	0.784	17.23	1.968
391	e 096 05	Eckchen [96] E	60	0.45	6.537	R	1	73.7	3	-543	1	1.2	0.784	17.19	1.968
392	e 096 06	Eckchen [96] F	60	0.45	5.051	R	1	60.4	3	-492	1	1.2	0.784	18.06	1.968
393	e 096 07	Eckchen [96] G	60	0.45	5.84	R	1	71.7	3	-451.5	1	1.2	0.784	17.31	1.968
394	e 096 08	Eckchen [96] H	60	0.45	5.374	R	1	68.6	3	-501	1	1.2	0.784	17.30	1.968

RILEM File no. and Author Record			Environment Condition	Concrete Properties					Time Data	Ultimate Experiment of Shrinkage Strain	BS Interim Values				
Serial no.	File	Author	Humidity (%)	w/c	etc	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t_c (Days)	$\epsilon_{cs}(t_c)$ ($\mu 10^{-6}$)	α_c	α_{cs}	K_a	K_s	D
386	e 086 08	Eckelchen (96) I	60	0.473	5.374	R	1	64.6	3	-438	1	1.2	0.784	17.76	1.968
406	e 086 20	Eckelchen (96) S	98	0.45	5.308	R	1	67.1	1	-175	1	1.20	0.059	19.21	1.968
408	e 086 22	Eckelchen (96) D	98	0.5	5.177	R	1	63.3	1	-124	1	1.20	0.059	19.49	1.968
410	e 086 24	Eckelchen (96) F	98	0.45	5.051	R	1	60.4	1	-128	1	1.20	0.059	19.72	1.968
412	e 086 26	Eckelchen (96) H	98	0.45	5.374	R	1	66.6	1	-68	1	1.20	0.059	19.11	1.968
413	e 086 27	Eckelchen (96) I	98	0.473	5.374	R	1	64.6	1	-64	1	1.20	0.059	19.39	1.968
421	e 089 01	Hladoff (99)	65	0.55	5.401	RS	3	40.3	1	-486	1.1	1.0	0.725	21.82	1.936
422	e 089 02	Hladoff (99)	65	0.55	5.401	RS	3	40.3	3	-563	1.1	1.0	0.725	19.99	1.936
423	e 089 03	Hladoff (99)	65	0.55	5.401	RS	3	40.3	7	-545	1.1	1.0	0.725	18.48	1.936
424	e 089 04	Hladoff (99)	65	0.55	5.401	RS	3	40.3	28	-540	1.1	1.0	0.725	16.72	1.936
425	e 089 05	Hladoff (99)	65	0.55	5.401	RS	3	40.3	90	-478	1.1	1.0	0.725	15.23	1.936
426	e 099 06	Hladoff (99)	65	0.55	5.401	RS	3	40.3	1	-605	1.1	1.0	0.725	21.97	1.936

APPENDIX G											
Shrinkage Experimental Data Sets from the RILEM Data Bank											
Utilized for the GL 2000 Model Analysis											
RILEM File and Author Record			Environment t Condition	Concrete Properties					Time Data	Ultimate Experimental Shrinkage Strain	GL 2000 Interim Values
Serial no.	File	Author	Humidity [%]	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} [N/mm ²]	t_c [Days]	$\epsilon_{cs}(t_c)$ [x10-6]	K
1	e 005 01	Troost [5]	50	0.59	5.669	R	1	16.5	28	-1140	1.00
2	e 005 02	Troost [5]	70	0.59	5.669	R	1	16.5	28	-790	1.00
9	e 011 01	Hummel [11]	65	0.55	5.366	SL	2	26.9	7	-430	0.70
11	e 011 03	Hummel [11]	65	0.45	5.362	SL	2	35.3	7	-340	0.70
13	e 011 05	Hummel [11]	65	0.55	5.366	R	1	41.9	7	-520	1.00
14	e 014 01	Rösch [14]	65	0.55	5.364	SL	2	24.4	7	-360	0.70
15	e 014 02	Rösch [14]	65	0.55	5.469	SL	2	25.8	7	-313	0.70
16	e 014 03	Rösch [14]	65	0.55	5.367	SL	2	26.4	7	-498	0.70
17	e 014 04	Rösch [14]	65	0.55	5.568	SL	2	23.4	7	-374	0.70
18	e 014 05	Rösch [14]	65	0.55	5.504	SL	2	27.8	7	-536	0.70
19	e 014 06	Rösch [14]	65	0.55	6.261	SL	2	28.4	7	-370	0.70
20	e 015 01	Keaton [15]	20	0.46	3.732	RS	3	45.2	8	-1100	1.15
21	e 015 02	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-1055	1.15
22	e 015 03	Keaton [15]	75	0.46	3.732	RS	3	45.2	8	-775	1.15
25	e 015 06	Keaton [15]	20	0.46	3.732	RS	3	45.2	8	-1070	1.15
26	e 015 07	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-1030	1.15
27	e 015 08	Keaton [15]	75	0.46	3.732	RS	3	45.2	8	-745	1.15
28	e 015 09	Keaton [15]	20	0.46	3.732	RS	3	45.2	8	-1015	1.15
29	e 015 10	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-965	1.15
30	e 015 11	Keaton [15]	75	0.46	3.732	RS	3	45.2	8	-655	1.15
32	e 015 13	Keaton [15]	20	0.46	3.732	RS	3	45.2	8	-775	1.15
33	e 015 14	Keaton [15]	20	0.46	3.732	RS	3	45.2	8	-760	1.15
34	e 015 15	Keaton [15]	20	0.46	3.732	RS	3	45.2	8	-710	1.15
35	e 015 16	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-615	1.15
36	e 015 17	Keaton [15]	75	0.46	3.732	RS	3	45.2	8	-450	1.15
37	e 015 18	Keaton [15]	75	0.46	3.732	RS	3	45.2	8	-435	1.15
38	e 015 19	Keaton [15]	20	0.46	3.732	RS	3	45.2	3	-1205	1.15
39	e 015 20	Keaton [15]	20	0.46	3.732	RS	3	45.2	24	-980	1.15
40	e 015 21	Keaton [15]	50	0.46	3.732	RS	3	45.2	3	-1120	1.15
41	e 015 22	Keaton [15]	50	0.46	3.732	RS	3	45.2	24	-935	1.15
43	e 015 24	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-960	1.15
44	e 015 25	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-795	1.15
45	e 015 26	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-545	1.15
46	e 015 27	Keaton [15]	50	0.46	3.732	RS	3	45.2	8	-490	1.15
55	e 017 09	Merrillan [17]	50	0.49	4.814	R	1	33.9	1	-491	1.00
56	e 017 10	Merrillan [17]	50	0.49	4.814	R	1	33.9	1	-467	1.00
97	e 022 01	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-565	1.00
98	e 022 02	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-539	1.00
99	e 022 03	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-528	1.00
100	e 022 04	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-576	1.00
101	e 022 05	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-525	1.00
102	e 022 06	Wallo [22]	50	0.5	4.4	R	1	46.2	28	-484	1.00
116	e 030 02	Hummel [30]	65	0.55	5.35	R	1	26.3	7	-490	1.00
117	e 030 03	R + H [30]	65	0.49	5.34	R	1	47.8	7	-480	1.00
118	e 030 04	R + H [30]	65	0.6	6.1	RS	3	36.5	1	-520	1.15
119	e 030 05	R + H [30]	65	0.46	5.41	RS	3	50.4	1	-480	1.15
121	e 030 07	R + H [30]	65	0.49	4.39	RS	3	43.8	7	-630	1.15
130	e 037 03	[37] York	96	0.428	4.624	SL	2	44.2	90	-1.1	0.70
136	e 051 05	[51] McDonald	96	0.425	4.645	SL	2	51.2	90	-4	0.70
137	e 051 06	[51] McDonald	96	0.425	4.645	SL	2	51.2	90	-27.3	0.70
138	e 051 07	[51] McDonald	96	0.425	4.645	SL	2	51.2	90	-76.3	0.70
140	e 051 09	[51] McDonald	96	0.434	3.671	SL	2	46.1	90	-2	0.70
141	e 051 10	[51] McDonald	96	0.434	3.671	SL	2	46.1	90	-11.5	0.70
142	e 051 11	[51] McDonald	96	0.434	3.671	SL	2	46.1	90	-152	0.70
172	e 059 01	Lambotte [59]	60	0.55	6.51	R	1	30.6	1	-375	1.00
173	e 059 02	Lambotte [59]	60	0.5	6.3	R	1	29.2	1	-551	1.00
174	e 059 03	Lambotte [59]	60	0.445	5.27	R	1	41.9	1	-539	1.00
175	e 059 04	Lambotte [59]	60	0.47	5.23	R	1	39	1	-461	1.00
176	e 061 01	Wiecher [61]	65	0.48	5.862	R	1	50.3	4.54	-432	1.00
177	e 061 02	Wiecher [61]	65	0.48	5.862	R	1	50.3	6	-455	1.00

RILEM File and Author Record			Environment Condition	Concrete Properties					Time Data	Ultimate Experimental Shrinkage Strain	GL 2000 Interim Values
Serial no.	File	Author	Humidity (%)	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t_c (Days)	$\epsilon_{cs}(t, t_c)$ [x10-6]	K
178	e 061 03	Wischer [61]	65	0.48	5.862	R	1	50.3	28	-440	1.00
179	e 061 04	Wischer [61]	65	0.48	4.239	R	1	46.4	4.92	-575	1.00
180	e 061 05	Wischer [61]	65	0.48	4.239	R	1	46.4	10	-545	1.00
181	e 061 06	Wischer [61]	65	0.48	4.239	R	1	46.4	28	-575	1.00
182	e 061 07	Wischer [61]	65	0.48	5.862	RS	3	56.3	0.83	-424	1.15
183	e 061 08	Wischer [61]	65	0.48	5.862	RS	3	56.3	2.92	-508	1.15
184	e 061 09	Wischer [61]	65	0.48	5.862	RS	3	56.3	28	-479	1.15
185	e 061 10	Wischer [61]	65	0.48	4.239	RS	3	50.8	1.42	-601	1.15
186	e 061 11	Wischer [61]	65	0.48	4.239	RS	3	50.8	2.92	-677	1.15
187	e 061 12	Wischer [61]	65	0.48	4.239	RS	3	50.8	28	-593	1.15
188	e 061 13	Wischer [61]	65	0.4	4.533	RS	3	60.3	0.42	-441	1.15
189	e 061 14	Wischer [61]	65	0.4	4.533	RS	3	60.3	1.5	-414	1.15
190	e 061 15	Wischer [61]	65	0.4	4.533	RS	3	60.3	28	-344	1.15
191	e 063 01	Wesche [63] A	65	0.55	5.387	R	1	33.2	3	-442	1.00
192	e 063 02	Wesche [63] A	65	0.55	5.387	R	1	33.2	7	-452	1.00
193	e 063 03	Wesche [63] C	65	0.55	5.395	RS	3	46.5	1	-638	1.15
194	e 063 04	Wesche [63] C	65	0.55	5.395	RS	3	46.5	3	-629	1.15
195	e 063 05	Wesche [63] C	65	0.55	5.395	RS	3	46.5	7	-620	1.15
196	e 063 06	Wesche [63] H	65	0.55	5.386	SL	2	33.9	3	-547	0.70
197	e 063 07	Wesche [63] H	65	0.55	5.386	SL	2	33.9	7	-474	0.70
198	e 063 08	Wesche [63] I	65	0.55	5.386	SL	2	33.1	7	-492	0.70
199	e 063 09	Wesche [63] J	65	0.55	5.386	SL	2	30.5	7	-530	0.70
200	e 067 01	Aschl [67]	65	0.52	5.066	SL	2	55.1	k.A.	-378	0.70
203	e 069 02	Stöckl [69]	65	0.599	8.32	SL	2	19	7	-366	0.70
204	e 069 03	Stöckl [69]	65	0.45	5.405	SL	2	23.9	7	-469	0.70
206	e 071 01	Weigler [71]	65	0.5	k.A.	SL	2	41.3	3	-526	0.70
207	e 071 02	Weigler [71]	65	0.5	k.A.	R	1	40.7	3	-496	1.00
208	e 071 03	Weigler [71]	65	0.5	k.A.	SL	2	37.5	3	-263	0.70
209	e 071 04	Weigler [71]	65	0.5	k.A.	R	1	44.7	3	-480	1.00
210	e 071 05	Weigler [71]	65	0.5	k.A.	RS	3	59.4	3	-526	1.15
211	e 071 06	Weigler [71]	65	0.6	k.A.	SL	2	34.2	3	-536	0.70
212	e 071 07	Weigler [71]	65	0.6	k.A.	R	1	38.4	3	-498	1.00
258	e 078 01	Russel [78]	50	0.432	4.04	R	1	52.4	7	-733	1.00
260	e 079 01	Shnitharan [79]	60	0.47	5.09	R	1	50.1	8	-740	1.00
261	e 079 02	Shnitharan [79]	60	0.47	5.09	R	1	50.1	8	-719	1.00
262	e 079 03	Shnitharan [79]	60	0.47	5.09	R	1	50.1	8	-686	1.00
263	e 079 04	Shnitharan [79]	60	0.47	5.09	R	1	50.1	8	-596	1.00
264	e 079 05	Shnitharan [79]	60	0.47	5.09	R	1	50.1	8	-585	1.00
265	e 079 06	Shnitharan [79]	96	0.47	5.09	R	1	50.1	8	-5	1.00
272	e 081 07	Pentala [81]	60	0.52	5.246	R	1	59.1	7	-388	1.00
273	e 081 08	Pentala [81]	45	0.52	5.246	R	1	59.1	7	-485	1.00
286	e 083 05	De Larrard [83]	50	0.416	3.77	R	1	73.8	1	-473	1.00
287	e 083 06	De Larrard [83]	96	0.416	3.77	R	1	73.8	1	-127	1.00
290	e 083 09	De Larrard [83]	50	0.411	3.769	R	1	64	1	-534	1.00
291	e 083 10	De Larrard [83]	96	0.411	3.769	R	1	64	1	-123	1.00
292	e 084 01	Wittmann [84]	65	0.48	5.428	R	1	33.2	7	-720	1.00
293	e 084 02	Wittmann [84]	65	0.48	5.428	R	1	33.2	7	-663	1.00
294	e 084 03	Wittmann [84]	65	0.48	5.428	R	1	33.2	7	-535	1.00
311	e 088 01	Hammer [88]	50	0.533	5.306	R	1	54.3	1	-623	1.00
314	e 088 04	Hammer [88]	96	0.533	5.306	R	1	54.3	1	-85	1.00
318	e 089 02	Hooton [89]	50	0.405	5.346	R	1	70.7	28	-391	1.00
319	e 089 03	Hooton [89]	50	0.428	5.616	R	1	75.2	28	-430	1.00
320	e 089 04	Hooton [89]	50	0.455	5.96	R	1	74.2	28	-445	1.00
362	e 091 39	S al 23A	96	0.48	3.723	R	1	48.7	1	-130	1.00
363	e 091 40	S al 23C(B)?	65	0.48	3.723	R	1	48.7	1	-445	1.00
387	e 096 01	Eickachen [96] A	60	0.45	5.309	R	1	72.1	3	-461	1.00
388	e 096 02	Eickachen [96] B	60	0.45	5.309	R	1	67.1	3	-559.4	1.00
389	e 096 03	Eickachen [96] C	60	0.4	5.44	R	1	77.9	3	-569	1.00
390	e 096 04	Eickachen [96] D	60	0.5	5.177	R	1	63.3	3	-646	1.00
391	e 096 05	Eickachen [96] E	60	0.45	6.527	R	1	73.7	3	-543	1.00
392	e 096 06	Eickachen [96] F	60	0.45	5.051	R	1	60.4	3	-692	1.00
393	e 096 07	Eickachen [96] G	60	0.45	5.84	R	1	71.7	3	-451.5	1.00
394	e 096 08	Eickachen [96] H	60	0.45	5.374	R	1	68.6	3	-501	1.00
395	e 096 09	Eickachen [96] I	60	0.473	5.374	R	1	64.6	3	-638	1.00
405	e 096 19	Eickachen [96] A	96	0.45	5.309	R	1	72.1	1	-51	1.00

RILEM File and Author Record			Environment t Condition	Concrete Properties					Time Data	Ultimate Experimental Shrinkage Strain	GL 2000 Interim Values
Serial no.	File	Author	Humidity (%)	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t _c (Days)	E _{ca} (t,t _c) [x10 ⁻⁶]	K
406	e 006 20	Eickachen [96] B	96	0.45	5.309	R	1	67.1	1	-73.4	1.00
407	e 006 21	Eickachen [96] C	96	0.4	5.44	R	1	77.9	1	-69	1.00
408	e 006 22	Eickachen [96] D	96	0.5	5.177	R	1	63.3	1	-24	1.00
409	e 006 23	Eickachen [96] E	96	0.45	6.527	R	1	73.7	1	-120	1.00
410	e 006 24	Eickachen [96] F	96	0.45	5.051	R	1	60.4	1	-30	1.00
411	e 006 25	Eickachen [96] G	96	0.45	5.84	R	1	71.7	1	-91	1.00
412	e 006 26	Eickachen [96] H	96	0.45	5.374	R	1	68.6	1	-30	1.00
413	e 006 27	Eickachen [96] I	96	0.473	5.374	R	1	64.6	1	-26	1.00
421	e 099 01	Hilsdorf [99]	65	0.55	5.401	RS	3	40.3	1	-498	1.15
422	e 099 02	Hilsdorf [99]	65	0.55	5.401	RS	3	40.3	3	-583	1.15
423	e 099 03	Hilsdorf [99]	65	0.55	5.401	RS	3	40.3	7	-545	1.15
424	e 099 04	Hilsdorf [99]	65	0.55	5.401	RS	3	40.3	28	-540	1.15
425	e 099 05	Hilsdorf [99]	65	0.55	5.401	RS	3	40.3	90	-478	1.15
426	e 099 06	Hilsdorf [99]	65	0.55	5.401	RS	3	40.3	1	-605	1.15

APPENDIX H					
Shrinkage Experimental Data Sets With $\omega_i^2 > 10$					
ACI 209 Model					
RILEM File No. and Author Record			Environment Condition		
Serial no.	File	Autor	Humidity [%]	t - t _c [Days]	W ²
24	e_015_05	Keeton [15]	99	7	89.01
31	e_015_12	Keeton [15]	99	1	11.27
281	e_082_08	[82] Budelmann	95	0	21.03
357	e_091_34	P aif_12A	98	0	32.82
362	e_091_39	S aif_23A	98	0	36.91
406	e_096_20	Eickschen [96] B	98	0	14.96
407	e_096_21	Eickschen [96] C	98	0	18.02
409	e_096_23	Eickschen [96] E	98	0	13.00
CEB 90 Model					
RILEM File No. and Author Record			Environment Condition		
Serial no.	File	Autor	Humidity [%]	t - t _c [Days]	W ²
285	e_083_04	De Larrard [83]	98	2.4	517.01
287	e_083_06	De Larrard [83]	98	1.6	203.75
289	e_083_08	De Larrard [83]	98	2.1	266.52
291	e_083_10	De Larrard [83]	98	1.8	118.45
314	e_088_04	Hammer [88]	98	7	244.71
315	e_088_05	Hammer [88]	98	7	555.71
324	e_091_01	[91] aif_1A	98	1	42.66
327	e_091_04	A aif_19AT	98	3	30.33
328	e_091_05	B aif_3A	98	3	31.50
331	e_091_08	C aif_4A	98	3	93.73
338	e_091_15	D aif_20A	98	3	21.68
342	e_091_19	G aif_6A	98	6	21.03
345	e_091_22	H aif_8A	98	1	388.39
346	e_091_23	I aif_27A	98	1	143.41
347	e_091_24	J aif_26A	98	1	686.62
349	e_091_26	K aif_14A	98	13	23.56
351	e_091_28	M aif_16A	98	1	155.07
359	e_091_36	Q aif_13A	98	8	286.70

CEB 90 Model					
RILEM File No. and Author Record			Environment Condition		
Serial no.	File	Autor	Humidity [%]	t - tc [Days]	W²
360	e_091_37	R aif_9A	98	2	253.42
361	e_091_38	O aif_30A	98	2	125.32
362	e_091_39	S aif_23A	98	1	74.47
368	e_094_03	Ravindrarah [94] C	65	3	16.04
405	e_096_19	Eickschen [96] A	98	2	17.11
406	e_096_20	Eickschen [96] B	98	2	64.72
407	e_096_21	Eickschen [96] C	98	2	111.66
408	e_096_22	Eickschen [96] D	98	2	19.16
409	e_096_23	Eickschen [96] E	98	2	77.48
410	e_096_24	Eickschen [96] F	98	2	15.61
411	e_096_25	Eickschen [96] G	98	2	96.99
412	e_096_26	Eickschen [96] H	98	2	10.69
413	e_096_27	Eickschen [96] I	98	6	11.10
414	e_098_01	[98] Dilger	98	2.1	123.51
417	e_098_04	[98] Dilger	98	1	245.00
419	e_098_06	[98] Dilger	98	1.1	180.63
B3 Model					
RILEM File No. and Author Record			Environment Condition		
Serial no.	File	Autor	Humidity [%]	t - tc [Days]	W²
291	e_083_10	De Larrard [83]	98	1.8	28.98
314	e_088_04	Hammer [88]	98	7	48.90
323	e_090_02	Oh [90]	98	0.7	70.74
362	e_091_39	S aif_23A	98	1	10.86
406	e_096_20	Eickschen [96] B	98	2	11.32
GL 2000 Model					
N.A.					

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APPENDIX I							
Shrinkage Experimental Data Points With Interim $F_i\%$ > 50%							
ACI 209 Model							
Original File No. and Author Record			Environment Condition	Time Data			CEB Statistical Method
	File	Autor	Humidity [%]	t [Days]	tc [Days]	t - tc [Days]	Interim $F_i\%$
112	e_026_01	[26] Hannat	98	360	180	180	380.84
112	e_026_01	[26] Hannat	98	830	180	650	68.90
112	e_026_01	[26] Hannat	98	545	180	365	63.11
112	e_026_01	[26] Hannat	98	460	180	280	59.48
187	e_061_12	Wischer [61]	65	29	28	1	51.60
190	e_061_15	Wischer [61]	65	29	28	1	236.12
309	e_086_05	De Larrard [86]	50	29	28	1	76.27
340	e_091_17	F aif_7C	65	46	32	14	2730.56
340	e_091_17	F aif_7C	65	74	32	42	179.54
340	e_091_17	F aif_7C	65	92	32	60	102.00
340	e_091_17	F aif_7C	65	43	32	11	101.19
340	e_091_17	F aif_7C	65	109	32	77	76.85
340	e_091_17	F aif_7C	65	67	32	35	75.72
340	e_091_17	F aif_7C	65	152	32	120	72.66
CEB 90 Model							
Original File No. and Author Record			Environment Condition	Time Data			CEB Statistical Method
	File	Autor	Humidity [%]	t [Days]	tc [Days]	t - tc [Days]	Interim $F_i\%$
9	e_011_01	Hummel [11]	65	11	7	4	78.46
12	e_011_04	Hummel [11]	65	14	7	7	169.48
204	e_069_03	Stöckl [69]	65	9	7	2	120.18
212	e_071_07	Weigler [71]	65	4	3	1	102.75

B3 Model							
Original File No. and Author Record			Environment Condition	Time Data			CEB Statistical Method
	File	Autor	Humidity [%]	t [Days]	tc [Days]	t - tc [Days]	Interim F, %
9	e_011_01	Hummel [11]	65	11	7	4	74.34
12	e_011_04	Hummel [11]	65	14	7	7	223.95
130	e_037_03	[37] York	98	202	- 90	112	66597.87
130	e_037_03	[37] York	98	258	90	168	3231.84
130	e_037_03	[37] York	98	174	90	84	1472.46
130	e_037_03	[37] York	98	230	90	140	1123.09
130	e_037_03	[37] York	98	146	90	56	1088.58
136	e_051_05	[51] McDonald	98	396	90	306	952.25
136	e_051_05	[51] McDonald	98	363	90	273	159.16
136	e_051_05	[51] McDonald	98	111	90	21	86.26
137	e_051_06	[51] McDonald	98	500	90	410	441.16
137	e_051_06	[51] McDonald	98	486	90	396	52.16
138	e_051_07	[51] McDonald	50	92	90	2	11297.64
138	e_051_07	[51] McDonald	50	96	90	6	205.32
138	e_051_07	[51] McDonald	50	98	90	8	60.93
140	e_051_09	[51] McDonald	98	117	90	27	64.49
142	e_051_11	[51] McDonald	50	91	90	1	146.57
142	e_051_11	[51] McDonald	50	92	90	2	95.75
187	e_061_12	Wischer [61]	65	29	28	1	497.84
190	e_061_15	Wischer [61]	65	29	28	1	1264.63
202	e_069_01	Stöckl [69]	65	8	7	1	52.27
204	e_069_03	Stöckl [69]	65	9	7	2	72.97
253	e_076_10	[76] Schwesinger	65	369.2	365	4.2	95.28
253	e_076_10	[76] Schwesinger	65	379.3	365	14.3	75.95
253	e_076_10	[76] Schwesinger	65	368.1	365	3.1	68.35
340	e_091_17	F aif_7C	65	46	32	14	4502.06
340	e_091_17	F aif_7C	65	43	32	11	201.96
340	e_091_17	F aif_7C	65	74	32	42	186.77
340	e_091_17	F aif_7C	65	92	32	60	97.17
340	e_091_17	F aif_7C	65	67	32	35	83.60
340	e_091_17	F aif_7C	65	109	32	77	69.69
340	e_091_17	F aif_7C	65	152	32	120	61.50

GL 2000 Model							
Original File No. and Author Record			Environment Condition	Time Data			CEB Statistical Method
	File	Autor	Humidity [%]	t [Days]	tc [Days]	t - tc [Days]	Interim F, %
9	e_011_01	Hummel [11]	65	11	7	4	120.77
138	e_051_07	[51] McDonald	50	92	90	2	8779.32
138	e_051_07	[51] McDonald	50	96	90	6	157.40
142	e_051_11	[51] McDonald	50	91	90	1	82.89
142	e_051_11	[51] McDonald	50	92	90	2	53.53
187	e_061_12	Wischer [61]	65	29	28	1	527.12
190	e_061_15	Wischer [61]	65	29	28	1	1847.43
197	e_063_07	Wesche [63] H	65	8	7	1	62.97
204	e_069_03	Stöckl [69]	65	9	7	2	195.97
212	e_071_07	Weigler [71]	65	4	3	1	224.26

APPENDIX J														
Creep Experimental Data Sets from the RILEM Data Bank														
Utilized for the ACI 209 Model Analysis														
File no. and Author			Environmental Conditions		Concrete Properties				Time Ranges		Ultimate Experimental Creep Compliance	ACI 209 Interim Values		
Serial no.	File	Author	Humidity [%]	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} [N/mm ²]	t ₀ [days]	t - t ₀ [days]	J(t,t ₀) [x10 ⁻⁶ / MPa]	b	c	
6	c 001 06	Dutro (1)	47.5	0.56	6.46	R	1	28.4	60	900	142	4	0.85	
13	c 005 01	Troval (5)	100	0.59	5.67	R	1	16.5	28	6979	118	4	0.85	
14	c 005 02	Troval (5)	98	0.59	5.67	R	1	16.5	28	6700	125	1	0.95	
15	c 005 03	Troval (5)	70	0.59	5.67	R	1	16.5	28	6924	194	4	0.85	
16	c 005 04	Troval (5)	50	0.59	5.67	R	1	16.5	28	8497	240	4	0.85	
23	c 006 07	Weil (6) C	65	0.52	5.03	R	1	46.9	28	767	89	4	0.85	
24	c 006 08	Weil (6) C	65	0.52	5.03	R	1	46.9	28	767	99	4	0.85	
27	c 006 11	Weil (6) C	65	0.52	5.03	R	1	46.9	28	767	104.7	4	0.85	
28	c 006 12	Weil (6) C	65	0.52	5.03	R	1	46.9	28	767	109.5	4	0.85	
33	c 011 05	Hummel (11)	65	0.55	5.40	R	1	41.9	28	1278	116.9	4	0.85	
34	c 011 08	Hummel (11)	65	0.55	5.40	R	1	41.9	90	1111	110.3	4	0.85	
56	c 015 01	Keeton (15)	99	0.46	3.73	RS	3	45.2	8	897	107	0.7	0.96	
57	c 015 02	Keeton (15)	75	0.46	3.73	RS	3	45.2	8	897	120	2.3	0.92	
58	c 015 03	Keeton (15)	50	0.46	3.73	RS	3	45.2	8	897	141	2.3	0.92	
60	c 015 05	Keeton (15)	99	0.46	3.73	RS	3	45.2	8	897	118	0.7	0.96	
61	c 015 06	Keeton (15)	75	0.46	3.73	RS	3	45.2	8	897	121	2.3	0.92	
62	c 015 07	Keeton (15)	50	0.46	3.73	RS	3	45.2	8	897	138	2.3	0.92	
64	c 017 01	L'Hermite,	50	0.49	4.81	R	1	33.9	7	2050	160	4	0.85	
65	c 017 02	Mermillan	50	0.49	4.81	R	1	33.9	21	475	104	4	0.85	
66	c 017 03	[17]	50	0.49	4.81	R	1	33.9	90	2050	117	4	0.85	
67	c 017 04	[17]	50	0.49	4.81	R	1	33.9	365	1765	71	4	0.85	
68	c 017 05	[17]	50	0.49	4.81	R	1	33.9	7	2050	183	4	0.85	
69	c 017 06	[17]	50	0.49	4.81	R	1	33.9	21	1980	123	4	0.85	
70	c 017 07	[17]	50	0.49	4.81	R	1	33.9	28	576	129	4	0.85	
71	c 017 08	[17]	50	0.49	4.81	R	1	33.9	90	2050	111	4	0.85	
72	c 017 09	[17]	50	0.49	4.81	R	1	33.9	365	1765	77	4	0.85	
73	c 017 10	[17]	50	0.49	4.81	R	1	33.9	720	1420	70	4	0.85	
74	c 017 11	[17]	100	0.49	4.81	R	1	33.9	7	2070	82	4	0.85	
75	c 017 12	[17]	100	0.49	4.81	R	1	33.9	21	475	54	4	0.85	
76	c 017 13	[17]	100	0.49	4.81	R	1	33.9	28	576	50	4	0.85	
77	c 017 14	[17]	100	0.49	4.81	R	1	33.9	365	1780	51	4	0.85	
78	c 017 15	[17]	100	0.49	4.81	R	1	33.9	730	1410	35	4	0.85	
79	c 017 16	[17]	100	0.49	4.81	R	1	33.9	7	2070	77	4	0.85	
80	c 017 17	[17]	100	0.49	4.81	R	1	33.9	14	415	58	4	0.85	
81	c 017 18	[17]	100	0.49	4.81	R	1	33.9	21	1980	62	4	0.85	
82	c 017 19	[17]	100	0.49	4.81	R	1	33.9	28	1740	52	4	0.85	
83	c 017 20	[17]	100	0.49	4.81	R	1	33.9	365	1780	46	4	0.85	
84	c 017 21	[17]	100	0.49	4.81	R	1	33.9	730	1410	36	4	0.85	
85	c 017 22	[17]	100	0.49	4.81	R	1	33.9	7	2070	72	4	0.85	
86	c 017 23	[17]	100	0.49	4.81	R	1	33.9	28	576	53	4	0.85	
87	c 017 24	[17]	100	0.49	4.81	R	1	33.9	365	1780	47	4	0.85	
88	c 017 25	[17]	100	0.49	4.81	R	1	33.9	730	1410	36	4	0.85	
90	c 017 27	[17]	50	0.49	4.81	R	1	33.9	28	479	111	4	0.85	
91	c 017 28	[17]	75	0.49	4.81	R	1	33.9	28	479	86	4	0.85	
92	c 017 29	[17]	99	0.49	4.81	R	1	33.9	28	479	51	1	0.95	
93	c 017 30	[17]	100	0.49	4.81	R	1	33.9	28	479	49	4	0.85	
94	c 020 01	Hanson	50	0.71	6.00	RS	3	41.3	8	1244	109.3	2.3	0.92	
95	c 020 02	Matlock (20)	50	0.71	6.00	RS	3	41.3	8	1515	136.3	2.3	0.92	
96	c 020 03	Matlock (20)	50	0.71	6.00	RS	3	41.3	8	1515	136.9	2.3	0.92	
97	c 020 04	Matlock (20)	50	0.71	6.00	RS	3	41.3	8	1508	109.4	2.3	0.92	
98	c 020 05	Matlock (20)	50	0.71	6.00	RS	3	41.3	8	1525	104.2	2.3	0.92	
99	c 020 06	Matlock (20)	50	0.71	6.00	RS	3	41.3	8	1735	108.3	2.3	0.92	
100	c 020 07	Matlock (20)	50	0.71	6.00	RS	3	41.3	8	1743	108	2.3	0.92	
101	c 020 08	Matlock (20)	50	0.71	6.00	RS	3	41.3	8	1486	110.9	2.3	0.92	
102	c 020 09	Matlock (20)	50	0.71	6.00	RS	3	41.3	8	1436	117.9	2.3	0.92	
103	c 020 10	Matlock (20)	50	0.71	6.00	RS	3	41.3	8	1366	123.9	2.3	0.92	
104	c 023 01	[23] Arthanari	98	0.58	3.75	R	1	35.1	15	60	59.2	4	0.85	
105	c 023 02	[23] Arthanari	98	0.58	3.75	R	1	35.1	15	60	70.2	4	0.85	
106	c 023 03	[23] Arthanari	98	0.58	3.75	R	1	35.1	15	60	67.6	4	0.85	
107	c 023 04	[23] Arthanari	98	0.58	3.75	R	1	35.1	15	60	97.6	4	0.85	

File no. and Author			Environmental Conditions	Concrete Properties				Time Ranges		Ultimate Experimental Creep Compliance	ACI 209 Interim Values		
Serial no.	File	Author	Humidity [%]	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} [N/mm ²]	t ₀ [days]	t - t ₀ [days]	J(t,t ₀) [x10 ⁻⁶ / MPa]	b	c
108	c 023 05	[23] Arthanari	98	0.56	3.75	R	1	35.1	15	60	108.4	4	0.85
109	c 025 01	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	178.8	4	0.85
110	c 025 02	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	150.6	4	0.85
111	c 025 03	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	155.8	4	0.85
112	c 025 04	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	164.8	4	0.85
113	c 025 05	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	181	4	0.85
114	c 025 06	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	117.1	4	0.85
115	c 025 07	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	132.9	4	0.85
116	c 025 08	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	124.9	4	0.85
117	c 025 09	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	135.7	4	0.85
118	c 025 10	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	121.3	4	0.85
119	c 025 11	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	93.4	4	0.85
120	c 025 12	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	91.4	4	0.85
121	c 025 13	[25] Browne	98	0.42	4.40	R	1	42.6	400	1000	86.6	4	0.85
122	c 025 14	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	105.5	4	0.85
123	c 025 15	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	71.5	4	0.85
124	c 025 16	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	78.6	4	0.85
125	c 025 17	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	78.8	4	0.85
126	c 025 18	[25] Browne	98	0.42	4.40	R	1	42.6	400	1000	55.5	4	0.85
127	c 026 01	[26] Hannat	98	0.47	4.50	R	1	58.6	180	743	45.8	4	0.85
128	c 026 02	[26] Hannat	98	0.47	4.50	R	1	58.6	180	743	94.3	4	0.85
129	c 026 03	[26] Hannat	98	0.47	4.50	R	1	58.6	180	743	125.8	4	0.85
130	c 026 04	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	46.7	4	0.85
131	c 026 05	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	88.3	4	0.85
132	c 026 06	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	132.6	4	0.85
133	c 026 07	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	46	4	0.85
134	c 026 08	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	80.6	4	0.85
135	c 026 09	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	93.7	4	0.85
136	c 026 10	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	123.7	4	0.85
142	c 030 01	[30] Rüsch	65	0.49	5.34	RS	3	48.6	29	403	83.6	2.3	0.92
143	c 030 02	[30] Rüsch	65	0.45	5.41	RS	3	48.4	466	511	45.7	2.3	0.92
161	c 043 01	[43] Rostasy	65	0.56	7.10	R	1	41.4	28	1315	79.8	4	0.85
162	c 043 02	[43] Rostasy	65	0.41	5.59	R	1	40.9	28	1315	72.2	4	0.85
163	c 043 03	[43] Rostasy	99	0.41	5.59	R	1	40.9	28	1315	60.9	1	0.96
164	c 044 01	[44] Seki	50	0.40	5.60	R	1	27.9	28	70	94.7	4	0.85
165	c 044 02	[44] Seki	98	0.40	5.60	R	1	27.9	28	70	52.5	4	0.85
166	c 044 03	[44] Seki	50	0.40	5.60	R	1	27.9	96	570	111.5	4	0.85
167	c 044 04	[44] Seki	98	0.40	5.60	R	1	27.9	96	570	56.3	4	0.85
169	c 044 06	[44] Seki	98	0.40	5.60	R	1	27.9	28	70	70.5	4	0.85
171	c 044 08	[44] Seki	98	0.40	5.60	R	1	27.9	100	570	68.2	4	0.85
173	c 044 10	[44] Seki	98	0.40	5.60	R	1	27.9	29	70	94.5	4	0.85
175	c 044 12	[44] Seki	98	0.40	5.60	R	1	27.9	105	300	105.8	4	0.85
176	c 046 01	[46] Kawasumi	98	0.40	5.60	R	1	44.5	28	69.6	51.6	4	0.85
177	c 046 02	[46] Kawasumi	50	0.40	5.60	R	1	44.5	28	71.1	93.5	4	0.85
178	c 046 03	[46] Kawasumi	98	0.40	5.60	R	1	44.5	96	568.2	56.6	4	0.85
179	c 046 04	[46] Kawasumi	50	0.40	5.60	R	1	44.5	96	568.2	110.7	4	0.85
180	c 046 05	[46] Kawasumi	98	0.40	5.60	R	1	44.5	29	68.1	68.4	4	0.85
182	c 046 07	[46] Kawasumi	98	0.40	5.60	R	1	44.5	100	585.9	66.7	4	0.85
184	c 046 09	[46] Kawasumi	98	0.40	5.60	R	1	44.5	29	68.4	93.2	4	0.85
186	c 046 11	[46] Kawasumi	98	0.40	5.60	R	1	44.5	105	287.8	104.7	4	0.85
233	c 055 01	[55] Okajima	50	0.53	5.49	R	1	42	30	111.7	188	4	0.85
234	c 055 02	[55] Okajima	98	0.53	5.49	R	1	42	28	91.6	61.1	4	0.85
235	c 055 03	[55] Okajima	50	0.53	5.49	R	1	42	90	67.5	100.6	4	0.85
236	c 055 04	[55] Okajima	98	0.53	5.49	R	1	42	28	90	83.7	4	0.85
241	c 058 01	[58] Lambotte	60	0.50	6.30	R	1	29.2	28	720	124	4	0.85
242	c 058 02	[58] Lambotte	60	0.44	5.27	R	1	41.9	15	1800	120	4	0.85
243	c 058 03	[58] Lambotte	60	0.44	5.27	R	1	37.8	7	1800	128	4	0.85
244	c 058 04	[58] Lambotte	60	0.47	5.23	R	1	38	17	1440	141	4	0.85
246	c 058 06	[58] Lambotte	60	0.52	5.57	R	1	30.8	60	720	103	4	0.85
247	c 058 07	[58] Lambotte	60	0.50	6.30	R	1	29.2	28	360	119.7	4	0.85
248	c 058 08	[58] Lambotte	60	0.50	5.31	R	1	33.6	28	360	84	4	0.85
249	c 058 09	[58] Lambotte	60	0.47	5.23	R	1	38.4	7	1800	175.8	4	0.85
250	c 058 10	[58] Lambotte	60	0.35	4.68	R	1	45.3	28	360	81.8	4	0.85
251	c 058 11	[58] Lambotte	60	0.58	4.84	R	1	48.2	7	720	127.3	4	0.85
252	c 058 12	[58] Lambotte	60	0.40	4.53	R	1	38.9	28	360	103.2	4	0.85

File no. and Author			Environmental Conditions	Concrete Properties				Time Ranges		Ultimate Experimental Creep Compliance	ACI 209 Interim Values		
Serial no.	File	Author	Humidity [%]	w/c	a/c	European Cement Type	Equivalent American Type	f_{max} [N/mm ²]	t ₀ [days]	t - t ₀ [days]	J(t,t ₀) [x10 ⁻⁶ / MPa]	b	c
253	c 058 13	Lambotte [58]	80	0.43	3.91	RS	3	43.2	28	360	78.4	2.3	0.92
256	c 058 16	Lambotte [58]	80	0.52	5.57	R	1	34.1	17	720	110.6	4	0.85
258	c 058 18	Lambotte [58]	80	0.57	5.97	R	1	36.6	28	360	68.1	4	0.85
260	c 061 02	Wischers [81]	65	0.48	5.86	R	1	54	8	2190	94.8	4	0.85
261	c 061 03	Wischers [81]	65	0.48	5.86	R	1	54	28	2190	77.4	4	0.85
263	c 061 05	Wischers [81]	65	0.48	4.24	R	1	46.4	10	2190	123.9	4	0.85
264	c 061 06	Wischers [81]	65	0.48	4.24	R	1	46.4	28	2190	93.6	4	0.85
269	c 061 11	Wischers [81]	65	0.48	4.24	RS	3	54.5	23	2190	112.6	2.3	0.92
270	c 061 12	Wischers [81]	65	0.48	4.24	RS	3	54.5	28	2190	96.4	2.3	0.92
273	c 061 15	Wischers [81]	65	0.40	4.53	RS	3	64.6	28	2190	58.4	2.3	0.92
275	c 063 02	Wesche [63] A	65	0.55	5.39	R	1	33.2	7	549	150.1	4	0.85
276	c 063 03	Wesche [63] A	65	0.55	5.39	R	1	33.2	28	796	136.7	4	0.85
277	c 063 04	Wesche [63] A	65	0.55	5.39	R	1	33.2	2470	761	58.9	4	0.85
278	c 063 05	Wesche [63] A	65	0.55	5.39	R	1	33.2	3065	731	46.6	4	0.85
279	c 063 06	Wesche [63] B	65	0.55	5.41	R	1	33.2	28	761	150.9	4	0.85
280	c 063 07	Wesche [63] B	65	0.55	5.41	R	1	33.2	2430	731	53	4	0.85
281	c 063 08	Wesche [63] B	65	0.55	5.41	R	1	33.2	3300	731	44.9	4	0.85
284	c 063 11	Wesche [63] C	65	0.55	5.40	RS	3	46.5	7	760	113.2	2.3	0.92
285	c 063 12	Wesche [63] C	65	0.55	5.40	RS	3	46.5	28	762	108.9	2.3	0.92
286	c 063 13	Wesche [63] C	65	0.55	5.40	RS	3	46.5	2700	731	45.4	2.3	0.92
287	c 063 14	Wesche [63] C	65	0.55	5.40	RS	3	46.5	3290	731	41	2.3	0.92
288	c 063 15	Wesche [63] D	65	0.52	5.41	R	1	34.9	28	761	200.4	4	0.85
289	c 063 16	Wesche [63] E	65	0.55	5.86	R	1	34.9	28	849	174.5	4	0.85
290	c 063 17	Wesche [63] F	65	0.49	5.41	R	1	39.9	28	817	160.1	4	0.85
291	c 063 18	Wesche [63] G	65	0.50	5.40	R	1	39.1	28	731	52.6	4	0.85
292	c 063 19	Wesche [63] D	65	0.52	5.41	R	1	34.9	2460	791	133.7	4	0.85
293	c 063 20	Wesche [63] E	65	0.55	5.86	R	1	34.9	2450	796	122.3	4	0.85
294	c 063 21	Wesche [63] F	65	0.49	5.41	R	1	39.9	2475	796	122.3	4	0.85
295	c 063 22	Wesche [63] G	65	0.50	5.40	R	1	39.1	2445	789	166.6	4	0.85
306	c 064 01	[64] Ohnuma	98	0.38	3.74	R	1	40.6	63	153.2	57.4	4	0.85
307	c 064 02	[64] Ohnuma	98	0.38	3.74	R	1	40.6	63	153.8	58.7	4	0.85
308	c 064 03	[64] Ohnuma	98	0.38	3.74	R	1	40.6	63	155.4	105.1	4	0.85
335	c 072 01	Brooks [72]	100	0.27	3.30	R	1	70.9	28	350	48.5	4	0.85
336	c 072 02	Brooks [72]	100	0.27	3.30	R	1	65.5	28	350	49.5	4	0.85
337	c 072 03	Brooks [72]	100	0.34	2.60	R	1	69.1	28	337.5	58.5	4	0.85
338	c 072 04	Brooks [72]	100	0.27	2.60	R	1	80.9	28	350	60.7	4	0.85
339	c 072 05	Brooks [72]	100	0.30	2.08	R	1	67.3	28	350	73	4	0.85
340	c 072 06	Brooks [72]	65	0.36	3.30	R	1	70.9	28	350	55.1	4	0.85
341	c 072 07	Brooks [72]	65	0.27	3.30	R	1	85.5	28	350	50.7	4	0.85
342	c 072 08	Brooks [72]	65	0.34	2.60	R	1	69.1	28	350	64.4	4	0.85
344	c 072 10	Brooks [72]	65	0.30	2.08	R	1	67.3	28	350	71.4	4	0.85
345	c 073 01	Stöckl [73]	65	0.55	5.35	R	1	30.3	57	206	152.2	4	0.85
346	c 073 02	Stöckl [73]	65	0.55	5.35	R	1	30.3	57	963	210.5	4	0.85
367	c 076 01	[76] Schwesinger	98	0.68	6.05	R	1	15.5	28	125	111.1	4	0.85
368	c 076 02	[76] Schwesinger	98	0.68	6.05	R	1	15.5	28	166.7	223.5	4	0.85
371	c 076 05	[76] Schwesinger	98	0.68	6.05	R	1	15.5	28	141.7	391.9	4	0.85
372	c 076 06	[76] Schwesinger	65	0.68	6.05	R	1	15.5	365	20.8	63.7	4	0.85
375	c 076 09	[76] Schwesinger	98	0.68	6.05	R	1	15.5	365	125	244.2	4	0.85
376	c 076 10	[76] Schwesinger	98	0.68	6.05	R	1	15.5	365	125	336.4	4	0.85
377	c 076 11	[76] Schwesinger	98	0.68	6.05	R	1	15.5	365	167.5	462.6	4	0.85
379	c 077 01	Espion [77]	60	k.A.	k.A.	R	1	36	14	1254	121.7	4	0.85
380	c 077 02	Espion [77]	60	k.A.	k.A.	R	1	36	14	1630	114.4	4	0.85
381	c 077 03	Espion [77]	60	k.A.	k.A.	R	1	36	14	1659	117.2	4	0.85
382	c 078 01	Russel [78]	98	0.43	4.04	R	1	52.4	28	6321	78.4	4	0.85
383	c 078 02	Russel [78]	50	0.43	4.04	R	1	52.4	28	6321	112	4	0.85
384	c 078 03	Russel [78]	50	0.43	4.04	R	1	52.4	182	6167	91	4	0.85
385	c 078 04	Russel [78]	50	0.43	4.04	R	1	52.4	361	5988	83.4	4	0.85
386	c 078 05	Russel [78]	98	0.38	3.34	R	1	63	28	6768	96.6	4	0.85
387	c 078 06	Russel [78]	50	0.38	3.34	R	1	63	28	6768	101.9	4	0.85
388	c 078 07	Russel [78]	50	0.38	3.34	R	1	63	181	5442	84.1	4	0.85
389	c 078 08	Russel [78]	50	0.38	3.34	R	1	63	730	6088	63.9	4	0.85
390	c 079 01	Shivtharan [79]	60	0.47	5.09	R	1	50.1	8	3492	190.7	4	0.85
391	c 079 02	Shivtharan [79]	60	0.47	5.09	R	1	50.1	14	3498	183	4	0.85
392	c 079 03	Shivtharan [79]	60	0.47	5.09	R	1	50.1	21	1922	175.4	4	0.85
393	c 079 04	Shivtharan [79]	60	0.47	5.09	R	1	50.1	28	3472	166.3	4	0.85

File no. and Author			Environmental Conditions	Concrete Properties				Time Ranges			Ultimate Experimental Creep Compliance	ACI 209 Interim Values	
Serial no.	File	Author	Humidity [%]	w/c	a/c	European Cement Type	Equivalent American Type	f_{max} [N/mm ²]	t_0 [days]	$t - t_0$ [days]	$J(t,t_0)$ [x10-6 / MPa]	b	c
394	c 079 06	Shritharan [79]	80	0.47	5.09	R	1	50.1	84	1850	141	4	0.85
395	c 079 08	Shritharan [79]	80	0.47	5.09	R	1	50.1	182	1781	113.3	4	0.85
396	c 079 07	Shritharan [79]	98	0.47	5.09	R	1	50.1	8	1935	100	4	0.85
397	c 079 08	Shritharan [79]	98	0.47	5.09	R	1	50.1	14	1929	92.3	4	0.85
398	c 079 08	Shritharan [79]	98	0.47	5.09	R	1	50.1	21	1922	97	4	0.85
399	c 079 10	Shritharan [79]	98	0.47	5.09	R	1	50.1	28	1915	82.9	4	0.85
400	c 079 11	Shritharan [79]	98	0.47	5.09	R	1	50.1	84	1850	78.7	4	0.85
401	c 079 12	Shritharan [79]	98	0.47	5.09	R	1	50.1	182	1781	64.6	4	0.85
402	c 079 13	Shritharan [79]	60	0.47	5.09	R	1	50.1	8	3486	191.6	4	0.85
403	c 079 14	Shritharan [79]	60	0.47	5.09	R	1	50.1	8	3486	168.6	4	0.85
404	c 079 15	Shritharan [79]	60	0.47	5.09	R	1	50.1	8	3486	154.3	4	0.85
405	c 079 16	Shritharan [79]	60	0.47	5.09	R	1	50.1	8	3486	140.6	4	0.85
406	c 082 01	[82] Budelmann	65	0.54	k.A.	R	1	44.1	150	39.8	98.1	4	0.85
407	c 082 02	[82] Budelmann	95	0.54	k.A.	R	1	44.1	150	39.8	84.2	4	0.85
408	c 082 03	[82] Budelmann	100	0.54	k.A.	R	1	44.1	150	39.8	92	4	0.85
409	c 082 04	[82] Budelmann	65	0.54	k.A.	R	1	44.1	150	39.6	124.2	4	0.85
410	c 082 05	[82] Budelmann	65	0.58	k.A.	R	1	44.9	150	39.6	133.3	4	0.85
412	c 082 07	[82] Budelmann	95	0.54	k.A.	R	1	44.1	150	39.6	138.6	4	0.85
413	c 082 08	[82] Budelmann	95	0.54	k.A.	R	1	40.7	150	39.6	152.4	4	0.85
414	c 082 09	[82] Budelmann	65	0.54	k.A.	R	1	44.1	150	39.4	157.1	4	0.85
415	c 082 10	[82] Budelmann	65	0.54	k.A.	R	1	44.1	150	40	165	4	0.85
416	c 082 11	[82] Budelmann	95	0.54	k.A.	R	1	44.1	150	39.4	146.2	4	0.85
417	c 082 12	[82] Budelmann	65	0.54	k.A.	R	1	40.7	150	39.4	146.2	4	0.85
418	c 082 13	[82] Budelmann	65	0.54	k.A.	R	1	44.1	150	39.4	221.2	4	0.85
419	c 082 14	[82] Budelmann	65	0.54	k.A.	R	1	44.1	150	39.4	233.3	4	0.85
420	c 082 15	[82] Budelmann	100	0.54	k.A.	R	1	44.1	150	39.4	129.6	4	0.85
421	c 085 01	Burg [85]	50	0.28	3.04	R	1	78.5	28	427	90.2	4	0.85
422	c 085 02	Burg [85]	50	0.32	3.58	RS	3	91.9	28	427	68	2.3	0.92
423	c 085 03	Burg [85]	50	0.28	2.95	RS	3	118.9	28	427	46.4	2.3	0.92
424	c 085 04	Burg [85]	50	0.32	3.50	RS	3	107	28	427	51	2.3	0.92
443	c 091 01	S af 1A	98	0.30	4.22	R	1	70.9	30	236	38.5	4	0.85
444	c 091 02	A af 1B	65	0.30	4.22	R	1	70.9	30	236	57.9	4	0.85
445	c 091 03	A af 19AT	98	0.30	4.22	R	1	65.1	30	222	39.4	4	0.85
446	c 091 04	B	98	0.30	3.63	R	1	75.6	30	236	42.7	4	0.85
447	c 091 05	Summer [91]	65	0.30	3.63	R	1	75.6	30	236	64.4	4	0.85
448	c 091 06	C	98	0.27	4.38	R	1	82.9	29	226	31	4	0.85
449	c 091 07	Summer [91]	65	0.27	4.38	R	1	82.9	29	226	36.5	4	0.85
451	c 091 09	Summer [91]	65	0.24	4.56	R	1	97	29	235	34.5	4	0.85
455	c 091 13	Summer [91]	65	0.38	3.99	R	1	57.7	32	231	84.8	4	0.85
466	c 091 24	Summer [91]	65	0.24	4.18	R	1	104.7	29	244	31	4	0.85
467	c 091 25	O	65	0.27	4.02	R	1	89.1	29	139	33.4	4	0.85
473	c 091 31	D af 218	65	0.24	4.56	R	1	97	7	244	31.9	4	0.85
477	c 091 35	A	65	0.30	4.22	R	1	70.9	28	226	53	4	0.85
478	c 091 36	D	65	0.24	4.56	R	1	97	28	226	31.2	4	0.85
481	c 091 38	S af 23C (7)	65	0.48	3.72	R	1	48.7	28	145	87.4	4	0.85
483	c 092 02	Yue [92]	60	0.32	4.88	RS	3	80.5	28	1472	52.3	2.3	0.92
484	c 092 03	Yue [92]	60	0.66	6.38	R	1	36.5	28	1472	130	4	0.85
485	c 093 01	Chern [93]	50	0.28	3.33	R	1	53.5	28	892	248.4	4	0.85
486	c 095 01	Han [95]	65	0.32	3.78	R	1	108.2	28	216	29.9	4	0.85
487	c 095 02	Han [95]	65	0.32	3.78	R	1	108.2	28	210	33.4	4	0.85
488	c 095 03	Han [95]	65	0.32	3.78	R	1	108.2	28	203	35	4	0.85
489	c 097 01	[97] Schweisinger A	65	0.38	3.99	R	1	74.5	77	4	23.9	4	0.85
501	c 097 04	[97] Schweisinger B	65	0.43	4.14	R	1	70.9	77	4	27.3	4	0.85
509	e 086 08	[98] Däger	50	0.34	4.33	R	1	80	7	745.3	78.4	4	0.85
512	c 088 03	Hiltdorf [98]	65	0.55	5.40	RS	3	40.3	7	820	113.9	2.3	0.92
513	c 088 04	Hiltdorf [98]	65	0.55	5.40	RS	3	40.3	28	770	107	2.3	0.92
514	c 088 05	Hiltdorf [98]	65	0.55	5.40	RS	3	40.3	80	750	98.4	2.3	0.92
516	c 088 07	Hiltdorf [98]	65	0.55	5.40	RS	3	40.3	7	878	113.4	2.3	0.92
517	c 088 08	Hiltdorf [98]	65	0.55	5.40	RS	3	40.3	28	879	109.3	2.3	0.92
518	c 088 09	Hiltdorf [98]	65	0.55	5.40	RS	3	40.3	80	796	85.1	2.3	0.92

APPENDIX K													
Creep Experimental Data Sets from the RILEM Data Bank													
Utilized for the CEB 90 Model Analysis													
RILEM File no. and Author			Environmental Conditions			Concrete Properties			Time Ranges		Ultimate Experimental Creep Compliance	CEB 90 Interim Values	
Serial no.	File	Author	Humidity [%]	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} [N/mm ²]	t ₀ [days]	t - t ₀ [days]	J(t,t ₀) [x10 ⁻⁶ /MPa]	Modified β_n	s
1	c 001 01	Dutron [1]	47.5	0.58	6.46	R	1	28.4	60	900	112	400	0.25
2	c 001 02	Dutron [1]	47.5	0.58	6.46	R	1	28.4	60	900	124	400	0.25
3	c 001 03	Dutron [1]	100	0.58	6.46	R	1	28.4	60	900	53	1500	0.25
4	c 001 04	Dutron [1]	100	0.58	6.46	R	1	28.4	60	900	54	1500	0.25
5	c 001 05	Dutron [1]	67.5	0.58	6.46	R	1	28.4	60	900	87	463	0.25
6	c 001 08	Dutron [1]	47.5	0.58	6.46	R	1	28.4	60	900	142	400	0.25
7	c 002 01	Hanson [2]	98	0.58	5.82	SL	2	22.3	28	3222	98	1500	0.38
8	c 002 02	Hanson [2]	98	0.58	6.14	SL	2	34.3	2	748	145	1500	0.38
9	c 002 03	Hanson [2]	98	0.58	6.14	SL	2	34.3	7	343	98	1500	0.38
10	c 002 04	Hanson [2]	98	0.58	6.14	SL	2	34.3	28	722	67	1500	0.38
11	c 002 05	Hanson [2]	98	0.58	6.14	SL	2	34.3	90	260	52	1500	0.38
12	c 002 08	Hanson [2]	98	0.58	6.14	SL	2	34.3	365	365	44	1500	0.38
17	c 006 01	Well [6] A	65	0.52	5.39	SL	2	25.4	28	768	124	326	0.38
18	c 006 02	Well [6] A	65	0.52	5.39	SL	2	25.4	28	768	125	402	0.38
19	c 006 03	Well [6] A	65	0.52	5.39	SL	2	25.4	28	768	112	478	0.38
20	c 006 04	Well [6] A	65	0.52	5.39	SL	2	25.4	28	768	107	705	0.38
21	c 006 05	Well [6] B	65	0.54	5.40	SL	2	28	28	736	127	326	0.38
22	c 006 06	Well [6] B	65	0.54	5.40	SL	2	28	28	736	154	326	0.38
23	c 006 07	Well [6] C	65	0.52	5.03	R	1	46.9	28	767	89	326	0.25
24	c 006 08	Well [6] C	65	0.52	5.03	R	1	46.9	28	767	99	326	0.25
25	c 006 09	Well [6] B	65	0.54	5.40	SL	2	28	28	736	198.6	326	0.38
26	c 006 10	Well [6] B	65	0.54	5.40	SL	2	28	28	772	213	326	0.38
27	c 006 11	Well [6] C	65	0.52	5.03	R	1	46.9	28	767	104.7	326	0.25
28	c 006 12	Well [6] C	65	0.52	5.03	R	1	46.9	28	767	109.5	326	0.25
29	c 011 01	Hummel [11]	65	0.55	5.40	SL	2	26.9	3	1224	177.4	402	0.38
30	c 011 02	Hummel [11]	65	0.55	5.40	SL	2	26.9	28	1585	153.8	402	0.38
31	c 011 03	Hummel [11]	65	0.55	5.40	SL	2	26.9	90	1137	157.3	402	0.38
32	c 011 04	Hummel [11]	65	0.55	5.40	R	1	41.9	3	1306	152.9	402	0.25
33	c 011 05	Hummel [11]	65	0.55	5.40	R	1	41.9	28	1278	116.9	402	0.25
34	c 011 06	Hummel [11]	65	0.55	5.40	R	1	41.9	90	1111	110.3	402	0.25
35	c 011 07	Hummel [11]	65	0.38	5.39	SL	2	43.1	28	1253	83.9	402	0.38
36	c 011 08	Hummel [11]	65	0.45	5.39	SL	2	35.3	28	1280	102	402	0.38
50	c 014 01	Rüsch [14]	65	0.55	5.39	SL	2	24.4	28	361	144.6	402	0.38
51	c 014 02	Rüsch [14]	65	0.55	5.47	SL	2	25.8	28	309	93.6	402	0.38
52	c 014 03	Rüsch [14]	65	0.55	5.40	SL	2	26.4	27	572	131.1	402	0.38
53	c 014 04	Rüsch [14]	65	0.55	5.50	SL	2	23.4	28	580	151.9	402	0.38
54	c 014 05	Rüsch [14]	65	0.55	5.50	SL	2	27.8	28	509	136.3	402	0.38
55	c 014 06	Rüsch [14]	65	0.55	6.26	SL	2	26.4	28	585	89.5	402	0.38
56	c 015 01	Keaton [15]	98	0.48	3.73	RS	3	45.2	8	897	107	1500	0.2
57	c 015 02	Keaton [15]	75	0.48	3.73	RS	3	45.2	8	897	120	316	0.2
58	c 015 03	Keaton [15]	50	0.48	3.73	RS	3	45.2	8	897	141	307	0.2
60	c 015 05	Keaton [15]	98	0.48	3.73	RS	3	45.2	8	897	118	1500	0.2
61	c 015 06	Keaton [15]	75	0.48	3.73	RS	3	45.2	8	897	121	381	0.2
62	c 015 07	Keaton [15]	50	0.48	3.73	RS	3	45.2	8	897	138	364	0.2
64	c 017 01	L'Hermite	50	0.48	4.81	R	1	33.9	7	2050	180	303	0.25
65	c 017 02	Marmillan	50	0.48	4.81	R	1	33.9	21	475	104	303	0.25
66	c 017 03	[17]	50	0.48	4.81	R	1	33.9	80	2050	117	303	0.25
67	c 017 04	[17]	50	0.48	4.81	R	1	33.9	385	1785	71	303	0.25
68	c 017 05	[17]	50	0.48	4.81	R	1	33.9	7	2050	183	303	0.25
69	c 017 06	[17]	50	0.48	4.81	R	1	33.9	21	1980	123	303	0.25
70	c 017 07	[17]	50	0.48	4.81	R	1	33.9	28	576	129	303	0.25
71	c 017 08	[17]	50	0.48	4.81	R	1	33.9	90	2050	111	303	0.25
72	c 017 09	[17]	50	0.48	4.81	R	1	33.9	385	1785	77	303	0.25
73	c 017 10	[17]	50	0.48	4.81	R	1	33.9	720	1420	70	303	0.25
74	c 017 11	[17]	100	0.48	4.81	R	1	33.9	7	2070	82	1500	0.25
75	c 017 12	[17]	100	0.48	4.81	R	1	33.9	21	475	54	1500	0.25
76	c 017 13	[17]	100	0.48	4.81	R	1	33.9	28	576	50	1500	0.25
77	c 017 14	[17]	100	0.48	4.81	R	1	33.9	385	1780	51	1500	0.25
78	c 017 15	[17]	100	0.48	4.81	R	1	33.9	730	1410	35	1500	0.25
79	c 017 16	[17]	100	0.48	4.81	R	1	33.9	7	2070	77	1500	0.25
80	c 017 17	[17]	100	0.48	4.81	R	1	33.9	14	415	58	1500	0.25
81	c 017 18	[17]	100	0.48	4.81	R	1	33.9	21	1980	62	1500	0.25
82	c 017 19	[17]	100	0.48	4.81	R	1	33.9	28	1740	52	1500	0.25
83	c 017 20	[17]	100	0.48	4.81	R	1	33.9	385	1780	46	1500	0.25

RILEM File no. and Author			Environmental Conditions	Concrete Properties				Time Ranges		Ultimate Experimental Creep Compliance	CEB 90 Interim Values		
Serial no.	File	Author	Humidity [%]	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} [N/mm ²]	t ₀ [days]	t - t ₀ [days]	J(t,t ₀) [x10 ⁻⁶ /MPa]	Modified β_n	s
84	c 017 21	[17]	100	0.49	4.81	R	1	33.9	730	1410	36	1500	0.25
85	c 017 22	[17]	100	0.49	4.81	R	1	33.9	7	2070	72	1500	0.25
86	c 017 23	[17]	100	0.49	4.81	R	1	33.9	28	576	53	1500	0.25
87	c 017 24	[17]	100	0.49	4.81	R	1	33.9	365	1780	47	1500	0.25
88	c 017 25	[17]	100	0.49	4.81	R	1	33.9	730	1410	36	1500	0.25
90	c 017 27	[17]	50	0.49	4.81	R	1	33.9	28	479	111	303	0.25
91	c 017 28	[17]	75	0.49	4.81	R	1	33.9	28	479	86	310	0.25
92	c 017 29	[17]	99	0.49	4.81	R	1	33.9	28	479	51	1469	0.25
93	c 017 30	[17]	100	0.49	4.81	R	1	33.9	28	479	49	1500	0.25
94	c 020 01	Hanson	50	0.71	6.00	RS	3	41.3	8	1244	109.3	334	0.2
95	c 020 02	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1515	136.3	364	0.2
96	c 020 03	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1515	136.9	402	0.2
97	c 020 04	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1508	109.4	479	0.2
98	c 020 05	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1525	104.2	355	0.2
99	c 020 06	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1735	108.3	631	0.2
100	c 020 07	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1743	108	708	0.2
101	c 020 08	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1486	110.9	355	0.2
102	c 020 09	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1438	117.9	403	0.2
103	c 020 10	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1366	123.9	327	0.2
104	c 023 01	[23] Arthanani	98	0.56	3.75	R	1	35.1	15	60	59.2	1500	0.25
105	c 023 02	[23] Arthanani	98	0.56	3.75	R	1	35.1	15	60	70.2	1500	0.25
106	c 023 03	[23] Arthanani	98	0.56	3.75	R	1	35.1	15	60	87.6	1500	0.25
107	c 023 04	[23] Arthanani	98	0.56	3.75	R	1	35.1	15	60	97.6	1500	0.25
108	c 023 05	[23] Arthanani	98	0.56	3.75	R	1	35.1	15	60	108.4	1500	0.25
109	c 025 01	[25] Browne	98	0.42	4.40	R	1	42.5	7	1000	176.8	1500	0.25
110	c 025 02	[25] Browne	98	0.42	4.40	R	1	42.5	28	1000	150.6	1500	0.25
111	c 025 03	[25] Browne	98	0.42	4.40	R	1	42.5	60	1000	155.8	1500	0.25
112	c 025 04	[25] Browne	98	0.42	4.40	R	1	42.5	180	1000	164.8	1500	0.25
113	c 025 05	[25] Browne	98	0.42	4.40	R	1	42.5	7	1000	181	1500	0.25
114	c 025 06	[25] Browne	98	0.42	4.40	R	1	42.5	28	1000	117.1	1500	0.25
115	c 025 07	[25] Browne	98	0.42	4.40	R	1	42.5	60	1000	132.9	1500	0.25
116	c 025 08	[25] Browne	98	0.42	4.40	R	1	42.5	180	1000	124.9	1500	0.25
117	c 025 09	[25] Browne	98	0.42	4.40	R	1	42.5	7	1000	135.7	1500	0.25
118	c 025 10	[25] Browne	98	0.42	4.40	R	1	42.5	28	1000	121.3	1500	0.25
119	c 025 11	[25] Browne	98	0.42	4.40	R	1	42.5	60	1000	93.4	1500	0.25
120	c 025 12	[25] Browne	98	0.42	4.40	R	1	42.5	180	1000	91.4	1500	0.25
121	c 025 13	[25] Browne	98	0.42	4.40	R	1	42.5	400	1000	86.6	1500	0.25
122	c 025 14	[25] Browne	98	0.42	4.40	R	1	42.5	7	1000	105.5	1500	0.25
123	c 025 15	[25] Browne	98	0.42	4.40	R	1	42.5	28	1000	71.5	1500	0.25
124	c 025 16	[25] Browne	98	0.42	4.40	R	1	42.5	60	1000	78.6	1500	0.25
125	c 025 17	[25] Browne	98	0.42	4.40	R	1	42.5	180	1000	78.8	1500	0.25
126	c 025 18	[25] Browne	98	0.42	4.40	R	1	42.5	400	1000	55.5	1500	0.25
142	c 030 01	Rüsch [30]	65	0.49	5.34	RS	3	48.6	29	403	63.6	341	0.2
143	c 030 02	Rüsch [30]	65	0.45	5.41	RS	3	48.4	466	511	45.7	341	0.2
150	c 037 01	[37] York	100	0.43	4.62	SL	2	45	90	364	48	1500	0.38
151	c 037 02	[37] York	80	0.43	4.62	SL	2	45	90	196	34.3	365	0.38
152	c 037 03	[37] York	100	0.43	4.62	SL	2	45.9	90	364	47.8	1500	0.38
153	c 037 04	[37] York	60	0.43	4.62	SL	2	45.9	90	364	49.3	365	0.38
155	c 037 06	[37] York	98	0.43	4.62	SL	2	45.9	90	308	68.5	1500	0.38
156	c 037 07	[37] York	98	0.43	4.62	SL	2	42.8	90	364	48.5	1500	0.38
158	c 037 09	[37] York	98	0.43	4.62	SL	2	44.9	90	336	63.7	1500	0.38
160	c 037 11	[37] York	98	0.43	4.62	SL	2	45.9	90	112	48.5	1500	0.38
161	c 043 01	Rostasy [43]	65	0.58	7.10	R	1	41.4	28	1315	79.8	402	0.25
162	c 043 02	Rostasy [43]	65	0.41	5.59	R	1	40.9	28	1315	72.2	402	0.25
163	c 043 03	Rostasy [43]	99	0.41	5.59	R	1	40.9	28	1315	60.9	1500	0.25
164	c 044 01	[44] Seld	50	0.40	5.60	R	1	27.9	28	70	94.7	363	0.25
165	c 044 02	[44] Seld	98	0.40	5.60	R	1	27.9	28	70	52.5	1500	0.25
166	c 044 03	[44] Seld	50	0.40	5.60	R	1	27.9	98	570	111.5	363	0.25
167	c 044 04	[44] Seld	98	0.40	5.60	R	1	27.9	98	570	56.3	1500	0.25
169	c 044 06	[44] Seld	98	0.40	5.60	R	1	27.9	28	70	70.5	1500	0.25
171	c 044 08	[44] Seld	98	0.40	5.60	R	1	27.9	100	570	68.2	1500	0.25
173	c 044 10	[44] Seld	98	0.40	5.60	R	1	27.9	29	70	94.5	1500	0.25
175	c 044 12	[44] Seld	98	0.40	5.60	R	1	27.9	105	300	105.8	1500	0.25
178	c 046 01	[46] Kawasumi	98	0.40	5.60	R	1	44.5	28	68.6	51.6	1500	0.25
178	c 046 03	[46] Kawasumi	98	0.40	5.60	R	1	44.5	98	568.2	56.6	1500	0.25
180	c 046 05	[46] Kawasumi	98	0.40	5.60	R	1	44.5	28	68.1	68.4	1500	0.25
182	c 046 07	[46] Kawasumi	98	0.40	5.60	R	1	44.5	100	565.9	68.7	1500	0.25
184	c 046 09	[46] Kawasumi	98	0.40	5.60	R	1	44.5	29	68.4	63.2	1500	0.25
186	c 046 11	[46] Kawasumi	98	0.40	5.60	R	1	44.5	105	287.8	104.7	1500	0.25
188	c 051 01	[51] McDonald	98	0.33	3.63	SL	2	46.1	90	366	30.2	1500	0.38

RILEM File no. and Author			Environmental Conditions	Concrete Properties				Time Ranges			Ultimate Experimental Creep Compliance	CEB 90 Interim Values	
Serial no.	File	Author	Humidity [%]	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} [N/mm ²]	t ₀ [days]	t - t ₀ [days]	J(t,t ₀) [x10 ⁻⁶ /MPa]	Modified β_n	s
188	c 051 02	[51] McDonald	50	0.33	3.63	SL	2	46.1	90	366	28.5	364	0.38
190	c 051 03	[51] McDonald	98	0.33	3.63	SL	2	46.1	90	366	30.7	1500	0.38
191	c 051 04	[51] McDonald	50	0.33	3.63	SL	2	46.1	90	366	32.1	364	0.38
192	c 051 05	[51] McDonald	98	0.33	3.63	SL	2	46.1	90	225	34.3	1500	0.38
194	c 051 07	[51] McDonald	98	0.33	3.63	SL	2	46.1	90	120.1	40.4	1500	0.38
196	c 051 08	[51] McDonald	98	0.43	4.65	SL	2	51.2	90	365	40.6	1500	0.38
197	c 051 10	[51] McDonald	50	0.43	4.65	SL	2	51.2	90	365	47.1	364	0.38
198	c 051 11	[51] McDonald	98	0.43	4.65	SL	2	51.2	90	365	40.8	1500	0.38
199	c 051 12	[51] McDonald	50	0.43	4.65	SL	2	51.2	90	365	45.7	364	0.38
200	c 051 13	[51] McDonald	98	0.43	4.65	SL	2	51.2	90	92.9	35.3	1500	0.38
202	c 051 15	[51] McDonald	98	0.43	3.67	SL	2	46.1	90	365	81	1500	0.38
203	c 051 16	[51] McDonald	50	0.43	3.67	SL	2	46.1	90	13.6	52.2	364	0.38
204	c 051 17	[51] McDonald	98	0.43	3.67	SL	2	46.1	90	28.3	79.9	1500	0.38
206	c 051 19	[51] McDonald	98	0.43	3.67	SL	2	46.1	90	273	77.1	1500	0.38
233	c 055 01	[55] Okajima	50	0.53	5.49	R	1	42	30	111.7	188	288	0.25
234	c 055 02	[55] Okajima	98	0.53	5.49	R	1	42	28	91.6	61.1	982	0.25
235	c 055 03	[55] Okajima	50	0.53	5.49	R	1	42	90	87.5	100.6	288	0.25
236	c 055 04	[55] Okajima	98	0.53	5.49	R	1	42	28	90	83.7	982	0.25
241	c 058 01	Lambotte [58]	60	0.50	6.30	R	1	29.2	28	720	124	363	0.25
242	c 058 02	Lambotte [58]	60	0.44	5.27	R	1	41.9	15	1800	120	363	0.25
243	c 058 03	Lambotte [58]	60	0.44	5.27	R	1	37.6	7	1800	128	363	0.25
244	c 058 04	Lambotte [58]	60	0.47	5.23	R	1	39	17	1440	141	363	0.25
246	c 058 06	Lambotte [58]	60	0.52	5.57	R	1	30.8	60	720	103	325	0.25
247	c 058 07	Lambotte [58]	60	0.50	6.30	R	1	29.2	28	360	119.7	363	0.25
248	c 058 08	Lambotte [58]	60	0.50	5.31	R	1	33.5	28	360	84	363	0.25
249	c 058 09	Lambotte [58]	60	0.47	5.23	R	1	39.4	7	1800	175.6	363	0.25
250	c 058 10	Lambotte [58]	60	0.35	4.66	R	1	45.3	28	360	81.8	363	0.25
251	c 058 11	Lambotte [58]	60	0.58	4.84	R	1	46.2	7	720	127.3	363	0.25
252	c 058 12	Lambotte [58]	60	0.40	4.53	R	1	38.9	28	360	103.2	363	0.25
253	c 058 13	Lambotte [58]	60	0.43	3.91	RS	3	43.2	28	360	78.4	363	0.2
256	c 058 16	Lambotte [58]	60	0.52	5.57	R	1	34.1	17	720	110.6	325	0.25
257	c 058 17	Lambotte [58]	60	0.57	5.97	R	1	36.6	4	360	104.5	325	0.25
258	c 058 18	Lambotte [58]	60	0.57	5.97	R	1	36.6	28	360	68.1	325	0.25
259	c 081 01	Wischers [61]	65	0.48	5.86	R	1	54	4.5	2190	103.2	364	0.25
260	c 081 02	Wischers [61]	65	0.48	5.86	R	1	54	8	2190	94.8	364	0.25
261	c 081 03	Wischers [61]	65	0.48	5.86	R	1	54	28	2190	77.4	364	0.25
262	c 081 04	Wischers [61]	65	0.48	4.24	R	1	48.4	5	2190	136.5	364	0.25
263	c 081 05	Wischers [61]	65	0.48	4.24	R	1	48.4	10	2190	123.9	364	0.25
264	c 081 06	Wischers [61]	65	0.48	4.24	R	1	48.4	28	2190	93.6	364	0.25
265	c 081 07	Wischers [61]	65	0.48	5.86	RS	3	60.4	0.9	2190	100.3	364	0.2
266	c 081 08	Wischers [61]	65	0.48	5.86	RS	3	60.4	3	2190	85.3	364	0.2
268	c 081 10	Wischers [61]	65	0.48	4.24	RS	3	54.5	1.5	2190	130.1	364	0.2
269	c 081 11	Wischers [61]	65	0.48	4.24	RS	3	54.5	23	2190	112.6	364	0.2
270	c 081 12	Wischers [61]	65	0.48	4.24	RS	3	54.5	28	2190	96.4	364	0.2
271	c 081 13	Wischers [61]	65	0.40	4.53	RS	3	64.6	0.5	2190	104.3	364	0.2
272	c 081 14	Wischers [61]	65	0.40	4.53	RS	3	64.6	1.6	2190	74.9	364	0.2
273	c 081 15	Wischers [61]	65	0.40	4.53	RS	3	64.6	28	2190	58.4	364	0.2
274	c 083 01	Weesche [63] A	65	0.55	5.39	R	1	33.2	3	553	173.6	402	0.25
275	c 083 02	Weesche [63] A	65	0.55	5.39	R	1	33.2	7	549	150.1	402	0.25
276	c 083 03	Weesche [63] A	65	0.55	5.39	R	1	33.2	28	796	136.7	402	0.25
277	c 083 04	Weesche [63] A	65	0.55	5.39	R	1	33.2	2470	761	58.9	402	0.25
278	c 083 05	Weesche [63] A	65	0.55	5.39	R	1	33.2	3055	731	46.6	402	0.25
279	c 083 06	Weesche [63] B	65	0.55	5.41	R	1	33.2	28	761	150.9	402	0.25
280	c 083 07	Weesche [63] B	65	0.55	5.41	R	1	33.2	2430	731	53	402	0.25
281	c 083 08	Weesche [63] B	65	0.55	5.41	R	1	33.2	3300	731	44.9	402	0.25
282	c 083 09	Weesche [63] C	65	0.55	5.40	RS	3	46.5	1	721	151.6	402	0.2
283	c 083 10	Weesche [63] C	65	0.55	5.40	RS	3	46.5	3	765	129.8	402	0.2
284	c 083 11	Weesche [63] C	65	0.55	5.40	RS	3	46.5	7	760	113.2	402	0.2
285	c 083 12	Weesche [63] C	65	0.55	5.40	RS	3	46.5	28	792	108.9	402	0.2
286	c 083 13	Weesche [63] C	65	0.55	5.40	RS	3	46.5	2700	731	45.4	402	0.2
287	c 083 14	Weesche [63] C	65	0.55	5.40	RS	3	46.5	3290	731	41	402	0.2
288	c 083 15	Weesche [63] D	65	0.52	5.41	R	1	34.9	28	761	200.4	402	0.25
289	c 083 16	Weesche [63] E	65	0.55	5.86	R	1	34.9	28	849	174.5	402	0.25
290	c 083 17	Weesche [63] F	65	0.48	5.41	R	1	39.9	28	617	160.1	402	0.25
291	c 083 18	Weesche [63] G	65	0.50	5.40	R	1	39.1	28	731	52.6	402	0.25
292	c 083 19	Weesche [63] D	65	0.52	5.41	R	1	34.9	2480	791	133.7	402	0.25
293	c 083 20	Weesche [63] E	65	0.55	5.86	R	1	34.9	2450	796	122.3	402	0.25
294	c 083 21	Weesche [63] F	65	0.48	5.41	R	1	39.9	2475	796	122.3	402	0.25
295	c 083 22	Weesche [63] G	65	0.50	5.40	R	1	39.1	2445	789	166.6	402	0.25
296	c 083 23	Weesche [63] H	65	0.55	5.39	SL	2	34.1	3	486	138.8	402	0.38

RILEM File no. and Author			Environmental Conditions	Concrete Properties				Time Ranges		Ultimate Experimental Creep Compliance	CEB 90 Interim Values		
Serial no.	File	Author	Humidity [%]	w/c	s/c	European Cement Type	Equivalent American Type	f_{cm} [N/mm ²]	t_0 [days]	$t - t_0$ [days]	$J(t,t_0)$ [x10-6 /MPa]	Modified β_n	s
297	c 063 24	Weesche [83] H	65	0.55	5.39	SL	2	34.1	7	731	70.9	402	0.38
298	c 063 25	Weesche [83] H	65	0.55	5.39	SL	2	34.1	28	731	118.6	402	0.38
299	c 063 26	Weesche [83] H	65	0.55	5.39	SL	2	34.1	2735	730	112.1	402	0.38
300	c 063 27	Weesche [83] I	65	0.55	5.39	SL	2	33.2	7	736	103.2	402	0.38
301	c 063 28	Weesche [83] I	65	0.55	5.39	SL	2	33.2	28	733	113	402	0.38
302	c 063 29	Weesche [83] I	65	0.55	5.39	SL	2	33.2	3295	781	45.3	402	0.38
303	c 063 30	Weesche [83] J	65	0.55	5.39	SL	2	30.8	7	731	46.3	402	0.38
304	c 063 31	Weesche [83] J	65	0.55	5.39	SL	2	30.8	28	731	46.3	402	0.38
305	c 063 32	Weesche [83] J	65	0.55	5.39	SL	2	30.8	2705	731	41.1	402	0.38
306	c 064 01	[64] Ohnuma	98	0.38	3.74	R	1	40.6	63	153.2	57.4	1500	0.25
307	c 064 02	[64] Ohnuma	98	0.38	3.74	R	1	40.6	63	153.8	58.7	1500	0.25
308	c 064 03	[64] Ohnuma	98	0.38	3.74	R	1	40.6	63	155.4	105.1	1500	0.25
310	c 066 02	[66] Takahashi	75	0.40	4.45	SL	2	57.1	100	212.6	50.3	328	0.38
312	c 066 04	[66] Takahashi	75	0.40	4.45	SL	2	56.6	30	289.2	73.6	328	0.38
315	c 067 01	Aschl [67]	65	0.52	5.07	SL	2	53.1	112	371	38	364	0.38
316	c 067 02	Aschl [67]	98	0.52	5.07	SL	2	53.1	112	265	38	1500	0.38
324	c 069 05	Stöckl [69]	65	0.45	5.41	SL	2	23.9	28	144	117.1	364	0.38
325	c 069 06	Stöckl [69]	65	0.45	5.41	SL	2	23.9	28	144	128.9	364	0.38
328	c 070 01	[70] Takahashi	98	0.40	4.18	SL	2	51.4	100	250.2	45.6	1500	0.38
329	c 070 02	[70] Takahashi	98	0.40	4.18	SL	2	51.4	100	246.3	62.9	1500	0.38
330	c 070 03	[70] Takahashi	98	0.40	4.18	SL	2	51.4	365	434.2	43.7	1500	0.38
331	c 070 04	[70] Takahashi	98	0.40	4.18	SL	2	51.4	365	434.2	44.1	1500	0.38
332	c 070 05	[70] Takahashi	98	0.45	5.59	SL	2	48.1	30	87.7	43.6	1500	0.38
333	c 070 06	[70] Takahashi	98	0.45	5.59	SL	2	48.1	30	87.5	44.3	1500	0.38
334	c 070 07	[70] Takahashi	98	0.45	5.59	SL	2	48.1	30	87.5	52.5	1500	0.38
335	c 072 01	Brooks [72]	100	0.36	3.30	R	1	70.9	28	350	48.5	1500	0.25
336	c 072 02	Brooks [72]	100	0.27	3.30	R	1	85.5	28	350	49.5	1500	0.25
337	c 072 03	Brooks [72]	100	0.34	2.60	R	1	69.1	28	337.5	58.5	1500	0.25
338	c 072 04	Brooks [72]	100	0.27	2.60	R	1	80.9	28	350	60.7	1500	0.25
339	c 072 05	Brooks [72]	100	0.30	2.08	R	1	67.3	28	350	73	1500	0.25
340	c 072 06	Brooks [72]	65	0.36	3.30	R	1	70.9	28	350	55.1	308	0.25
341	c 072 07	Brooks [72]	65	0.27	3.30	R	1	85.5	28	350	50.7	308	0.25
342	c 072 08	Brooks [72]	65	0.34	2.60	R	1	69.1	28	350	64.4	308	0.25
344	c 072 10	Brooks [72]	65	0.30	2.08	R	1	67.3	28	350	71.4	308	0.25
345	c 073 01	Stöckl [73]	65	0.55	5.35	R	1	30.3	57	206	152.2	341	0.25
346	c 073 02	Stöckl [73]	65	0.55	5.35	R	1	30.3	57	963	210.5	341	0.25
379	c 077 01	Espion [77]	60	k.A.	k.A.	R	1	36	14	1254	121.7	363	0.25
380	c 077 02	Espion [77]	60	k.A.	k.A.	R	1	36	14	1630	114.4	363	0.25
381	c 077 03	Espion [77]	60	k.A.	k.A.	R	1	36	14	1659	117.2	363	0.25
382	c 078 01	Russel [78]	98	0.43	4.04	R	1	52.4	28	6321	78.4	1500	0.25
383	c 078 02	Russel [78]	50	0.43	4.04	R	1	52.4	28	6321	112	364	0.25
384	c 078 03	Russel [78]	50	0.43	4.04	R	1	52.4	182	6167	91	364	0.25
385	c 078 04	Russel [78]	50	0.43	4.04	R	1	52.4	361	5968	83.4	364	0.25
386	c 078 05	Russel [78]	98	0.39	3.34	R	1	63	28	6768	96.6	1500	0.25
387	c 078 06	Russel [78]	50	0.39	3.34	R	1	63	28	6768	101.9	364	0.25
388	c 078 07	Russel [78]	50	0.39	3.34	R	1	63	181	5442	84.1	364	0.25
389	c 078 08	Russel [78]	50	0.39	3.34	R	1	63	730	6066	63.9	364	0.25
390	c 079 01	Shritharan [79]	60	0.47	5.09	R	1	50.1	8	3492	190.7	363	0.25
391	c 079 02	Shritharan [79]	60	0.47	5.09	R	1	50.1	14	3486	183	363	0.25
392	c 079 03	Shritharan [79]	60	0.47	5.09	R	1	50.1	21	1922	175.4	363	0.25
393	c 079 04	Shritharan [79]	60	0.47	5.09	R	1	50.1	28	3472	168.3	363	0.25
394	c 079 05	Shritharan [79]	60	0.47	5.09	R	1	50.1	84	1859	141	363	0.25
395	c 079 06	Shritharan [79]	60	0.47	5.09	R	1	50.1	182	1761	113.3	363	0.25
396	c 079 07	Shritharan [79]	98	0.47	5.09	R	1	50.1	8	1935	100	1500	0.25
397	c 079 08	Shritharan [79]	98	0.47	5.09	R	1	50.1	14	1929	92.3	1500	0.25
398	c 079 09	Shritharan [79]	98	0.47	5.09	R	1	50.1	21	1922	97	1500	0.25
399	c 079 10	Shritharan [79]	98	0.47	5.09	R	1	50.1	28	1915	82.9	1500	0.25
400	c 079 11	Shritharan [79]	98	0.47	5.09	R	1	50.1	84	1859	78.7	1500	0.25
401	c 079 12	Shritharan [79]	98	0.47	5.09	R	1	50.1	182	1761	64.6	1500	0.25
402	c 079 13	Shritharan [79]	60	0.47	5.09	R	1	50.1	8	3486	181.6	323	0.25
403	c 079 14	Shritharan [79]	60	0.47	5.09	R	1	50.1	8	3486	168.6	400	0.25
404	c 079 15	Shritharan [79]	60	0.47	5.09	R	1	50.1	8	3486	154.3	476	0.25
405	c 079 16	Shritharan [79]	60	0.47	5.09	R	1	50.1	8	3486	140.6	551	0.25
406	c 082 01	[82] Budelmann	65	0.54	k.A.	R	1	44.1	150	39.8	98.1	288	0.25
407	c 082 02	[82] Budelmann	95	0.54	k.A.	R	1	44.1	150	39.8	84.2	684	0.25
408	c 082 03	[82] Budelmann	100	0.54	k.A.	R	1	44.1	150	39.8	92	1296	0.25
409	c 082 04	[82] Budelmann	65	0.54	k.A.	R	1	44.1	150	39.8	124.2	288	0.25
410	c 082 05	[82] Budelmann	65	0.58	k.A.	R	1	44.9	150	39.6	133.3	288	0.25
411	c 082 06	[82] Budelmann	65	0.54	k.A.	SL	2	37.3	150	39.6	145.3	288	0.38
412	c 082 07	[82] Budelmann	95	0.54	k.A.	R	1	44.1	150	39.6	138.6	684	0.25

RILEM File no. and Author			Environmental Conditions	Concrete Properties				Time Ranges			Ultimate Experimental Creep Compliance	CEB 90 Interim Values	
Serial no.	File	Author	Humidity [%]	w/c	s/c	European Cement Type	Equivalent American Type	f_{cm} [N/mm ²]	t ₀ [days]	t - t ₀ [days]	J(t,t ₀) [x10 ⁻⁶ /MPa]	Modified β_{cs}	s
413	c 082 08	[82] Budelmann	85	0.54	k.A.	R	1	40.7	150	39.6	152.4	684	0.25
414	c 082 08	[82] Budelmann	85	0.54	k.A.	R	1	44.1	150	39.4	157.1	288	0.25
415	c 082 10	[82] Budelmann	85	0.54	k.A.	R	1	44.1	150	40	185	288	0.25
416	c 082 11	[82] Budelmann	85	0.54	k.A.	R	1	44.1	150	39.4	148.2	684	0.25
417	c 082 12	[82] Budelmann	85	0.54	k.A.	R	1	40.7	150	39.4	148.2	288	0.25
418	c 082 13	[82] Budelmann	85	0.54	k.A.	R	1	44.1	150	39.4	221.2	288	0.25
419	c 082 14	[82] Budelmann	85	0.54	k.A.	R	1	44.1	150	39.4	233.3	288	0.25
420	c 082 15	[82] Budelmann	100	0.54	k.A.	R	1	44.1	150	39.4	129.6	1286	0.25
421	c 085 01	Burg [85]	50	0.28	3.04	R	1	78.6	28	427	90.2	364	0.25
443	c 081 01	S. [81] A af 1A	98	0.30	4.22	R	1	70.9	30	236	38.5	1500	0.25
444	c 081 02	A af 1B	85	0.30	4.22	R	1	70.9	30	236	57.9	326	0.25
445	c 081 03	A af 1BAT	98	0.30	4.22	R	1	85.1	30	222	39.4	1500	0.25
446	c 081 04	B	98	0.30	3.63	R	1	75.6	30	236	42.7	1500	0.25
447	c 081 05	Summer [91]	65	0.30	3.63	R	1	75.6	30	236	64.4	326	0.25
448	c 081 08	C	98	0.27	4.38	R	1	82.9	29	226	31	1500	0.25
449	c 081 07	Summer [91]	65	0.27	4.38	R	1	82.9	29	226	36.5	326	0.25
455	c 081 13	Summer [91]	65	0.38	3.98	R	1	57.7	32	231	84.8	326	0.25
457	c 081 15	Summer [91]	65	0.30	4.19	SL	2	55.9	30	236	61.8	326	0.38
467	c 081 25	O	65	0.27	4.02	R	1	89.1	29	139	33.4	326	0.25
477	c 081 35	A	65	0.30	4.22	R	1	70.9	28	226	53	326	0.25
481	c 081 39	S af 23C (?)	65	0.48	3.72	R	1	48.7	28	145	87.4	326	0.25
483	c 092 02	Yue [92]	60	0.32	4.88	RS	3	80.5	28	1472	52.3	363	0.2
484	c 092 03	Yue [92]	60	0.66	6.38	R	1	36.5	28	1472	130	363	0.25
485	c 093 01	Chern [93]	50	0.28	3.33	R	1	53.5	28	692	248.4	325	0.25
498	c 087 01 [97]	Schweisinger A	65	0.36	3.98	R	1	74.5	77	4	23.9	364	0.25
501	c 087 04 [97]	Schweisinger B	65	0.45	4.14	R	1	70.9	77	4	27.3	364	0.25
505	e 098 02	[98] Däger	50	0.34	4.33	R	1	80	1	745.3	120.5	325	0.25
507	e 098 04	[98] Däger	50	0.34	4.33	R	1	80	3	745.3	101.1	325	0.25
509	e 098 06	[98] Däger	50	0.34	4.33	R	1	80	7	745.3	78.4	325	0.25
510	c 099 01	Hilsdorf [99]	65	0.55	5.40	RS	3	40.3	1	790	132.8	402	0.2
511	c 099 02	Hilsdorf [99]	65	0.55	5.40	RS	3	40.3	3	775	116.2	402	0.2
512	c 099 03	Hilsdorf [99]	65	0.55	5.40	RS	3	40.3	7	820	113.9	402	0.2
513	c 099 04	Hilsdorf [99]	65	0.55	5.40	RS	3	40.3	28	770	107	402	0.2
514	c 099 05	Hilsdorf [99]	65	0.55	5.40	RS	3	40.3	90	750	99.4	402	0.2
515	c 099 06	Hilsdorf [99]	65	0.55	5.40	RS	3	40.3	3	907	131.6	402	0.2
516	c 099 07	Hilsdorf [99]	65	0.55	5.40	RS	3	40.3	7	878	113.4	402	0.2
517	c 099 08	Hilsdorf [99]	65	0.55	5.40	RS	3	40.3	28	879	109.3	402	0.2
518	c 099 09	Hilsdorf [99]	65	0.55	5.40	RS	3	40.3	90	796	85.1	402	0.2

APPENDIX L													
Creep Experimental Data Sets from the RILEM Data Bank													
Utilized for the B3 Model Analysis													
RILEM File no. and Author			Environmental Conditions	Concrete Properties					Time Ranges		Ultimate Experimental Creep Compliance	B3 Interim Values	
Serial no.	File	Author	Humidity (%)	w/c	a/c	European Cement Type	Equivalent American Type	f _{cm} (N/mm ²)	t ₀ (days)	t - t ₀ (days)	J(t,t ₀) [x10 ⁻⁶ /MPa]	C _{d1}	C _{d2}
1	c 001 01	Dutton [1]	47.5	0.56	6.46	R	1	28.4	60	900	112	1	1
2	c 001 02	Dutton [1]	47.5	0.56	6.46	R	1	28.4	60	900	124	1	1
3	c 001 03	Dutton [1]	100	0.56	6.46	R	1	28.4	60	900	53	1	1
4	c 001 04	Dutton [1]	100	0.56	6.46	R	1	28.4	60	900	54	1	1
5	c 001 05	Dutton [1]	67.5	0.56	6.46	R	1	28.4	60	900	87	1	1
6	c 001 06	Dutton [1]	47.5	0.56	6.46	R	1	28.4	60	900	142	1	1
7	c 002 01	Hanson [2]	98	0.56	5.62	SL	2	22.3	28	3222	96	0.85	1
8	c 002 02	Hanson [2]	98	0.56	6.14	SL	2	34.3	2	748	145	0.85	1
9	c 002 03	Hanson [2]	98	0.56	6.14	SL	2	34.3	7	343	96	0.85	1
10	c 002 04	Hanson [2]	98	0.56	6.14	SL	2	34.3	28	722	67	0.85	1
11	c 002 05	Hanson [2]	98	0.56	6.14	SL	2	34.3	90	280	52	0.85	1
12	c 002 06	Hanson [2]	98	0.56	6.14	SL	2	34.3	365	385	44	0.85	1
17	c 006 01	Wiel [6] A	65	0.52	5.39	SL	2	25.4	28	768	124	0.85	1
18	c 006 02	Wiel [6] A	65	0.52	5.39	SL	2	25.4	28	768	125	0.85	1
19	c 006 03	Wiel [6] A	65	0.52	5.39	SL	2	25.4	28	768	112	0.85	1
20	c 006 04	Wiel [6] A	65	0.52	5.39	SL	2	25.4	28	768	107	0.85	1
21	c 006 05	Wiel [6] B	65	0.54	5.40	SL	2	28	28	736	127	0.85	1
22	c 006 06	Wiel [6] B	65	0.54	5.40	SL	2	28	28	736	154	0.85	1
23	c 006 07	Wiel [6] C	65	0.52	5.03	R	1	46.9	28	767	89	1	1
24	c 006 08	Wiel [6] C	65	0.52	5.03	R	1	46.9	28	767	99	1	1
25	c 006 09	Wiel [6] B	65	0.54	5.40	SL	2	28	28	736	196.6	0.85	1
26	c 006 10	Wiel [6] B	65	0.54	5.40	SL	2	28	28	772	213	0.85	1
27	c 006 11	Wiel [6] C	65	0.52	5.03	R	1	46.9	28	767	104.7	1	1
28	c 006 12	Wiel [6] C	65	0.52	5.03	R	1	46.9	28	767	108.5	1	1
29	c 011 01	Hummel [11]	65	0.55	5.40	SL	2	26.9	3	1224	177.4	0.85	1
30	c 011 02	Hummel [11]	65	0.55	5.40	SL	2	26.9	28	1585	153.8	0.85	1
31	c 011 03	Hummel [11]	65	0.55	5.40	SL	2	26.9	90	1137	157.3	0.85	1
32	c 011 04	Hummel [11]	65	0.55	5.40	R	1	41.9	3	1306	152.9	1	1
33	c 011 05	Hummel [11]	65	0.55	5.40	R	1	41.9	28	1278	116.9	1	1
34	c 011 06	Hummel [11]	65	0.55	5.40	R	1	41.9	90	1111	110.3	1	1
35	c 011 07	Hummel [11]	65	0.38	5.39	SL	2	43.1	28	1253	83.9	0.85	1
36	c 011 08	Hummel [11]	65	0.45	5.39	SL	2	35.3	28	1280	102	0.85	1
37	c 011 09	Hummel [11]	65	0.65	5.39	SL	2	19	28	1168	186	0.85	1
50	c 014 01	Rosch [14]	65	0.55	5.39	SL	2	24.4	28	361	144.6	0.85	1
51	c 014 02	Rosch [14]	65	0.55	5.47	SL	2	25.8	28	309	93.6	0.85	1
52	c 014 03	Rosch [14]	65	0.55	5.40	SL	2	26.4	27	572	131.1	0.85	1
53	c 014 04	Rosch [14]	65	0.55	5.59	SL	2	23.4	28	580	151.9	0.85	1
54	c 014 05	Rosch [14]	65	0.55	5.50	SL	2	27.6	28	509	136.3	0.85	1
55	c 014 06	Rosch [14]	65	0.55	6.26	SL	2	28.4	28	565	89.5	0.85	1
56	c 015 01	Keeton [15]	99	0.46	3.73	RS	3	45.2	8	897	107	1.1	0.75
57	c 015 02	Keeton [15]	75	0.46	3.73	RS	3	45.2	8	897	120	1.1	1
58	c 015 03	Keeton [15]	50	0.46	3.73	RS	3	45.2	8	897	141	1.1	1
60	c 015 05	Keeton [15]	99	0.46	3.73	RS	3	45.2	8	897	116	1.1	0.75
61	c 015 06	Keeton [15]	75	0.46	3.73	RS	3	45.2	8	897	121	1.1	1
62	c 015 07	Keeton [15]	50	0.46	3.73	RS	3	45.2	8	897	138	1.1	1
64	c 017 01	L'Hermite	50	0.49	4.81	R	1	33.9	7	2050	160	1	1
65	c 017 02	Marmisani	50	0.49	4.81	R	1	33.9	21	475	104	1	1
66	c 017 03	[17]	50	0.49	4.81	R	1	33.9	90	2050	117	1	1
67	c 017 04	[17]	50	0.49	4.81	R	1	33.9	365	1785	71	1	1
68	c 017 05	[17]	50	0.49	4.81	R	1	33.9	7	2050	183	1	1
69	c 017 06	[17]	50	0.49	4.81	R	1	33.9	21	1980	123	1	1
70	c 017 07	[17]	50	0.49	4.81	R	1	33.9	28	576	129	1	1
71	c 017 08	[17]	50	0.49	4.81	R	1	33.9	90	2050	111	1	1
72	c 017 09	[17]	50	0.49	4.81	R	1	33.9	365	1785	77	1	1
73	c 017 10	[17]	50	0.49	4.81	R	1	33.9	720	1420	70	1	1
74	c 017 11	[17]	100	0.49	4.81	R	1	33.9	7	2070	82	1	1
75	c 017 12	[17]	100	0.49	4.81	R	1	33.9	21	475	54	1	1
76	c 017 13	[17]	100	0.49	4.81	R	1	33.9	28	576	90	1	1
77	c 017 14	[17]	100	0.49	4.81	R	1	33.9	365	1780	51	1	1
78	c 017 15	[17]	100	0.49	4.81	R	1	33.9	730	1410	35	1	1
79	c 017 16	[17]	100	0.49	4.81	R	1	33.9	7	2070	77	1	1
80	c 017 17	[17]	100	0.49	4.81	R	1	33.9	14	415	58	1	1
81	c 017 18	[17]	100	0.49	4.81	R	1	33.9	21	1980	62	1	1
82	c 017 19	[17]	100	0.49	4.81	R	1	33.9	28	1740	52	1	1
83	c 017 20	[17]	100	0.49	4.81	R	1	33.9	365	1780	48	1	1
84	c 017 21	[17]	100	0.49	4.81	R	1	33.9	730	1410	38	1	1
85	c 017 22	[17]	100	0.49	4.81	R	1	33.9	7	2070	72	1	1
86	c 017 23	[17]	100	0.49	4.81	R	1	33.9	28	576	53	1	1
87	c 017 24	[17]	100	0.49	4.81	R	1	33.9	365	1780	47	1	1
88	c 017 25	[17]	100	0.49	4.81	R	1	33.9	730	1410	36	1	1
90	c 017 27	[17]	50	0.49	4.81	R	1	33.9	28	479	111	1	1
91	c 017 28	[17]	75	0.49	4.81	R	1	33.9	28	479	86	1	1
92	c 017 29	[17]	98	0.49	4.81	R	1	33.9	28	479	51	1	0.75
93	c 017 30	[17]	100	0.49	4.81	R	1	33.9	28	479	48	1	1

RILEM File no. and Author			Environmental Conditions	Concrete Properties					Time Ranges		Ultimate Experimental Creep Compliance	93 Interim Values	
Serial no.	File	Author	Humidity (%)	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t ₀ (days)	t - t ₀ (days)	J(t,t ₀) (x10 ⁻⁶ /MPa)	C ₆₀	C ₆₅
94	c 020 01	Hanson	50	0.71	6.00	RS	3	41.3	8	1244	108.3	1.1	1
95	c 020 02	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1515	136.3	1.1	1
96	c 020 03	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1515	136.9	1.1	1
97	c 020 04	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1508	109.4	1.1	1
98	c 020 05	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1525	104.2	1.1	1
99	c 020 06	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1735	108.3	1.1	1
100	c 020 07	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1743	108	1.1	1
101	c 020 08	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1468	110.9	1.1	1
102	c 020 09	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1436	117.9	1.1	1
103	c 020 10	Mattock [20]	50	0.71	6.00	RS	3	41.3	8	1366	123.9	1.1	1
104	c 023 01	[23] Arthanan	98	0.56	3.75	R	1	35.1	15	60	59.2	1	1
105	c 023 02	[23] Arthanan	98	0.56	3.75	R	1	35.1	15	60	70.2	1	1
106	c 023 03	[23] Arthanan	98	0.56	3.75	R	1	35.1	15	60	87.6	1	1
107	c 023 04	[23] Arthanan	98	0.56	3.75	R	1	35.1	15	60	97.6	1	1
108	c 023 05	[23] Arthanan	98	0.56	3.75	R	1	35.1	15	60	108.4	1	1
109	c 025 01	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	176.8	1	1
110	c 025 02	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	150.6	1	1
111	c 025 03	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	155.8	1	1
112	c 025 04	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	164.8	1	1
113	c 025 05	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	181	1	1
114	c 025 06	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	117.1	1	1
115	c 025 07	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	132.9	1	1
116	c 025 08	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	124.9	1	1
117	c 025 09	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	135.7	1	1
118	c 025 10	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	121.3	1	1
119	c 025 11	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	93.4	1	1
120	c 025 12	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	91.4	1	1
121	c 025 13	[25] Browne	98	0.42	4.40	R	1	42.6	400	1000	86.6	1	1
122	c 025 14	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	105.5	1	1
123	c 025 15	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	71.5	1	1
124	c 025 16	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	78.6	1	1
125	c 025 17	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	78.8	1	1
126	c 025 18	[25] Browne	98	0.42	4.40	R	1	42.6	400	1000	55.5	1	1
142	c 030 01	Rusch [30]	65	0.49	5.34	RS	3	48.5	29	403	83.6	1.1	1
143	c 030 02	Rusch [30]	65	0.45	5.41	RS	3	48.4	466	511	45.7	1.1	1
150	c 037 01	[37] York	100	0.43	4.62	SL	2	45	90	364	48	0.85	1
151	c 037 02	[37] York	60	0.43	4.62	SL	2	45	90	364	34.3	0.85	1
152	c 037 03	[37] York	100	0.43	4.62	SL	2	45.9	90	364	47.8	0.85	1
153	c 037 04	[37] York	60	0.43	4.62	SL	2	45.9	90	364	49.3	0.85	1
155	c 037 05	[37] York	98	0.43	4.62	SL	2	45.9	90	364	68.5	0.85	1
156	c 037 06	[37] York	98	0.43	4.62	SL	2	45.9	90	364	68.5	0.85	1
158	c 037 07	[37] York	98	0.43	4.62	SL	2	45.9	90	364	63.7	0.85	1
160	c 037 11	[37] York	98	0.43	4.62	SL	2	45.9	90	364	49.5	0.85	1
161	c 043 01	Rostasy [43]	65	0.56	7.10	R	1	41.4	28	1315	79.8	1	1
162	c 043 02	Rostasy [43]	65	0.41	5.59	R	1	40.9	28	1315	72.2	1	1
163	c 043 03	Rostasy [43]	99	0.41	5.59	R	1	40.9	28	1315	60.9	1	0.75
164	c 044 01	[44] Seo	50	0.40	5.60	R	1	27.9	28	70	94.7	1	1
165	c 044 02	[44] Seo	98	0.40	5.60	R	1	27.9	28	70	52.5	1	1
166	c 044 03	[44] Seo	50	0.40	5.60	R	1	27.9	96	570	111.5	1	1
167	c 044 04	[44] Seo	98	0.40	5.60	R	1	27.9	96	570	56.3	1	1
169	c 044 06	[44] Seo	98	0.40	5.60	R	1	27.9	28	70	70.5	1	1
171	c 044 08	[44] Seo	98	0.40	5.60	R	1	27.9	100	570	68.2	1	1
173	c 044 10	[44] Seo	98	0.40	5.60	R	1	27.9	29	70	94.5	1	1
175	c 044 12	[44] Seo	98	0.40	5.60	R	1	27.9	105	300	105.8	1	1
176	c 046 01	[46] Kawasumi	98	0.40	5.60	R	1	44.5	28	69.5	51.6	1	1
177	c 046 02	[46] Kawasumi	50	0.40	5.60	R	1	44.5	28	71.1	93.5	1	1
178	c 046 03	[46] Kawasumi	98	0.40	5.60	R	1	44.5	96	568.2	55.6	1	1
179	c 046 04	[46] Kawasumi	50	0.40	5.60	R	1	44.5	96	568.2	110.7	1	1
180	c 046 05	[46] Kawasumi	98	0.40	5.60	R	1	44.5	29	68.1	68.4	1	1
182	c 046 07	[46] Kawasumi	98	0.40	5.60	R	1	44.5	100	565.9	66.7	1	1
184	c 046 09	[46] Kawasumi	98	0.40	5.60	R	1	44.5	29	68.4	93.2	1	1
186	c 046 11	[46] Kawasumi	98	0.40	5.60	R	1	44.5	105	287.8	104.7	1	1
189	c 051 02	[51] McDonald	50	0.33	3.83	SL	2	46.1	90	366	28.5	0.85	1
191	c 051 04	[51] McDonald	50	0.33	3.83	SL	2	46.1	90	366	32.1	0.85	1
196	c 051 09	[51] McDonald	98	0.43	4.65	SL	2	51.2	90	365	40.6	0.85	1
197	c 051 10	[51] McDonald	50	0.43	4.65	SL	2	51.2	90	365	47.1	0.85	1
198	c 051 11	[51] McDonald	98	0.43	4.65	SL	2	51.2	90	365	40.6	0.85	1
199	c 051 12	[51] McDonald	50	0.43	4.65	SL	2	51.2	90	365	46.7	0.85	1
200	c 051 13	[51] McDonald	98	0.43	4.65	SL	2	51.2	90	365	35.3	0.85	1
202	c 051 15	[51] McDonald	98	0.43	3.67	SL	2	46.1	90	365	81	0.85	1
203	c 051 16	[51] McDonald	50	0.43	3.67	SL	2	46.1	90	13.6	52.2	0.85	1
204	c 051 17	[51] McDonald	98	0.43	3.67	SL	2	46.1	90	26.3	79.9	0.85	1
206	c 051 19	[51] McDonald	98	0.43	3.67	SL	2	46.1	90	273	77.1	0.85	1
233	c 055 01	[55] Okayama	50	0.53	5.48	R	1	42	30	111.7	188	1	1
234	c 055 02	[55] Okayama	98	0.53	5.48	R	1	42	28	91.6	61.1	1	1
235	c 055 03	[55] Okayama	50	0.53	5.48	R	1	42	90	87.5	100.5	1	1
236	c 055 04	[55] Okayama	98	0.53	5.48	R	1	42	28	90	63.7	1	1
241	c 058 01	Lambotte [58]	60	0.50	6.30	R	1	39.2	28	720	124	1	1
242	c 058 02	Lambotte [58]	60	0.44	5.27	R	1	41.9	15	1800	120	1	1
243	c 058 03	Lambotte [58]	60	0.44	5.27	R	1	37.8	7	1800	128	1	1

RILEM File no. and Author			Environmental Conditions	Concrete Properties					Time Ranges		Ultimate Experimental Creep Compliance	EC Interim Values	
Serial no.	File	Author	Humidity [%]	w/c	s/c	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t ₀ [days]	t - t ₀ [days]	J(t,t ₀) (x10 ⁻⁶ /MPa)	ϕ_{cs}	ϕ_{cs}
244	c 058 04	Lambotte [58]	60	0.47	5.23	R	1	39	17	1440	141	1	1
246	c 058 06	Lambotte [58]	60	0.52	5.57	R	1	30.8	60	720	103	1	1
247	c 058 07	Lambotte [58]	60	0.50	6.30	R	1	28.2	28	360	119.7	1	1
248	c 058 08	Lambotte [58]	60	0.50	5.31	R	1	33.6	28	360	84	1	1
249	c 058 09	Lambotte [58]	60	0.47	5.23	R	1	39.4	7	1800	175.6	1	1
250	c 058 10	Lambotte [58]	60	0.35	4.68	R	1	45.3	28	360	81.8	1	1
251	c 058 11	Lambotte [58]	60	0.58	4.84	R	1	46.2	7	720	127.3	1	1
252	c 058 12	Lambotte [58]	60	0.40	4.53	R	1	38.9	28	360	103.2	1	1
253	c 058 13	Lambotte [58]	60	0.43	3.91	RS	3	43.2	28	360	78.4	1.1	1
256	c 058 16	Lambotte [58]	60	0.52	5.57	R	1	34.1	17	720	110.6	1	1
257	c 058 17	Lambotte [58]	60	0.57	5.97	R	1	36.6	4	360	104.5	1	1
258	c 058 18	Lambotte [58]	60	0.57	5.97	R	1	36.6	28	360	68.1	1	1
259	c 061 01	Wischers [61]	65	0.48	5.66	R	1	54	4.5	2190	103.2	1	1
260	c 061 02	Wischers [61]	65	0.48	5.66	R	1	54	8	2190	94.8	1	1
261	c 061 03	Wischers [61]	65	0.48	5.66	R	1	54	28	2190	77.4	1	1
262	c 061 04	Wischers [61]	65	0.48	4.24	R	1	46.4	5	2190	136.5	1	1
263	c 061 05	Wischers [61]	65	0.48	4.24	R	1	46.4	10	2190	121.9	1	1
264	c 061 06	Wischers [61]	65	0.48	4.24	R	1	46.4	28	2190	93.6	1	1
265	c 061 07	Wischers [61]	65	0.48	5.66	RS	3	60.4	0.9	2190	100.3	1.1	1
266	c 061 08	Wischers [61]	65	0.48	5.66	RS	3	60.4	3	2190	85.3	1.1	1
268	c 061 10	Wischers [61]	65	0.48	4.24	RS	3	54.5	1.5	2190	130.1	1.1	1
269	c 061 11	Wischers [61]	65	0.48	4.24	RS	3	54.5	23	2190	112.6	1.1	1
270	c 061 12	Wischers [61]	65	0.48	4.24	RS	3	54.5	28	2190	96.4	1.1	1
271	c 061 13	Wischers [61]	65	0.40	4.53	RS	3	64.6	0.5	2190	104.3	1.1	1
272	c 061 14	Wischers [61]	65	0.40	4.53	RS	3	64.6	1.6	2190	74.9	1.1	1
273	c 061 15	Wischers [61]	65	0.40	4.53	RS	3	64.6	28	2190	58.4	1.1	1
274	c 063 01	Wesche [63] A	65	0.55	5.39	R	1	33.2	3	553	173.6	1	1
275	c 063 02	Wesche [63] A	65	0.55	5.39	R	1	33.2	7	549	150.1	1	1
276	c 063 03	Wesche [63] A	65	0.55	5.39	R	1	33.2	28	796	136.7	1	1
277	c 063 04	Wesche [63] A	65	0.55	5.39	R	1	33.2	2470	761	58.9	1	1
278	c 063 05	Wesche [63] A	65	0.55	5.39	R	1	33.2	3055	731	46.6	1	1
279	c 063 06	Wesche [63] B	65	0.55	5.41	R	1	33.2	28	761	150.9	1	1
280	c 063 07	Wesche [63] B	65	0.55	5.41	R	1	33.2	2430	731	53	1	1
281	c 063 08	Wesche [63] B	65	0.55	5.41	R	1	33.2	3300	731	44.9	1	1
282	c 063 09	Wesche [63] C	65	0.55	5.40	RS	3	46.5	1	721	151.6	1.1	1
283	c 063 10	Wesche [63] C	65	0.55	5.40	RS	3	46.5	3	765	129.8	1.1	1
284	c 063 11	Wesche [63] C	65	0.55	5.40	RS	3	46.5	7	760	113.2	1.1	1
285	c 063 12	Wesche [63] C	65	0.55	5.40	RS	3	46.5	28	762	108.9	1.1	1
286	c 063 13	Wesche [63] C	65	0.55	5.40	RS	3	46.5	2700	731	45.4	1.1	1
287	c 063 14	Wesche [63] C	65	0.55	5.40	RS	3	46.5	3290	731	41	1.1	1
288	c 063 15	Wesche [63] D	65	0.52	5.41	R	1	34.9	28	761	200.4	1	1
289	c 063 16	Wesche [63] E	65	0.55	5.36	R	1	34.9	28	849	174.5	1	1
290	c 063 17	Wesche [63] F	65	0.49	5.41	R	1	39.9	28	817	160.1	1	1
291	c 063 18	Wesche [63] G	65	0.50	5.40	R	1	39.1	28	731	52.5	1	1
292	c 063 19	Wesche [63] D	65	0.52	5.41	R	1	34.9	2460	791	133.7	1	1
293	c 063 20	Wesche [63] E	65	0.55	5.36	R	1	34.9	2450	796	122.3	1	1
294	c 063 21	Wesche [63] F	65	0.49	5.41	R	1	39.9	2475	796	122.3	1	1
295	c 063 22	Wesche [63] G	65	0.50	5.40	R	1	39.1	2445	789	166.6	1	1
296	c 063 23	Wesche [63] H	65	0.55	5.39	SL	2	34.1	3	486	138.8	0.85	1
297	c 063 24	Wesche [63] H	65	0.55	5.39	SL	2	34.1	7	731	70.9	0.85	1
298	c 063 25	Wesche [63] H	65	0.55	5.39	SL	2	34.1	28	731	118.6	0.85	1
299	c 063 26	Wesche [63] H	65	0.55	5.39	SL	2	34.1	2735	730	112.1	0.85	1
300	c 063 27	Wesche [63] I	65	0.55	5.39	SL	2	33.2	7	736	103.2	0.85	1
301	c 063 28	Wesche [63] I	65	0.55	5.39	SL	2	33.2	28	733	113	0.85	1
302	c 063 29	Wesche [63] I	65	0.55	5.39	SL	2	33.2	3295	781	45.3	0.85	1
303	c 063 30	Wesche [63] J	65	0.55	5.39	SL	2	30.6	7	731	46.3	0.85	1
304	c 063 31	Wesche [63] J	65	0.55	5.39	SL	2	30.6	28	731	46.3	0.85	1
305	c 063 32	Wesche [63] J	65	0.55	5.39	SL	2	30.6	2705	731	41.1	0.85	1
306	c 064 01	[64] Ohnuma	98	0.38	3.74	R	1	40.6	63	153.2	57.4	1	1
307	c 064 02	[64] Ohnuma	98	0.38	3.74	R	1	40.6	63	153.6	58.7	1	1
308	c 064 03	[64] Ohnuma	98	0.38	3.74	R	1	40.6	63	155.4	105.1	1	1
309	c 066 01	[66] Takahashi	98	0.40	4.45	SL	2	56.5	100	213.3	39.2	0.85	1
310	c 066 02	[66] Takahashi	75	0.40	4.45	SL	2	57.1	100	212.6	50.3	0.85	1
311	c 066 03	[66] Takahashi	98	0.40	4.45	SL	2	56.7	30	267.6	48.7	0.85	1
312	c 066 04	[66] Takahashi	75	0.40	4.45	SL	2	56.6	30	269.2	73.8	0.85	1
313	c 066 05	[66] Takahashi	98	0.40	4.45	SL	2	56.5	100	216.4	46.1	0.85	1
315	c 067 01	Aechi [67]	65	0.52	5.07	SL	2	53.1	112	371	38	0.85	1
316	c 067 02	Aechi [67]	98	0.52	5.07	SL	2	53.1	112	285	38	0.85	1
320	c 069 01	Stoick [69]	65	0.60	5.02	SL	2	17.7	28	150	161.6	0.85	1
321	c 069 02	Stoick [69]	65	0.60	5.02	SL	2	17.7	28	150	173.9	0.85	1
322	c 069 03	Stoick [69]	65	0.60	6.32	SL	2	19	28	150	132	0.85	1
323	c 069 04	Stoick [69]	65	0.60	6.32	SL	2	19	28	150	132.3	0.85	1
324	c 069 05	Stoick [69]	65	0.45	5.41	SL	2	23.9	28	144	117.1	0.85	1
325	c 069 06	Stoick [69]	65	0.45	5.41	SL	2	23.9	28	144	126.8	0.85	1
328	c 070 01	[70] Takahashi	98	0.40	4.18	SL	2	51.4	100	250.2	46.4	0.85	1
329	c 070 02	[70] Takahashi	98	0.40	4.18	SL	2	51.4	100	246.3	62.9	0.85	1
330	c 070 03	[70] Takahashi	98	0.40	4.18	SL	2	51.4	365	434.2	43.7	0.85	1
331	c 070 04	[70] Takahashi	98	0.40	4.18	SL	2	51.4	365	434.2	44.1	0.85	1
332	c 070 05	[70] Takahashi	98	0.45	5.59	SL	2	46.1	30	67.7	43.6	0.85	1
333	c 070 06	[70] Takahashi	98	0.45	5.59	SL	2	46.1	30	67.5	44.3	0.85	1

RILEM File no. and Author			Environmental Conditions	Concrete Properties					Time Ranges		Ultimate Experimental Creep Compliance	BS Interim Values	
Serial no.	File	Author	Humidity [%]	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} [MPa]	t ₀ [days]	t - t ₀ [days]	J(t,t ₀) [x10 ⁻⁶ /MPa]	C _{cr}	C _{cr}
334	c 070 07	(70) Takahashi	98	0.45	5.59	SL	2	48.1	30	67.5	52.5	0.85	1
348	e 073 01	Stock (73)	65	0.35	5.35	R	1	30.3	57	208	152.2	1	1
348	e 073 02	Stock (73)	65	0.35	5.35	R	1	30.3	57	208	210.5	1	1
382	c 078 01	Russel (78)	98	0.43	4.04	R	1	32.4	28	6321	78.4	1	1
383	c 078 02	Russel (78)	50	0.43	4.04	R	1	32.4	28	6321	112	1	1
384	c 078 03	Russel (78)	50	0.43	4.04	R	1	32.4	182	6167	91	1	1
385	c 078 04	Russel (78)	50	0.43	4.04	R	1	32.4	381	5888	63.4	1	1
386	c 078 05	Russel (78)	98	0.38	3.34	R	1	63	28	6768	98.6	1	1
387	c 078 06	Russel (78)	50	0.38	3.34	R	1	63	28	6768	101.9	1	1
388	c 078 07	Russel (78)	50	0.38	3.34	R	1	63	181	5442	84.1	1	1
388	c 078 08	Russel (78)	50	0.38	3.34	R	1	63	730	6086	63.9	1	1
390	c 079 01	Shvethan (79)	60	0.47	5.09	R	1	50.1	8	3482	190.7	1	1
391	c 079 02	Shvethan (79)	60	0.47	5.09	R	1	50.1	14	3486	183	1	1
392	c 079 03	Shvethan (79)	60	0.47	5.09	R	1	50.1	21	1922	175.4	1	1
393	c 079 04	Shvethan (79)	60	0.47	5.09	R	1	50.1	28	3472	166.3	1	1
394	c 079 05	Shvethan (79)	60	0.47	5.09	R	1	50.1	84	1859	141	1	1
395	c 079 06	Shvethan (79)	60	0.47	5.09	R	1	50.1	182	1781	113.3	1	1
396	c 079 07	Shvethan (79)	98	0.47	5.09	R	1	50.1	8	1935	100	1	1
397	c 079 08	Shvethan (79)	98	0.47	5.09	R	1	50.1	14	1929	92.3	1	1
398	c 079 09	Shvethan (79)	98	0.47	5.09	R	1	50.1	21	1922	97	1	1
399	c 079 10	Shvethan (79)	98	0.47	5.09	R	1	50.1	28	1915	82.9	1	1
400	c 079 11	Shvethan (79)	98	0.47	5.09	R	1	50.1	84	1859	78.7	1	1
401	c 079 12	Shvethan (79)	98	0.47	5.09	R	1	50.1	182	1781	64.6	1	1
402	c 079 13	Shvethan (79)	60	0.47	5.09	R	1	50.1	8	3486	191.6	1	1
403	c 079 14	Shvethan (79)	60	0.47	5.09	R	1	50.1	8	3486	168.6	1	1
404	c 079 15	Shvethan (79)	60	0.47	5.09	R	1	50.1	8	3486	154.3	1	1
405	c 079 16	Shvethan (79)	60	0.47	5.09	R	1	50.1	8	3486	140.6	1	1
455	c 091 13	Summer (91)	65	0.38	3.99	R	1	57.7	32	231	84.8	1	1
457	c 091 15	Summer (91)	65	0.30	4.19	SL	2	55.9	30	236	61.8	0.85	1
481	c 091 39	S af 23C (7)	65	0.48	3.72	R	1	48.7	28	145	87.4	1	1
484	c 092 03	Yue (92)	60	0.66	6.38	R	1	36.5	28	1472	130	1	1
485	c 093 01	Chem (93)	50	0.28	3.33	R	1	53.5	28	692	248.4	1	1
510	c 099 01	Hisdorf (99)	65	0.55	5.40	RS	3	40.3	1	750	132.8	1	1
511	c 099 02	Hisdorf (99)	65	0.55	5.40	RS	3	40.3	3	775	116.2	1	1
512	c 099 03	Hisdorf (99)	65	0.55	5.40	RS	3	40.3	7	820	113.9	1	1
513	c 099 04	Hisdorf (99)	65	0.55	5.40	RS	3	40.3	28	770	107	1	1
514	c 099 05	Hisdorf (99)	65	0.55	5.40	RS	3	40.3	90	750	99.4	1	1
515	c 099 06	Hisdorf (99)	65	0.55	5.40	RS	3	40.3	3	907	131.6	1	1
516	c 099 07	Hisdorf (99)	65	0.55	5.40	RS	3	40.3	7	878	113.4	1	1
517	c 099 08	Hisdorf (99)	65	0.55	5.40	RS	3	40.3	28	879	109.3	1	1
518	c 099 09	Hisdorf (99)	65	0.55	5.40	RS	3	40.3	90	796	85.1	1	1

APPENDIX M

Creep Experimental Data Sets from the RILEM Data Bank

Utilized for the GL 2000 Model Analysis

File no. and Author			Environmental Conditions	Concrete Properties				Time Ranges		Ultimate Experimental Creep Compliance	GL 2000 Interim Values		
Serial no.	File	Author	Humidity (%)	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} [N/mm ²]	t ₀ [days]	t - t ₀ [days]	J(t,t ₀) [$\times 10^{-6}$ / MPa]	$\phi(t)$	a b
1	c 001 01	Dutron [1]	47.5	0.58	6.48	R	1	28.4	60	900	112	0.7945	2.80 0.77
2	c 001 02	Dutron [1]	47.5	0.58	6.48	R	1	28.4	60	900	124	0.7945	2.80 0.77
3	c 001 03	Dutron [1]	100	0.58	6.48	R	1	28.4	60	900	53	0.7945	2.80 0.77
4	c 001 04	Dutron [1]	100	0.58	6.48	R	1	28.4	60	900	54	0.7945	2.80 0.77
5	c 001 05	Dutron [1]	67.5	0.58	6.48	R	1	28.4	60	900	87	0.7945	2.80 0.77
6	c 001 06	Dutron [1]	47.5	0.58	6.48	R	1	28.4	60	900	142	1.0000	2.80 0.77
7	c 002 01	Hanson [2]	98	0.58	5.62	SL	2	22.3	28	3222	98	0.8167	3.40 0.72
8	c 002 02	Hanson [2]	98	0.58	6.14	SL	2	34.3	2	748	146	0.9655	3.40 0.72
9	c 002 03	Hanson [2]	98	0.58	6.14	SL	2	34.3	7	343	98	0.9142	3.40 0.72
10	c 002 04	Hanson [2]	98	0.58	6.14	SL	2	34.3	28	722	87	0.8167	3.40 0.72
11	c 002 05	Hanson [2]	98	0.58	6.14	SL	2	34.3	90	280	52	0.6785	3.40 0.72
12	c 002 06	Hanson [2]	98	0.58	6.14	SL	2	34.3	385	385	44	0.4563	3.40 0.72
13	c 005 01	Trossel [5]	100	0.59	5.67	R	1	16.5	28	6079	118	1.0000	2.80 0.77
14	c 005 02	Trossel [5]	98	0.59	5.67	R	1	16.5	28	6700	125	1.0000	2.80 0.77
15	c 005 03	Trossel [5]	70	0.59	5.67	R	1	16.5	28	6824	194	1.0000	2.80 0.77
16	c 005 04	Trossel [5]	50	0.59	5.67	R	1	16.5	28	8497	240	1.0000	2.80 0.77
17	c 006 01	Weil [6] A	65	0.52	5.39	SL	2	25.4	28	768	124	0.7564	3.40 0.72
18	c 006 02	Weil [6] A	65	0.52	5.39	SL	2	25.4	28	768	125	0.8773	3.40 0.72
19	c 006 03	Weil [6] A	65	0.52	5.39	SL	2	25.4	28	768	112	0.9188	3.40 0.72
20	c 006 04	Weil [6] A	65	0.52	5.39	SL	2	25.4	28	768	107	0.9599	3.40 0.72
21	c 006 05	Weil [6] B	65	0.54	5.40	SL	2	28	28	736	127	0.7564	3.40 0.72
22	c 006 06	Weil [6] B	65	0.54	5.40	SL	2	28	28	736	154	0.7564	3.40 0.72
23	c 006 07	Weil [6] C	65	0.52	5.03	R	1	46.9	28	767	89	0.7564	2.80 0.77
24	c 006 08	Weil [6] C	65	0.52	5.03	R	1	46.9	28	767	99	0.7564	2.80 0.77
25	c 006 09	Weil [6] B	65	0.54	5.40	SL	2	28	28	736	198.6	0.7564	3.40 0.72
26	c 006 10	Weil [6] B	65	0.54	5.40	SL	2	28	28	272	213	0.7564	3.40 0.72
27	c 006 11	Weil [6] C	65	0.52	5.03	R	1	46.9	28	767	104.7	0.7564	2.80 0.77
28	c 006 12	Weil [6] C	65	0.52	5.03	R	1	46.9	28	767	108.5	0.7564	2.80 0.77
29	c 011 01	Hummel [11]	65	0.56	5.40	SL	2	26.9	3	1224	177.4	1.0000	3.40 0.72
30	c 011 02	Hummel [11]	65	0.56	5.40	SL	2	26.9	28	1585	153.8	0.8773	3.40 0.72
31	c 011 03	Hummel [11]	65	0.56	5.40	SL	2	26.9	90	1137	157.3	0.7578	3.40 0.72
32	c 011 04	Hummel [11]	65	0.56	5.40	R	1	41.9	3	1306	152.9	1.0000	2.80 0.77
33	c 011 05	Hummel [11]	65	0.56	5.40	R	1	41.9	28	1278	116.9	0.8773	2.80 0.77
34	c 011 06	Hummel [11]	65	0.56	5.40	R	1	41.9	90	1111	110.3	0.7578	2.80 0.77
35	c 011 07	Hummel [11]	65	0.46	5.39	SL	2	35.3	28	1260	102	0.8773	3.40 0.72
36	c 014 01	Rösch [14]	65	0.56	5.39	SL	2	24.4	28	361	144.6	0.8773	3.40 0.72
37	c 014 02	Rösch [14]	65	0.56	5.47	SL	2	25.8	28	309	93.6	0.8773	3.40 0.72
38	c 014 03	Rösch [14]	65	0.56	5.40	SL	2	26.4	27	572	131.1	0.8903	3.40 0.72
39	c 014 04	Rösch [14]	65	0.56	5.59	SL	2	23.4	28	580	151.9	0.8773	3.40 0.72
40	c 014 05	Rösch [14]	65	0.56	5.50	SL	2	27.8	28	508	136.3	0.8773	3.40 0.72
41	c 014 06	Rösch [14]	65	0.56	6.26	SL	2	28.4	28	585	89.5	0.8773	3.40 0.72
42	c 015 01	Keaton [15]	98	0.48	3.73	RS	3	45.2	8	887	107	0.8134	1.00 0.92
43	c 015 02	Keaton [15]	75	0.48	3.73	RS	3	45.2	8	887	120	0.8134	1.00 0.92
44	c 015 03	Keaton [15]	50	0.48	3.73	RS	3	45.2	8	887	141	0.8134	1.00 0.92
45	c 015 04	Keaton [15]	20	0.48	3.73	RS	3	45.2	8	887	150	0.8134	1.00 0.92
46	c 015 05	Keaton [15]	98	0.48	3.73	RS	3	45.2	8	887	118	0.9072	1.00 0.92
47	c 015 06	Keaton [15]	75	0.48	3.73	RS	3	45.2	8	887	121	0.9072	1.00 0.92
48	c 015 07	Keaton [15]	50	0.48	3.73	RS	3	45.2	8	887	138	0.9072	1.00 0.92
49	c 015 08	Keaton [15]	20	0.48	3.73	RS	3	45.2	8	887	146	0.9072	1.00 0.92
50	c 023 01	[23] Arthanari	98	0.58	3.75	R	1	36.1	15	60	98.2	0.9011	2.80 0.77
51	c 023 02	[23] Arthanari	98	0.58	3.75	R	1	36.1	15	60	70.2	0.9011	2.80 0.77
52	c 023 03	[23] Arthanari	98	0.58	3.75	R	1	36.1	15	60	87.6	0.9011	2.80 0.77
53	c 023 04	[23] Arthanari	98	0.58	3.75	R	1	36.1	15	60	87.8	0.9011	2.80 0.77
54	c 023 05	[23] Arthanari	98	0.58	3.75	R	1	36.1	15	60	108.4	0.9011	2.80 0.77
55	c 025 01	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	176.8	0.9145	2.80 0.77
56	c 025 02	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	190.6	0.8172	2.80 0.77
57	c 025 03	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	196.8	0.7337	2.80 0.77
58	c 025 04	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	184.8	0.5730	2.80 0.77
59	c 025 05	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	181	0.9145	2.80 0.77
60	c 025 06	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	117.1	0.8172	2.80 0.77
61	c 025 07	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	132.9	0.7337	2.80 0.77
62	c 025 08	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	124.9	0.5730	2.80 0.77
63	c 025 09	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	136.7	0.9145	2.80 0.77
64	c 025 10	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	121.3	0.8172	2.80 0.77
65	c 025 11	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	93.4	0.7337	2.80 0.77
66	c 025 12	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	91.4	0.5730	2.80 0.77
67	c 025 13	[25] Browne	98	0.42	4.40	R	1	42.6	400	1000	88.6	0.4423	2.80 0.77
68	c 025 14	[25] Browne	98	0.42	4.40	R	1	42.6	7	1000	108.5	0.9145	2.80 0.77
69	c 025 15	[25] Browne	98	0.42	4.40	R	1	42.6	28	1000	71.5	0.8172	2.80 0.77
70	c 025 16	[25] Browne	98	0.42	4.40	R	1	42.6	60	1000	78.8	0.7337	2.80 0.77
71	c 025 17	[25] Browne	98	0.42	4.40	R	1	42.6	180	1000	78.8	0.5730	2.80 0.77

File no. and Author			Environmental Conditions		Concrete Properties				Time Ranges		Ultimate Experimental Creep Compliance	GL 2000 Interim Values		
Serial no.	File	Author	Humidity (%)	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} (N/mm ²)	t ₀ [days]	t - t ₀ [days]	J(t,t ₀) [x10 ⁻⁶ / MPa]	$\phi(t)$	a	b
126	c 025 18	[25] Browne	98	0.42	4.40	R	1	42.8	400	1000	56.5	0.4423	2.80	0.77
127	c 026 01	[26] Hannat	98	0.47	4.50	R	1	58.6	180	743	45.8	0.7377	2.80	0.77
128	c 026 02	[26] Hannat	98	0.47	4.50	R	1	58.6	180	743	94.3	0.7377	2.80	0.77
129	c 026 03	[26] Hannat	98	0.47	4.50	R	1	58.6	180	743	125.8	0.7377	2.80	0.77
130	c 026 04	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	46.7	0.7377	2.80	0.77
131	c 026 05	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	88.3	0.7377	2.80	0.77
132	c 026 06	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	132.6	0.7377	2.80	0.77
133	c 026 07	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	46	0.7377	2.80	0.77
134	c 026 08	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	80.8	0.7377	2.80	0.77
135	c 026 09	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	93.7	0.7377	2.80	0.77
136	c 026 10	[26] Hannat	98	0.47	4.50	R	1	58.6	180	736	123.7	0.7377	2.80	0.77
142	c 030 01	Rösch [30]	65	0.49	5.34	RS	3	48.6	29	403	83.6	0.7910	1.00	0.92
143	c 030 02	Rösch [30]	65	0.45	5.41	RS	3	48.4	466	511	45.7	0.7481	1.00	0.92
150	c 037 01	[37] York	100	0.43	4.62	SL	2	45	90	364	45	0.6792	1.40	0.72
151	c 037 02	[37] York	60	0.43	4.62	SL	2	45	90	196	34.3	0.6820	1.40	0.72
152	c 037 03	[37] York	100	0.43	4.62	SL	2	45.9	90	364	47.8	0.6792	1.40	0.72
153	c 037 04	[37] York	60	0.43	4.62	SL	2	45.9	90	364	49.3	0.6820	1.40	0.72
155	c 037 06	[37] York	96	0.43	4.62	SL	2	45.9	90	308	68.5	0.6792	1.40	0.72
156	c 037 07	[37] York	96	0.43	4.62	SL	2	42.8	90	364	48.5	0.6792	1.40	0.72
158	c 037 08	[37] York	96	0.43	4.62	SL	2	44.9	90	336	63.7	0.6792	1.40	0.72
160	c 037 11	[37] York	96	0.43	4.62	SL	2	45.9	90	112	49.5	0.6792	1.40	0.72
161	c 043 01	Rostasy [43]	65	0.56	7.10	R	1	41.4	28	1315	79.8	0.8773	2.80	0.77
162	c 043 02	Rostasy [43]	65	0.41	5.59	R	1	40.9	28	1315	72.2	0.8773	2.80	0.77
163	c 043 03	Rostasy [43]	99	0.41	5.59	R	1	40.9	28	1315	60.9	0.8773	2.80	0.77
176	c 046 01	[46] Kawasumi	96	0.40	5.60	R	1	44.5	28	69.6	51.6	0.8143	2.80	0.77
177	c 046 02	[46] Kawasumi	50	0.40	5.60	R	1	44.5	28	71.1	93.5	0.8143	2.80	0.77
178	c 046 03	[46] Kawasumi	96	0.40	5.60	R	1	44.5	96	568.2	55.6	0.6654	2.80	0.77
179	c 046 04	[46] Kawasumi	50	0.40	5.60	R	1	44.5	96	568.2	110.7	0.6654	2.80	0.77
180	c 046 05	[46] Kawasumi	96	0.40	5.60	R	1	44.5	29	68.1	68.4	0.8110	2.80	0.77
181	c 046 06	[46] Kawasumi	28	0.40	5.60	R	1	44.5	29	71.1	135.9	0.8110	2.80	0.77
182	c 046 07	[46] Kawasumi	96	0.40	5.60	R	1	44.5	100	565.9	66.7	0.6594	2.80	0.77
183	c 046 08	[46] Kawasumi	28	0.40	5.60	R	1	44.5	100	494.3	115.2	0.6594	2.80	0.77
184	c 046 09	[46] Kawasumi	96	0.40	5.60	R	1	44.5	29	68.4	93.2	0.8110	2.80	0.77
186	c 046 11	[46] Kawasumi	96	0.40	5.60	R	1	44.5	105	287.8	104.7	0.6522	2.80	0.77
197	c 051 10	[51] McDonald	50	0.43	4.65	SL	2	51.2	90	365	47.1	0.6890	1.40	0.72
198	c 051 11	[51] McDonald	96	0.43	4.65	SL	2	51.2	90	365	40.8	0.6792	1.40	0.72
199	c 051 12	[51] McDonald	50	0.43	4.65	SL	2	51.2	90	365	45.7	0.6890	1.40	0.72
200	c 051 13	[51] McDonald	96	0.43	4.65	SL	2	51.2	90	92.9	35.3	0.6792	1.40	0.72
202	c 051 15	[51] McDonald	96	0.43	3.67	SL	2	46.1	90	365	81	0.6792	1.40	0.72
203	c 051 16	[51] McDonald	50	0.43	3.67	SL	2	46.1	90	13.6	52.2	0.6890	1.40	0.72
204	c 051 17	[51] McDonald	96	0.43	3.67	SL	2	46.1	90	26.3	79.9	0.6792	1.40	0.72
206	c 051 19	[51] McDonald	96	0.43	3.67	SL	2	46.1	90	273	77.1	0.6792	1.40	0.72
241	c 058 01	Lambotte [58]	60	0.50	6.30	R	1	29.2	28	720	124	0.8143	2.80	0.77
242	c 058 02	Lambotte [58]	60	0.44	5.27	R	1	41.9	15	1800	120	0.8663	2.80	0.77
243	c 058 03	Lambotte [58]	60	0.44	5.27	R	1	37.8	7	1800	128	0.9131	2.80	0.77
244	c 058 04	Lambotte [58]	60	0.47	5.23	R	1	39	17	1440	141	0.8570	2.80	0.77
246	c 058 06	Lambotte [58]	60	0.52	5.57	R	1	30.8	60	720	103	0.6152	2.80	0.77
247	c 058 07	Lambotte [58]	60	0.50	6.30	R	1	29.2	28	360	119.7	0.8143	2.80	0.77
248	c 058 08	Lambotte [58]	60	0.50	5.31	R	1	33.6	28	360	84	0.8143	2.80	0.77
249	c 058 09	Lambotte [58]	60	0.47	5.23	R	1	39.4	7	1800	175.6	0.9131	2.80	0.77
251	c 058 11	Lambotte [58]	60	0.58	4.84	R	1	46.2	7	720	127.3	0.9131	2.80	0.77
252	c 058 12	Lambotte [58]	60	0.40	4.53	R	1	38.9	28	360	103.2	0.8143	2.80	0.77
253	c 058 13	Lambotte [58]	60	0.43	3.91	RS	3	43.2	28	360	78.4	0.8143	1.00	0.92
256	c 058 16	Lambotte [58]	60	0.52	5.57	R	1	34.1	17	720	110.6	0.8000	2.80	0.77
257	c 058 17	Lambotte [58]	60	0.57	5.97	R	1	36.6	4	360	104.5	0.8000	2.80	0.77
258	c 058 18	Lambotte [58]	60	0.57	5.97	R	1	36.6	28	360	68.1	0.8000	2.80	0.77
259	c 081 01	Wiechers [81]	65	0.48	5.86	R	1	54	4.5	2190	103.2	0.8000	2.80	0.77
260	c 081 02	Wiechers [81]	65	0.48	5.86	R	1	54	8	2190	84.8	0.8000	2.80	0.77
261	c 081 03	Wiechers [81]	65	0.48	5.86	R	1	54	28	2190	77.4	0.8000	2.80	0.77
262	c 081 04	Wiechers [81]	65	0.48	4.24	R	1	46.4	5	2190	136.5	0.8000	2.80	0.77
263	c 081 05	Wiechers [81]	65	0.48	4.24	R	1	46.4	10	2190	123.9	0.8000	2.80	0.77
264	c 081 06	Wiechers [81]	65	0.48	4.24	R	1	46.4	28	2190	93.6	0.8000	2.80	0.77
266	c 081 08	Wiechers [81]	65	0.48	5.86	RS	3	60.4	3	2190	85.3	0.9891	1.00	0.92
268	c 081 10	Wiechers [81]	65	0.48	4.24	RS	3	54.5	1.5	2190	130.1	0.9891	1.00	0.92
269	c 081 11	Wiechers [81]	65	0.48	4.24	RS	3	54.5	23	2190	112.6	0.8397	1.00	0.92
270	c 081 12	Wiechers [81]	65	0.48	4.24	RS	3	54.5	28	2190	86.4	0.8000	1.00	0.92
272	c 081 14	Wiechers [81]	65	0.40	4.53	RS	3	64.8	1.6	2190	74.9	0.9891	1.00	0.92
273	c 081 15	Wiechers [81]	65	0.40	4.53	RS	3	64.8	28	2190	58.4	0.8000	1.00	0.92
274	c 083 01	Wesche [83] A	65	0.55	5.39	R	1	33.2	3	563	173.6	0.8000	2.80	0.77
275	c 083 02	Wesche [83] A	65	0.56	5.39	R	1	33.2	7	549	150.1	0.8000	2.80	0.77
276	c 083 03	Wesche [83] A	65	0.56	5.39	R	1	33.2	28	796	136.7	0.8773	2.80	0.77
277	c 083 04	Wesche [83] A	65	0.56	5.39	R	1	33.2	2470	761	58.9	0.2615	2.80	0.77
278	c 083 06	Wesche [83] A	65	0.56	5.39	R	1	33.2	3086	731	46.8	0.2374	2.80	0.77
279	c 083 08	Wesche [83] B	65	0.55	5.41	R	1	33.2	28	781	150.9	0.8773	2.80	0.77
280	c 083 07	Wesche [83] B	65	0.56	5.41	R	1	33.2	2430	731	53	0.2635	2.80	0.77
281	c 083 08	Wesche [83] B	65	0.55	5.41	R	1	33.2	3300	731	44.9	0.2391	2.80	0.77
282	c 083 09	Wesche [83] C	65	0.55	5.40	RS	3	46.5	1	721	151.6	0.8000	1.00	0.92

File no. and Author			Environmental Conditions	Concrete Properties				Time Ranges		Ultimate Experimental Creep Compliance	GL 2000 Interim Values		
Serial no.	File	Author	Humidity (%)	w/c	a/c	European Cement Type	Equivalent American Type	f_{cm} [N/mm ²]	t ₀ (days)	t - t ₀ (days)	J(t,t ₀) [x10 ⁻⁶ / MPa]	$\phi(t)$	a b
283	c 083 10	Weasche (63) C	65	0.56	5.40	RS	3	48.5	3	765	129.8	1.0000	1.00 0.92
284	c 083 11	Weasche (63) C	65	0.56	5.40	RS	3	48.5	7	780	113.2	1.0000	1.00 0.92
285	c 083 12	Weasche (63) C	65	0.56	5.40	RS	3	48.5	28	782	108.9	0.8773	1.00 0.92
286	c 083 13	Weasche (63) C	65	0.56	5.40	RS	3	48.5	2700	731	45.4	0.2512	1.00 0.92
287	c 083 14	Weasche (63) C	65	0.56	5.40	RS	3	48.5	3290	731	41	0.2294	1.00 0.92
288	c 083 15	Weasche (63) D	65	0.52	5.41	R	1	34.9	28	781	200.4	0.8773	2.80 0.77
289	c 083 16	Weasche (63) E	65	0.55	5.86	R	1	34.9	28	849	174.5	0.8773	2.80 0.77
290	c 083 17	Weasche (63) F	65	0.49	5.41	R	1	39.9	28	817	180.1	0.8773	2.80 0.77
291	c 083 18	Weasche (63) G	65	0.50	5.40	R	1	39.1	28	731	52.6	0.8773	2.80 0.77
292	c 083 19	Weasche (63) D	65	0.52	5.41	R	1	34.9	2480	781	133.7	0.2620	2.80 0.77
293	c 083 20	Weasche (63) E	65	0.55	5.86	R	1	34.9	2450	786	122.3	0.2625	2.80 0.77
294	c 083 21	Weasche (63) F	65	0.49	5.41	R	1	39.9	2475	798	122.3	0.2613	2.80 0.77
295	c 083 22	Weasche (63) G	65	0.50	5.40	R	1	39.1	2445	789	168.6	0.2628	2.80 0.77
296	c 083 23	Weasche (63) H	65	0.55	5.39	SL	2	34.1	3	486	138.8	1.0000	3.40 0.72
297	c 083 24	Weasche (63) H	65	0.55	5.39	SL	2	34.1	7	731	70.9	1.0000	3.40 0.72
298	c 083 25	Weasche (63) H	65	0.55	5.39	SL	2	34.1	28	731	118.6	0.8773	3.40 0.72
299	c 083 26	Weasche (63) H	65	0.55	5.39	SL	2	34.1	2735	730	112.1	0.2497	3.40 0.72
300	c 083 27	Weasche (63) I	65	0.55	5.39	SL	2	33.2	7	736	103.2	1.0000	3.40 0.72
301	c 083 28	Weasche (63) I	65	0.55	5.39	SL	2	33.2	28	733	113	0.8773	3.40 0.72
302	c 083 29	Weasche (63) I	65	0.55	5.39	SL	2	33.2	3295	781	45.3	0.2293	3.40 0.72
303	c 083 30	Weasche (63) J	65	0.55	5.39	SL	2	30.8	7	731	46.3	1.0000	3.40 0.72
304	c 083 31	Weasche (63) J	65	0.55	5.39	SL	2	30.8	28	731	46.3	0.8773	3.40 0.72
305	c 083 32	Weasche (63) J	65	0.55	5.39	SL	2	30.8	2705	731	41.1	0.2510	3.40 0.72
309	c 086 01	[66] Takahashi	98	0.40	4.45	SL	2	58.5	100	213.3	39.2	0.5499	3.40 0.72
310	c 086 02	[66] Takahashi	75	0.40	4.45	SL	2	57.1	100	212.6	50.3	0.5499	3.40 0.72
311	c 086 03	[66] Takahashi	98	0.40	4.45	SL	2	56.7	30	287.6	48.7	0.8213	3.40 0.72
312	c 086 04	[66] Takahashi	75	0.40	4.45	SL	2	56.6	30	289.2	73.6	0.8213	3.40 0.72
313	c 086 05	[66] Takahashi	98	0.40	4.45	SL	2	58.5	100	216.4	46.1	0.5499	3.40 0.72
315	c 087 01	Aschi (67)	65	0.52	5.07	SL	2	53.1	112	371	38	0.6562	3.40 0.72
316	c 087 02	Aschi (67)	98	0.52	5.07	SL	2	53.1	112	285	38	0.6562	3.40 0.72
320	c 089 01	Stöckl (69)	65	0.60	5.02	SL	2	17.7	28	150	181.6	0.8361	3.40 0.72
321	c 089 02	Stöckl (69)	65	0.60	5.02	SL	2	17.7	28	150	173.5	0.8361	3.40 0.72
322	c 089 03	Stöckl (69)	65	0.60	8.32	SL	2	19	28	150	132	0.8361	3.40 0.72
323	c 089 04	Stöckl (69)	65	0.60	8.32	SL	2	19	28	150	132.3	0.8361	3.40 0.72
324	c 089 05	Stöckl (69)	65	0.45	5.41	SL	2	23.9	28	144	117.1	0.8361	3.40 0.72
325	c 089 06	Stöckl (69)	65	0.45	5.41	SL	2	23.9	28	144	126.9	0.8361	3.40 0.72
328	c 070 01	[70] Takahashi	98	0.40	4.18	SL	2	51.4	100	250.2	45.6	0.6594	3.40 0.72
329	c 070 02	[70] Takahashi	98	0.40	4.18	SL	2	51.4	100	246.3	62.9	0.6594	3.40 0.72
330	c 070 03	[70] Takahashi	98	0.40	4.18	SL	2	51.4	365	434.2	43.7	0.4520	3.40 0.72
331	c 070 04	[70] Takahashi	98	0.40	4.18	SL	2	51.4	365	434.2	44.1	0.4520	3.40 0.72
332	c 070 05	[70] Takahashi	98	0.45	5.59	SL	2	48.1	30	87.7	43.6	0.8235	3.40 0.72
333	c 070 06	[70] Takahashi	98	0.45	5.59	SL	2	48.1	30	87.5	44.3	0.8235	3.40 0.72
334	c 070 07	[70] Takahashi	98	0.45	5.59	SL	2	48.1	30	87.5	52.5	0.8235	3.40 0.72
345	c 073 01	Stöckl (73)	65	0.55	5.35	R	1	30.3	57	208	152.2	0.6929	2.80 0.77
346	c 073 02	Stöckl (73)	65	0.55	5.35	R	1	30.3	57	983	210.5	0.6929	2.80 0.77
382	c 078 01	Russel (78)	98	0.43	4.04	R	1	52.4	28	6321	78.4	0.8167	2.80 0.77
383	c 078 02	Russel (78)	50	0.43	4.04	R	1	52.4	28	6321	112	0.8167	2.80 0.77
384	c 078 03	Russel (78)	50	0.43	4.04	R	1	52.4	182	6167	91	0.5703	2.80 0.77
385	c 078 04	Russel (78)	50	0.43	4.04	R	1	52.4	361	5988	83.4	0.4581	2.80 0.77
390	c 079 01	Shritharan (79)	60	0.47	5.09	R	1	50.1	8	3492	190.7	0.9208	2.80 0.77
391	c 079 02	Shritharan (79)	60	0.47	5.09	R	1	50.1	14	3486	183	0.8817	2.80 0.77
392	c 079 03	Shritharan (79)	60	0.47	5.09	R	1	50.1	21	1922	175.4	0.8483	2.80 0.77
393	c 079 04	Shritharan (79)	60	0.47	5.09	R	1	50.1	28	3472	166.3	0.8213	2.80 0.77
394	c 079 05	Shritharan (79)	60	0.47	5.09	R	1	50.1	84	1859	141	0.6879	2.80 0.77
395	c 079 06	Shritharan (79)	60	0.47	5.09	R	1	50.1	182	1781	113.3	0.5679	2.80 0.77
396	c 079 07	Shritharan (79)	98	0.47	5.08	R	1	50.1	8	1935	100	0.9189	2.80 0.77
397	c 079 08	Shritharan (79)	98	0.47	5.09	R	1	50.1	14	1929	92.3	0.8931	2.80 0.77
398	c 079 09	Shritharan (79)	98	0.47	5.09	R	1	50.1	21	1922	97	0.8570	2.80 0.77
399	c 079 10	Shritharan (79)	98	0.47	5.08	R	1	50.1	28	1915	82.9	0.8235	2.80 0.77
400	c 079 11	Shritharan (79)	98	0.47	5.09	R	1	50.1	84	1859	78.7	0.6914	2.80 0.77
401	c 079 12	Shritharan (79)	98	0.47	5.08	R	1	50.1	182	1781	64.6	0.5697	2.80 0.77
402	c 079 13	Shritharan (79)	60	0.47	5.09	R	1	50.1	8	3486	191.6	0.8803	2.80 0.77
403	c 079 14	Shritharan (79)	60	0.47	5.09	R	1	50.1	8	3486	168.6	0.9409	2.80 0.77
404	c 079 15	Shritharan (79)	60	0.47	5.09	R	1	50.1	8	3486	154.3	0.9609	2.80 0.77
405	c 079 16	Shritharan (79)	60	0.47	5.08	R	1	50.1	8	3486	140.6	0.9708	2.80 0.77
481	c 081 38	S. et al. ZIC (7)	65	0.48	3.72	R	1	48.7	28	145	87.4	0.7260	2.80 0.77
501	c 087 04	[97] Schwesinger B	65	0.45	4.14	R	1	70.9	77	4	27.3	0.6967	2.80 0.77
510	c 088 01	Hiladorf (98)	65	0.56	5.40	RS	3	40.3	1	790	132.8	1.0000	1.00 0.92
511	c 088 02	Hiladorf (98)	65	0.56	5.40	RS	3	40.3	3	775	116.2	0.9429	1.00 0.92
512	c 088 03	Hiladorf (98)	65	0.56	5.40	RS	3	40.3	7	820	113.9	0.9332	1.00 0.92
513	c 088 04	Hiladorf (98)	65	0.56	5.40	RS	3	40.3	28	770	107	0.8607	1.00 0.92
514	c 088 05	Hiladorf (98)	65	0.56	5.40	RS	3	40.3	90	790	98.4	0.7497	1.00 0.92
515	c 088 06	Hiladorf (98)	65	0.56	5.40	RS	3	40.3	3	807	131.6	1.0000	1.00 0.92
516	c 088 07	Hiladorf (98)	65	0.56	5.40	RS	3	40.3	7	878	113.4	1.0000	1.00 0.92
517	c 088 08	Hiladorf (98)	65	0.56	5.40	RS	3	40.3	23	879	108.3	1.0000	1.00 0.92
518	c 088 09	Hiladorf (98)	65	0.56	5.40	RS	3	40.3	90	796	85.1	1.0000	1.00 0.92