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本局檔號 OUR REF.:
來函檔號 YOUR REF.:

電話 Tel. No.: 3509 7280
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14 March 2019

Clerk to Panel on Transport
Legislative Council Secretariat,
Legislative Council Complex,
1 Legislative Council Road,
Central, Hong Kong
(Attn: Ms Sophie LAU)

Dear Ms LAU,

## Legislative Council Panel on Transport Central - Wan Chai Bypass and Island Eastern Corridor Link – Works Quality and Related Matters

Thank you for your letter dated 19 February 2019 for referral of Hon Tanya CHAN's letter dated 11 January 2019. In response to Hon CHAN's enquiry about the quality of concrete works of the Central - Wan Chai Bypass and Island Eastern Corridor Link project (CWB), we understand that a letter on the same subject was issued to the Highways Department (HyD) by Hon CHAN on 9 January 2019 (see **Annex I**). The HyD provided a substantive reply on 21 January 2019 (see **Annex II**) confirming that the exceedance of peak temperature and temperature differential in the concrete will not affect durability or the structure of the tunnel. The relevant independent expert report was also provided to account for the study and elaborate on the justifications.

As mentioned in HyD's reply, the Government has always accorded top priority to works quality and work safety in the implementation of transport infrastructure projects. Our consultants' resident site staff will adopt the prevailing management mechanism in a rigorous manner to closely monitor the performance of contractors and instruct contractors to carry out effective improvement measures in cases of non-compliance, so as to ensure that the construction quality meets the relevant standards.

Yours sincerely,

G. Chan

(Gillian CHAN)
for Secretary for Transport and Housing

c.c. :

Director of Highways (Attn.: Mr Patrick LAI) (Fax: 2714 5289)

立法會 Legislative Council
陳淑莊議員 Hon CHAN Tanya
公民黨 CIVIC PARTY

九龍何文田忠孝街八十八號
何文田政府合署五樓
路政署總辦事處
路政署署長
陳派明先生, JP

RECEIVED
- 9 JAN 2019
DEPARTMENT
HEADQUARTERS

陳署長：

**有關中環灣仔繞道事宜**

中環灣仔繞道日前被傳媒揭發部分石屎在澆注和凝固時的溫度和溫差不合格。鑑於事件涉及公眾安全問題，就此，本人現特致函　閣下提出下列查詢：

(一)就報導提及，政府當局指中國建築已委託專家調查，認為不會減弱石屎強度和隧道結構。請　貴署說明為何政府當局未有自行委託第三方進行調查及採納上述報告的原因；

(二)除報導提及於 2013 至 2014 年發生上述事故外，整個中環灣仔繞道工程期間是否仍有同類型狀況發生；若有，請提供相關詳情；

(三)請說明為何承建商多次未有遵從當局定下的相關質量要求，　貴署卻仍然接收一個未符合施工質量的工程，及；

(四)就承建商多次未有遵從當局定下的質量要求，　貴署是否曾向有關承建商作出任何懲處；若有，有關懲處為何；若否，原因為何？

鑑於事件涉及重大公眾安全問題，亦直接影響公眾對中環灣仔繞道結構安全信心，故本人要求　貴署公開承建商委託專家所作的調查報告。盼望　閣下能盡快回應本人的查詢，並準確地提供所有相關的資料。如有任何垂詢，煩請電 2521 6106 與本人聯絡。

| DHy | DD | AD/T | AD/D | TS | SE/P | SE/CA1 | SE/CAII | SE/SEA | SE/PR | SGE 1 | SGE 2 | SE/QM | SE/T&C | SE/BIM | DS | STA | |
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| B.U. | | | | | C.C. | | | | | Ref. To | | | | | | | |

陳淑莊

立法會議員
陳淑莊　謹啟

二零一九年一月九日

Annex II

[ ]

郵遞急件

**HIGHWAYS DEPARTMENT**
**MAJOR WORKS PROJECT MANAGEMENT OFFICE**
3 & 6/F, HO MAN TIN GOVERNMENT OFFICES
88 CHUNG HAU STREET, HOMANTIN, KOWLOON, HONG KONG
Web site: http://www.hyd.gov.hk

**路政署**
**主要工程管理處**
香港九龍何文田忠孝街八十八號
何文田政府合署三及六樓
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本署檔案 Our Ref. (JCR1) in HyD MWO 11/1/579TH/1/2
來函檔號 Your Ref.
電　話 Tel. 2762 3503
圖文傳真 Fax 2714 5289

香港中區
立法會道1號
立法會綜合大樓814室
陳淑莊議員

敬啟者：

## 有關中環及灣仔繞道事宜

謝謝你在2019年1月9日致本署署長的函件，詢問有關中環及灣仔繞道(“繞道”)混凝土質量的事宜，本署現就閣下的關注有以下回覆：

一般來說，控制混凝土的溫度和其表面及核心的溫差的主要目的是為了避免混凝土由於過度收縮引起的熱裂紋。因此，關於繞道的混凝土護養，按照合約一般要求，混凝土在護養過程中溫度不應高於70度，而混凝土表面及核心的溫差不應高於24度，以有助防止熱裂紋的產生。但根據檢測結果，這些護養溫度上限及溫差控制的要求，與混凝土的最終強度和質量，並無絕對的直接關係。若然混凝土養護工序未能符合上述溫度控制的要求，有可能會因影響水泥的水化過程(即水泥與水經過化學反應從而硬化並續步增強混凝土的強度)而減弱混凝土的長遠強度，但影響程度將因應其他因素例如混凝土的不同設計而有所差異。溫差過大則可能會導致混凝土出現熱裂紋而影響混凝土的質量。另一方面，合約同時要求在混凝土的設計中，必須加入不少於25%的粉煤灰以增強長遠強度，該作用剛好抵消了或因未能符合護養溫度及溫差標準而可能引起的強度及質量問題。

翻查記錄，本署駐工地人員在2013年至2014年間，分別發現承建商在混凝土養護工序中的溫度及溫差上未能符合合約的要求。為了保證混凝土的質量達標，本署駐工地人員已要求承建商對相關隧道段的混凝土質量進行檢測及提高護養效果。據工地記錄，有關混凝土在完成養護工序後，並沒有出現特別因溫差影響引起的熱裂紋問題。

ISO 9001 : 2015
證書編號：CC 1881

ISO 14001 : 2015
證書編號：CC 2634

其後，承建商就溫度及溫差不達合約要求事件更委託了獨立專家進行調查研究。調查研究結果要點如下：

（一）調查研究檢視了有關混凝土及鋼筋設計和混凝土試磚強度測試報告，並且該混凝土試磚強度測試報告證實了混凝土強度遠高於設計要求；

（二）獨立專家根據英國歐盟標準 BS EN 1992 混凝土結構設計和 CIRIA C660“混凝土早期熱裂紋控制”報告，按相關錄得的混凝土强度及最高溫差，推算出混凝土澆灌後第三天的估計最大裂紋寬度僅為 0.03 毫米，遠低於路政署的「道路及鐵路結構設計手冊」的指引容許之上限要求：0.25 毫米。因此，裂紋符合上述設計手冊的標準；

（三）根據 CIRIA C660 附錄 A9 關於“峰值溫度對早期混凝土強度的影響”，報告指出如果在早期階段混凝土迅速加熱，混凝土的長期性能可能會受到不利影響；但如果在混凝土成份中加入粉煤灰，將會有效減低在早期熱循環中，高溫對該混凝土所產生的不利影響，從而保留混凝土的相應強度。根據記錄，承建商在混凝土的設計上，完全按照合約要求加入了不少於 25%的粉煤灰。獨立專家認為此含有粉煤灰的混凝土設計，有效地抵消了因護養溫度過高而有可能產生的影響。因此，混凝土的長遠强度及質量並未受影響；

（四）獨立專家檢閱了有關混凝土完成養護工序後觀察到的輕度裂紋報告，在該段有關約 750 米長的隧道內發現有輕度裂紋散布在不同位置、長度不同但寬度不超過 0.25 毫米。他認為上述裂紋沒有特定的圖案，並且長度和散布方向不同，極不可能是由於上述護養溫度及溫差不達合約要求而導致的熱裂紋，加上這些裂紋被確認遠低於路政署的「道路及鐵路結構設計手冊」的指引容許之上限要求： 0.25 毫米。因此，證明裂紋符合上述設計手冊的標準；

（五）基於以上考慮，獨立專家確立了雖然在護養期間有關部分溫度及溫差不達合約的要求，但不會減弱混凝土的強度，同時亦不會對隧道的結構、保養及耐用程度構成影響。

本署駐工地人員綜合檢視個案詳情及研究該專家的意見後，有如下的看法：

（六）根據混凝土強度壓力測試報告，這些混凝土試磚的強度均大幅度高於合約要求。這足以抵消上述可能發生的不利影響，令到有關混凝土的長期強度不會減弱，因此是可以接受的；

（七）就該養護工序是否導致混凝土表面產生裂紋，本署駐工地人員同意上述獨立專家的意見。他們認為英國歐盟標準 BS EN 1992 混凝土結構設計是國際受認可的設計規格標準，而 CIRIA 是一個獨立的建築業研究和信息協會。該協會的 CIRIA C660 報告內容更被用作制定英國混凝土早期熱裂紋設計的國家標準基礎。因此基於上述標準和報告的研究而推算出的最大裂紋是可以接受的。他們認為裂紋寬度大幅小於 0.25 毫米，已滿足 0.25 毫米設計要求，並相信這些裂紋是因為濕度變化而導致的收縮裂紋，不屬於溫差影響引起的熱裂紋。這些收縮裂紋已在混凝土鋪設防水保護層前，以環氧樹脂填料完成修補；

（八）綜合上面所述，本署駐工地人員審閱了該獨立專家的報告並與該獨立專家意見一致。有關繞道部分在養護期間，雖曾出現溫度及溫差檢測未能符合合約的一般要求，但不會因此而減弱混凝土的強度，同時亦不會對隧道的結構，保養及耐用程度構成影響。

考慮到上述調查研究報告已經由獨立專家進行，而駐工地人員也認同報告的結論，本署研究後認為沒有需要另外再委託獨立專家進行同樣的調查。另外，該調查研究報告屬於承建商擁有，我們得到他們的允許隨函夾附有關的研究報告供參考。

在上文中，我們已經扼要地交代了該調查研究的結果及獨立專家的專業意見。因上述事件，本署駐工地人員已屢次去信和在每月進度會議中告誡承建商有關不合乎合約要求的混凝土養護工作、督促他們需嚴格遵守合約要求，並按合約條款要求承建商作出相關改善措施。就此，承建商提交及落實了關於混凝土澆灌及養護流程的改善措施，例如：改善冷卻管的設計，並收緊溫度的控制，確保質量符合相關標準。整個繞道工程沒有出現混凝土不符合質量的情況。

工程質量及施工安全為本署首要關注。本署駐工地人員一貫採用嚴緊的管理機制，以及監察各個工序的流程，密切監督承建商以確保工程的設計及建造均符合相關要求，確保工程質量。綜上所述，本署已就閣下關注事宜作詳細說明。如閣下尚有任何查詢，請與我們聯絡。

路政署主要工程管理處 總工程師 4
(黎國輝 黎國輝 )

附件：獨立專家調查研究報告

副本送：
路政署總辦事處公共關係組(經辦人：楊漢輝先生） 傳真：2187 2243

二零一九年一月廿一日

附件

## 1.0 INTRODUCTION

1.1 I, Dr Lam Siu-shu Eddie, am instructed by China State Construction Engineering (Hong Kong) Limited to express my expert opinion on matters related to concrete temperature under Contract No HY/2009/15, Central-Wan Chai Bypass – Tunnel (Causeway Bay Typhoon Shelter Section).

1.2 I, Dr Lam Siu-shu Eddie, am an Associate Professor of The Hong Kong Polytechnic University, Barrister and Mediator.

1.3 I am Fellow of the Hong Kong Institution of Engineers, Fellow and Council Member of the Institution of Structural Engineers, Member of the Institution of Mechanical Engineers, Registered Structural Engineering (Hong Kong) and Class-1 Registered Structural Engineering (PRC).

1.4 I was the Chairman of the HKIE Structural Division (2011-2012), the Chairman of Quality Building Award 2012, a chairman of Disciplinary Tribunal Panel of the Builders' Lifts and Tower Working Platforms (Safety) Ordinance, a chairman of the Construction Registration Committee for Registered General Building Contractors and for Specialist Contractors (Foundation), etc.

1.5 I was a member of Appeal Tribunal (Building), Town Planning Appeal Board Panel, Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers Committee, etc.

1.6 I have acted as an expert witness on disputes concerning building collapse, structural engineering, defects, workmanship, etc., and my expert opinion was accepted by the Court.

## 2.0 BACKGROUND

2.1 At the material time, concreting work with concrete temperatures recorded was carried out on the TPCWAE tunnel structure.

2.2 With reference to Particular Specification of the captioned at clause 16.46(2) ("the Clause"), temperature control for concrete requires (a) peak temperature not higher than 70C; and (b) maximum temperature differential not exceeding 24C.

2.3 Based on the measurements obtained from thermocouples installed in concrete, non-the compliance with the Clause was reported at various locations including wall, base slab and roof slab.

2.4 The matter to address is whether the non-compliance with the Clause has adversely affected the structural performance and durability. To assess the effect of temperature to structural performance, crack width based on tensile strength and other properties of concrete, concrete cover, reinforcement detail, etc. is assessed.

2.5 The main concerns are on (a) the early strength (3 days) and (b) the effect of peak temperature on in-situ strength. CIRIA C660 on "Early-age thermal cracking in concrete" refers.

## 3.0 THE DATA

3.1 Annex A gives the mean compressive strength of test cubes at the age of or about 28 days in respect of the matter as per based on the test results on mean compressive strength of test cubes (Annex D: "20151201 TPCWAE Concrete cube summary.1.xlsx").

a. Overall averaged compressive strength is 65.4 MPa.

b. Grade of concrete is 65.4 – 5 MPa = 60.4 MPa or C60.

3.2 Based on the temperature records as per enclosed in the tables exhibited in letter dated 4/6/2013 from AECOM, ref: CWB(HY/2009/15)/C40/340/15B010064 (Annex B) and additional information (in yellow) in the reports on temperature monitoring (Annex D: Roof slab T5 "CCWI013221.pdf", Base slab C3-C and Roof slab T6 "CCWI013393.pdf", Roof slab T1 and Base slab C3-B "CCWI013529.pdf", Base slab B6 "CCWI013869.pdf", Wall W12 "CCWI014037.pdf", Wall W3, Wall W8A "CCWI04297.pdf" and Roof Slab T2 "CSF ref. No.: CCW/2002/CSF/WAE/4216O") , temperatures as per recorded are summarised in Table 3.1.

Table 3.1 Measured temperatures non-compliance with the Clause

| Type | Bay no | Thickness (mm) | Maximum T (C) | Maximum ΔT (C) |
|---|---|---|---|---|
| Wall | W9 | 1500 | 78 | 18 |
| | W10 | 1500 | 78 | 21 |
| | W5 | 1500 | 81 | 34 |
| | W6 | 1500 | **80** | **37** |
| | W1 | 1500 | 74 | 19 |
| | W2 | 1500 | 73 | 16 |
| | W7 | 1500 | 77 | 18 |
| | W11 | 1500 | 78 | 31 |
| | W15b | 1500 | 77 | 24 |
| | W12 | 1500 | 78.7 | 17.5 |
| | W3 | 1500 | 68.7 | 28.4 |
| | W8A | 1500 | 74.4 | 25.2 |
| Base slab | B1-1 & B2-1 | 2500 | 82 | 31 |
| | B3-1 & B4-1 | 2500 | 82 | 28 |
| | B1-2 & B2-2 | 2500 | **79** | **35** |
| | B3-2 & B4-2 | 2500 | 84 | 33 |

| | | | | |
|---|---|---|---|---|
| | B5 | 2500 | 77 | 20 |
| | C3-C | 2500 | 74.9 | 17.0 |
| | C3-B | 2500 | 81.4 | 28.3 |
| | B6 | 2500 | 74.3 | 23.5 |
| Roof slab | T3 | 3000 | 84 | 27 |
| | T4 | 3000 | 84 | 22 |
| | T5 | 3000 | 83.8 | 27.8 |
| | T1 | 3000 | 79.8 | 32.3 |
| | T6 | 3000 | 79.9 | 20.3 |
| | T2 | 3000 | 89.9 | 30.1 |
| | Shaft A | 3000 | 80.6 | 20.1 |

3.3 Reinforcement detail of the relevant wall, base slab and roof slab are compiled in Table 3.2 with the respective concrete cover given in Table 3.3.

Table 3.2 Reinforcement detail (staggered laps)

| Description | Longitudinal reinforcements | Transverse reinforcements |
|---|---|---|
| External wall W01 | T25@150 – 2 layers | T50@150 – 2 layers |
| External wall W03 | T25@150 – 2 layers | T50@150 – 2 layers |
| Base slab | T40@150 – 2 layers | T50@150 – 2 layers |
| Roof slab | T40@150 – 2 layers | T50@150 – 2 layers |

Table 3.3 Nominal cover

| LOCATION | NOMINAL COVER (mm) |
|---|---|
| INTERNAL WALL | 40 |
| ROOF/BASE SLAB/CAST IN-SITU EXTERNAL WALL<br>- EXTERNAL<br>- INTERNAL | <br>40<br>55* |

*Galvanized mesh D49 (2.5 mm diameter at 100 mm spacing both ways) should be provided to internal face of suspended cover of 20 mm to achieve a fire rating of 4 hours.

# 4.0 THE ANALYSIS AND CONCLUSIONS

## Early strength

4.1 Crack widths at the age of 3 days of C60 concrete at measured temperature differentials are compared with that of C40 concrete at maximum temperature differentials (i.e. 24C) pursuant to the Clause. Computations are given in Annex C based on CIRIA C660, "Early-age thermal crack control in concrete". N.B. The equivalence of C60 and C40 to CIRIA C660 are C50/60 and C30/37 respectively.

4.2 The following are assumed following the recommendation in CIRIA C660.

a. Coefficient of thermal expansion of concrete/aggregate is based on design value for granite at 10 micro-strain/C, Table 4.4 of C660.

b. Characteristic yield strength of reinforcements is 500 MPa.

c. Internal restrain R = 0.42, Section 4.7.2 of C660.

4.3 The results are summarized in Table 4.1.

Table 4.1 Estimated crack width due to internal restraint

| Type | T (mm) | Reinforcement | Cover (mm) | Concrete grade | ΔT (C) | Crack width (mm) |
|---|---|---|---|---|---|---|
| Wall | 1500 | T25@150 x 2 | 40 | C40 | 24 | 0.01 |
| | | | | C60 | 37 | 0.03 |
| Base slab | 2500 | T40@150 x 2 | 40 | C40 | 24 | 0.01 |
| | | | | C60 | 35 | 0.02 |
| Roof slab | 3000 | T40@150 x 2 | 40 | C40 | 24 | 0.01 |
| | | | | C60 | 32.3 | 0.02 |

4.4 Pursuant to Structures Design Manual for Highways and Railways (3rd Edition) at

Table 21 (Annex E), design crack width is 0.25 mm for C40 (with nominal cover at 35 mm only). As shown in Table 4.1, crack width due to temperature effect is 0.03 mm at most. Thus, the requirement on design crack width is deemed to satisfy.

4.5 Further, autogenous healing takes place for young concrete, like in the present case at the age of 3 days. Autogenous healing is primarily due to the hydration of cement combined with the deposition of calcium carbonate from the cementitious material. The maximum crack width of which can undergo autogenous healing is commonly recognized to be 0.1 mm to 0.2 mm. It is generally believed that BS 8007:1987 "Code of practice for design of concrete structures for retaining aqueous liquids" and its successor BS EN 1992-3:2006 "Eurocode 2. Design of concrete structures. Liquid retaining and containing structures" have adopted the concept of autogenous healing to define the crack width limits.

4.6 All in all, the crack width caused by temperature effect at 0.03 mm at most will not affect the durability of the structure.

## Effect of peak temperature

4.7 As quoted from CIRIA C600 at Annex A9, "*It is well recognized that if concrete is heated rapidly during the early period of hydration, the long term properties may be adversely affected*"; "*One commonly used value is 70C*"; and "*In particular the heat cycled 28-day strength for CEM I concrete was appreciably lower than that of standard cured cubes.*" However, the above does not apply to the present case.

a. Fly ash (at a level of >20%) is used in the concrete mixes. This has the beneficial effect of enhancing the in-situ strength at 28 days instead of adversely affecting the early thermal cycle.

b. The above can be verified by examining the in-site strength as per estimated earlier by coring.

c. In respect of the (unlikely) risk of delayed ettringite formation ("DEF"), a delayed form of sulphate attack in concrete with relatively high sulfate content and experienced high temperature at the earlier age, fly ash at level of > 20% is used. This prevents DEF-induced expansion in concrete when subjected to peak temperature up to 100C. In the present case, the peak temperatures are 81C to 89.9C and well below 100C.

## 5.0 CRACKS IN TPCWAE TUNNEL WALL

5.1 Various cracks were observed upon inspection by others on 5 November 2015, 12 November 2015 and 15 January 2016 as per reported in Annex F.

5.2 Upon perusal of the above-mentioned cracks from the reports especially locations and directions of propagation, I am of the opinion that the above-mentioned cracks have no specific patterns; that they vary in length and directions of propagation; and that they are highly unlikely caused by the non-compliance with the Clause.

# A9 The effect of peak temperature on the *in situ* strength and durability of concrete

## A9.1 Strength development

### *A9.1.1 Background data*

It has been recognised for many years that if concrete is heated too rapidly during the early period of hydration, the long term properties may be adversely affected. This is demonstrated by the limits placed on the rate of heating for precast heat cured elements (Richardson, 2003). While it is difficult to control the rate of heat evolution *in situ*, the maximum peak temperature is commonly specified for massive sections and concretes likely to achieve a significant temperature rise during hydration. A commonly used value is 70 °C. One reason for this limit is to ensure that the *in situ* strength is not impaired significantly.

In a study of the influence of the natural heat cycle in very thick sections (Bamforth, 1980) significant changes in the rate of strength development of heat cycled concretes were observed. In particular the heat cycled 28-day strength for CEM I concrete was appreciably lower than that of standard cured cubes. Similar findings have been reported more recently by Barnett *et al* (2005), Sato *et al* (2001) and Sugiyama *et al* (2000). In the most extreme case, (Sato *et al*, 2001) the core strength at 56 days for concrete with a peak temperature of 70 °C was less than 50 per cent of cores removed from the same concrete with a peak temperature of 56 °C.

Sugiyama *et al* (2000) imposed a variety of temperature cycles on the concrete, with variation in the start time, the rate of temperature rise and fall and the peak temperature. The results, shown in Figure A9.1, were obtained for concrete subjected to a heat cycle that closely represented a natural early age heat cycle.

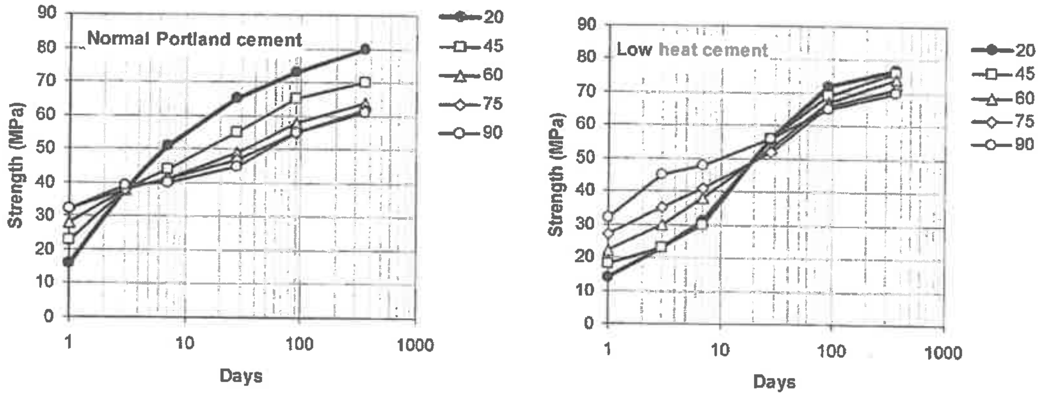

**Figure A9.1** *Strength development as affected by the peak temperature achieved during an early age heat cycle (Sugiyama et al, 2000)*

It can be seen that for CEM I concrete, while the early temperature cycle resulted in acceleration of the strength development within the first few days, the subsequent rate of strength gain was reduced such that at 28 days, the heat cycled strength was up to 25 per cent below the strength of concrete cured at 20 °C. With low heat cement, however, the early benefit in strength development was still observed (during the initial 14 days) but without the long term strength development being impaired.

### *A9.1.2 The Concrete Society Study*

In a comprehensive study of the *in situ* strength of concrete to establish the relationship between core and cube strength (Concrete Society, 2004) similar findings were reported. The testing was carried out to measure the *in situ* strength of a variety of concrete mixes cast into elements of differing geometry. The following factors were investigated

- concrete strength class - target strengths of 30MPa and 50MPa were used to represent low and medium strength concrete
- cement type – four cement types were used, CEM I, Portland limestone cement (LPC), 70 per cent CEM I/30 per cent fly ash and 50 per cent CEM I/50 per cent ggbs
- aggregate type – limestone and quartzite gravel
- element geometry – Concrete blocks (1.5 × 1.7 × 1.2m) insulated on all but one face, 300mm walls cast in plywood formwork and 200 mm thick slabs
- time of casting – winter and summer.

The early age temperature rise was measured in each of the specimens and cores were extracted for testing at 28, 42, 84 and 365 days. An example is shown in Figure A9.2 for the 30 MPa CEM I concrete using quartzite gravel aggregate cast in the summer into the different elements. The influence of the peak temperature on the rate of strength development is clear. In the section which achieved the highest peak temperature of about 60 °C, the core strength at 28 days was about 35 per cent lower than the cube strength. While these results were broadly in line with the findings of Bamforth (1980) and Sugiyama et al (2000) other researchers have reported less influence of the early heat cycle. Barrett *et al* (2005) reported a difference between heat cycled and standard cured cubes at 28 days of only 10 per cent. It is clear, however, that for CEM I cement concretes, the *in situ* strength may be adversely affected, and to a considerable extent, by permitting a high peak temperature.

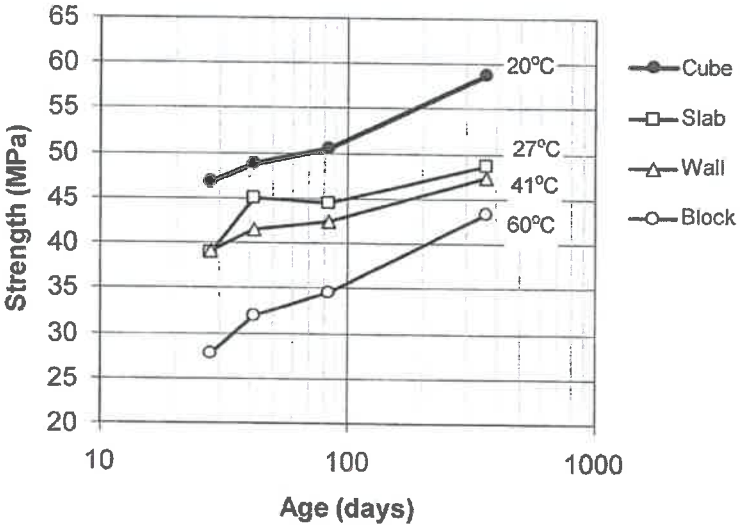

**Figure A9.1** *The strength development in elements of different size and achieving different peak temperatures (shown) during the early thermal cycle (Concrete Society, 2004)*

Figure A9.3 shows the relationship between peak temperature $T_p$ and the ratio of core/cube strength obtained from the Concrete Society study for the range of elements and concretes cast using CEM I concrete. This shows an approximately linear relationship between the peak temperature and the *in situ* strength expressed as a proportion of the 28-day cube strength.

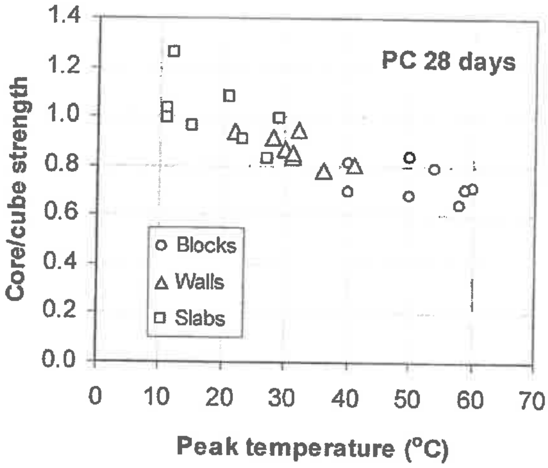

**Figure A9.3** *The effect of the peak early age temperature on the ratio of the core/cube strength at 28 days(Concrete Society, 2004)*

In order to develop a better understanding of the way in which the peak temperature influences strength, the Concrete Society data have been analysed in more detail. Results are shown in Figure A9.4 (expressed as the ratio of the core strength achieved at 28, 42, 84 days and 1 year to the 28-day cube strength) for concretes using each of the four cement types. While there is some scatter to the results, clear trends are apparent. For example, the lower *in situ* strength achieved with higher peak temperature for CEM I concrete was also observed for Limestone Portland cement concrete, although at 28 days the reduction was less, being about 20 per cent at 60 °C. However, the performance of concretes containing fly ash and ggbs differed significantly from that of CEM I and LPC concretes in two principal respects. Firstly, at 28-days the *in situ* strength did not reduce with an increase in the peak temperature, with a trend for a higher *in situ* strength in those elements achieving the higher peak temperatures, at least up to about 60 °C. And secondly, the development of *in situ* strength over the long term was significantly higher for the fly ash and ggbs concretes. At 1 year, none of the elements containing pfa or ggbs exhibited strengths less than the 28-day cube strength, regardless of peak temperature, while for CEM I concrete, this was only achieved in concretes with peak early-age temperatures of less than about 40 °C.

Figure A9.5 illustrates more clearly the way in which the relative strength changes with age for concretes with the four cement types. Based on the best fit linear relationships derived for each data set, the results indicate that under conditions within which the peak temperature is likely to exceed 40 °C, concretes containing CEM I or Portland limestone cement are unlikely to achieve an *in situ* strength which exceeds the 28-day cube strength, even after one year. For the concretes containing fly ash and ggbs, however, the *in situ* strength had achieved the 28-day cube strength within 42 days, even when the peak temperature reached 60 °C. By comparison, CEM I concretes, even after 1 year, exhibited *in situ* strengths which were only about 85 per cent of the 28-day cube strength.

These finding are broadly consistent with those of Bamforth (1980) who measured the strength development for concretes containing fly ash (30 per cent) and ggbs (70 per cent) using temperature matched curing. Unlike CEM I concrete, for which the *in situ* strength was adversely affected at 28 days, in both cases the heat cycled strength exceeded the cube strength. This indicated that such mixes are far more tolerant to early temperature rise.

The difference between the performance of CEM I concrete and mixes containing fly ash and ggbs can have significant implications. It is clear from the results reported that for a given class of concrete, higher *in situ* strength will be achieved if the concrete contains fly ash or ggbs. In a study of fly ash concretes Bamforth (1984) indicated that in structural concrete in sections exposed to peak temperatures in the order of 70 °C, fly ash concrete achieves a heat cycled strength that may be 10MPa higher than the same class of concrete using CEM I. The converse of this is that to achieve the same *in situ* strength, a lower strength class may be used. Hence, under appropriate circumstances, it may be acceptable to not only benefit from the reduction in heat generation resulting from the inclusion of fly ash or ggbs, but also to achieve a lower binder content associated with a lower strength class. This is similar in effect to specifying the strength at a later age, as sometimes occurs in practice.

An argument against utilizing the benefit from the early age temperature rise with fly ash and ggbs concretes has been that the surface is generally subjected to a lower temperature rise than the centre of a section. However, with the use of plywood formwork, the surface temperature may achieve a level at which it becomes significant and where knowledge is available on the construction process, consideration may be given to specifying either a lower strength class or later age compliance when using fly ash of ggbs concrete.

In order to understand the reasons for the observed scatter, the results have also been presented to shown the effects of strength class (Figure A9.6), time of casting (Figure A9.7) and aggregate type (Figure A9.8).

**Strength class**
The results shown in Figure A9.6 indicate that the *in situ* strength for the lower strength concrete achieved a higher proportion of the cube strength at both 28 days and after 1 year. The difference is small but consistent across the range of mixes. The difference was most apparent for the fly ash concrete after one year and was least apparent for the ggbs concrete.

**Time of casting**
The results shown in Figure A9.7 indicate that the time of casting (winter or summer) had little effect on the relationship between *in situ* strength and cube strength for CEM I and PLC concretes. Similarly, after 1 year, the time of casting had little effect on the fly ash and ggbs concretes. However, the time of casting did have some effect on the *in situ* strength of these mixes at 28 days. As expected, the slower rate of hydration of these mixes resulted in lower early strengths, particularly when the peak temperature was low.

**Aggregate type**
Differences in the gradients of the best fit linear relationships between peak temperature and *in situ*/28-day cube strength indicate that the influence of peak temperature was more detrimental, (or less beneficial) in concrete containing limestone aggregate when compared with gravel aggregate concrete. This indicates that the effect of the early age temperature change is in part mechanical. The coefficient of thermal expansion of limestone is significantly lower than that of quartzite gravel and both are lower than the thermal expansion of cement paste. Hence changes in temperature in limestone aggregate concrete will result in greater differential expansion and contraction between the aggregate and cement paste, leading to localized thermal stresses that may cause micro-cracking and loss of strength. The average difference in the gradient was -0.0042 indicating that, over a temperature change of 40°C limestone aggregate concrete would achieve an *in situ* strength about 17 per cent less than achieved with a gravel aggregate concrete having the same strength at 20 °C. It was also observed, however, that the *in situ* strength of limestone aggregate concrete at 20 °C generally achieved a marginally higher proportion of the cube strength (by about 4 per cent), partially offsetting the effect of the subsequent change in temperature, which reduces to 13% on average at 60 °C.

### A9.1.3 General conclusions relating to strength development

From the analysis of the Concrete Society study, the following may be concluded.

1. The strength development of CEM I concrete was adversely affected by the early temperature cycle to the extent that at 28 days the *in situ* strength may be only 65 per cent of the 28 day cube strength if the peak temperature reaches 60 °C. In the longer term the *in situ* strength increased but after 1 year it was still, on average, only about 85 per cent of the 28-day cube strength if the high peak temperature had been achieved.
2. Concrete containing Portland limestone cement was also adversely affected by the early thermal cycle but to a lesser extent than CEM I concrete. At 28 days the *in situ* strength was typically abut 80 per cent of the 28 day cube strength, increasing to about 90 per cent after one year for concretes achieving 60 °C during the early thermal cycle.
3. The influence of the early thermal cycle on both fly ash and ggbs concretes was to enhance the *in situ* strength at 28 days such that it achieved 100 per cent of the 28 day cube strength within 42 days. After one year the *in situ* strength exceeded the 28-day cube strength by 10 per cent for

those concretes with the highest peak temperature and by a considerably higher margin for concretes experiencing lower peak temperatures.

4. For a given peak temperature, the lower grade of concrete achieved a higher proportion of the 28 day cube strength, with the difference being greatest during the early life of the concrete.
5. The time of casting (winter v summer) had little effect on the relationship between peak temperature and the *in situ* strength relative to the cube strength
6. The aggregate type was significant and indicates that the effect of the early temperature rise will be most detrimental (or less beneficial) for concrete containing lower thermal expansion aggregates (when comparing limestone with quartzite gravel).

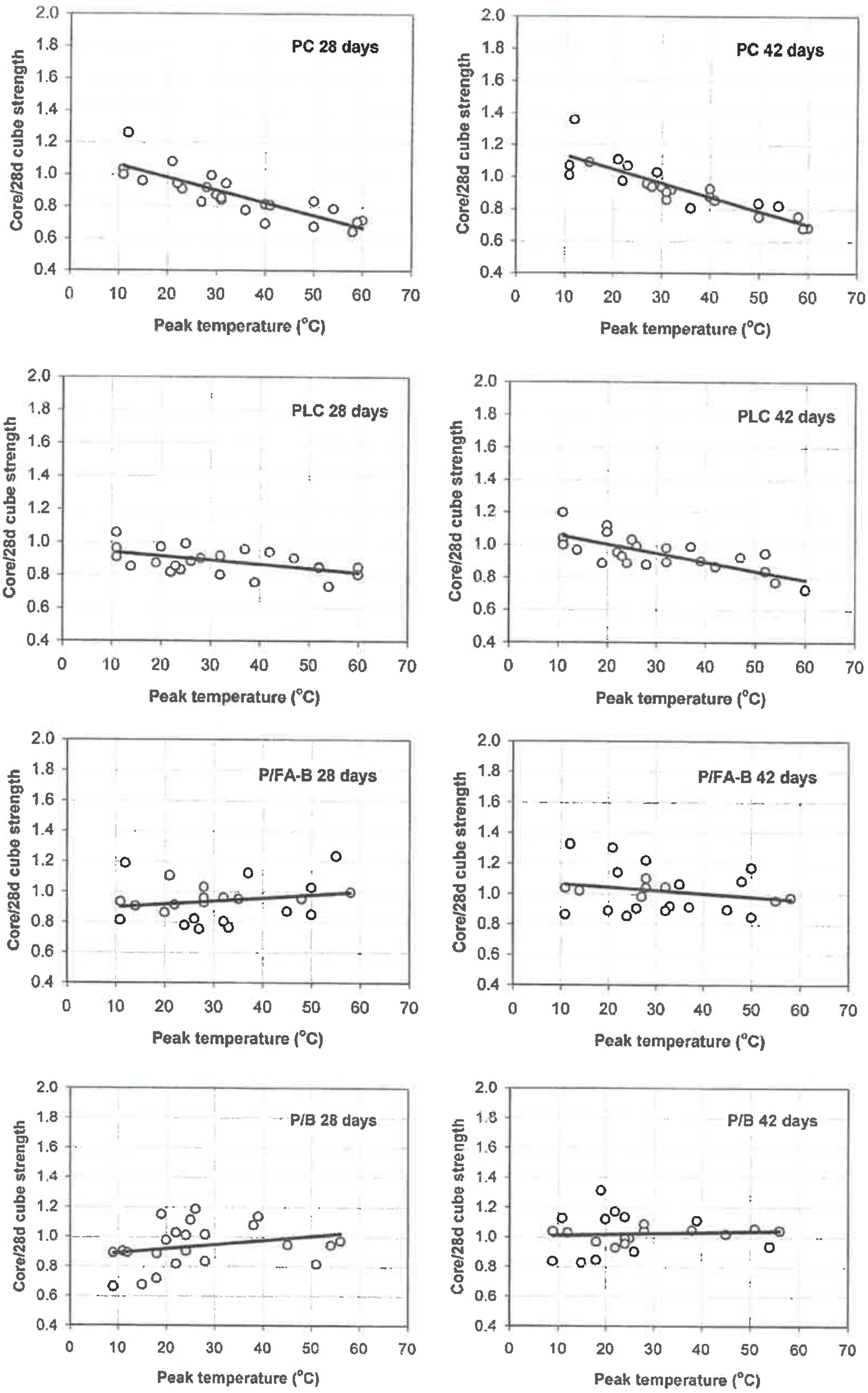

**Figure A9.4** *The influence of the peak temperature achieved during the early thermal cycle on the insitu strength of concrete (at 28 and 42 days) expressed in relation to the 28-day cube strength*

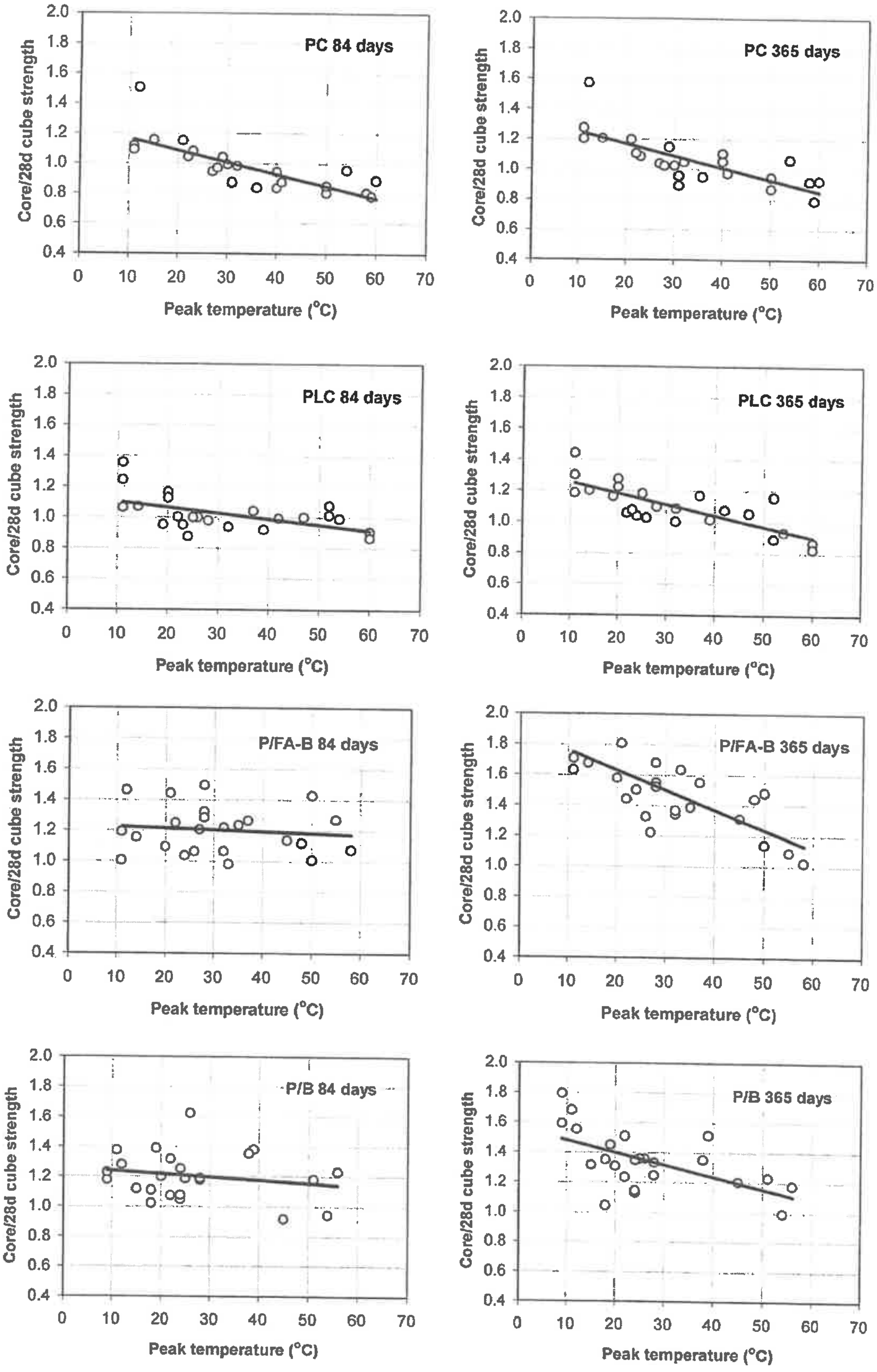

**Figure A9.4 (contd)** *The influence of the peak temperature achieved during the early thermal cycle on the insitu strength of concrete at 84 and 365 days expressed in relation to the 28-day cube strength*

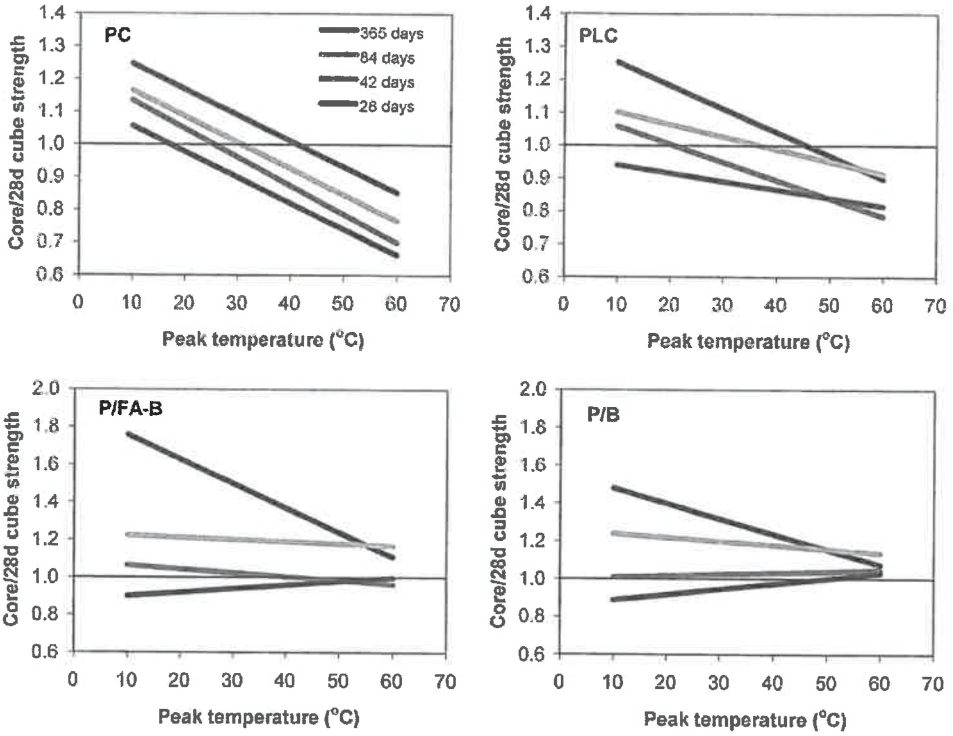

**Figure A9.5** *The relationship between the peak temperature and the strength (relative to the 28-day cube) using CEM I cement , Portland limestone cement (PLC), and combinations of CEM I cement with 30 per cent fly ash cement (P/FA-B) and 50 per cent ggbs (P/B)*

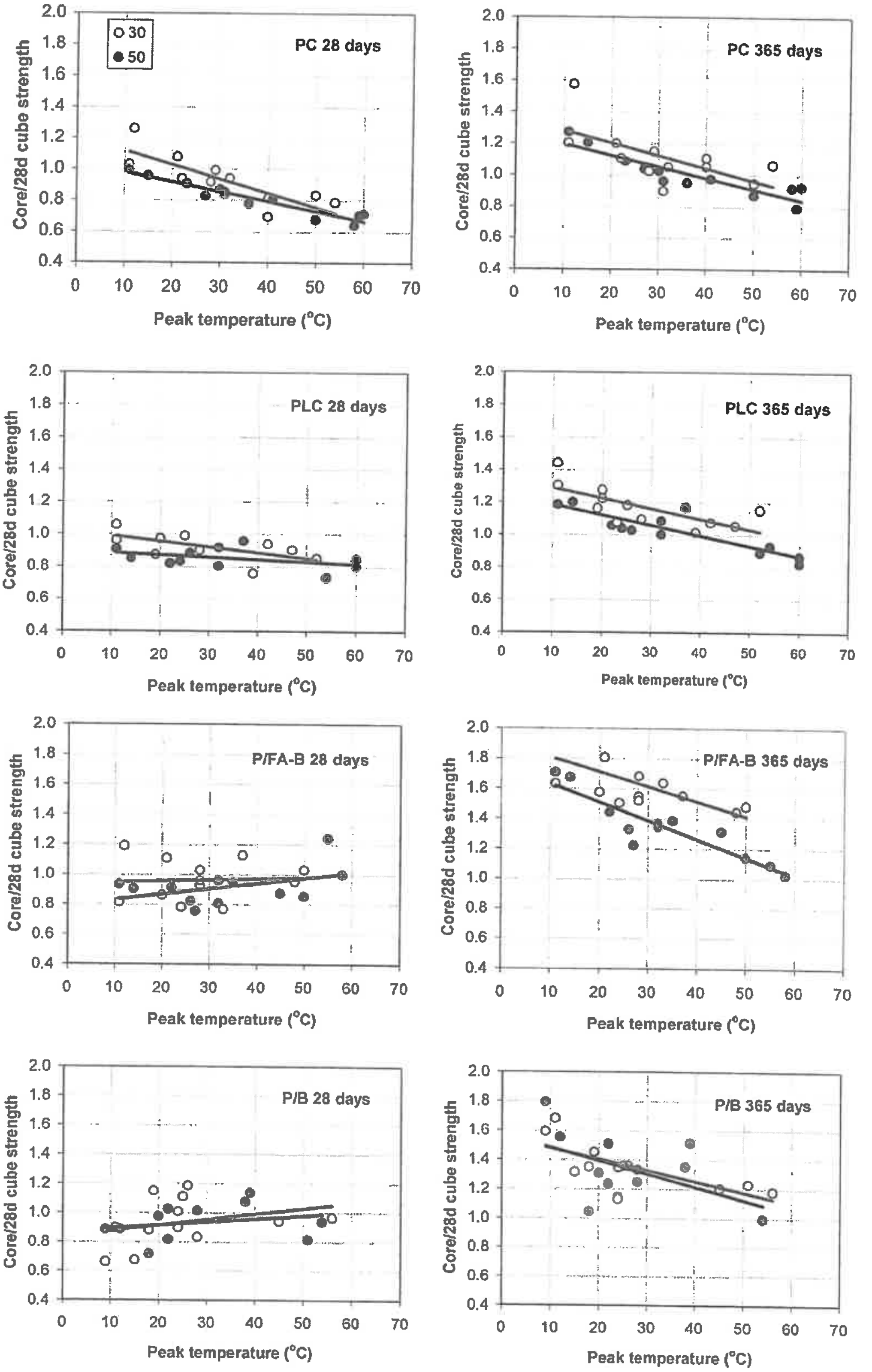

**Figure A9.6** *The relationship between peak temperature and strength as affected by concrete strength class*

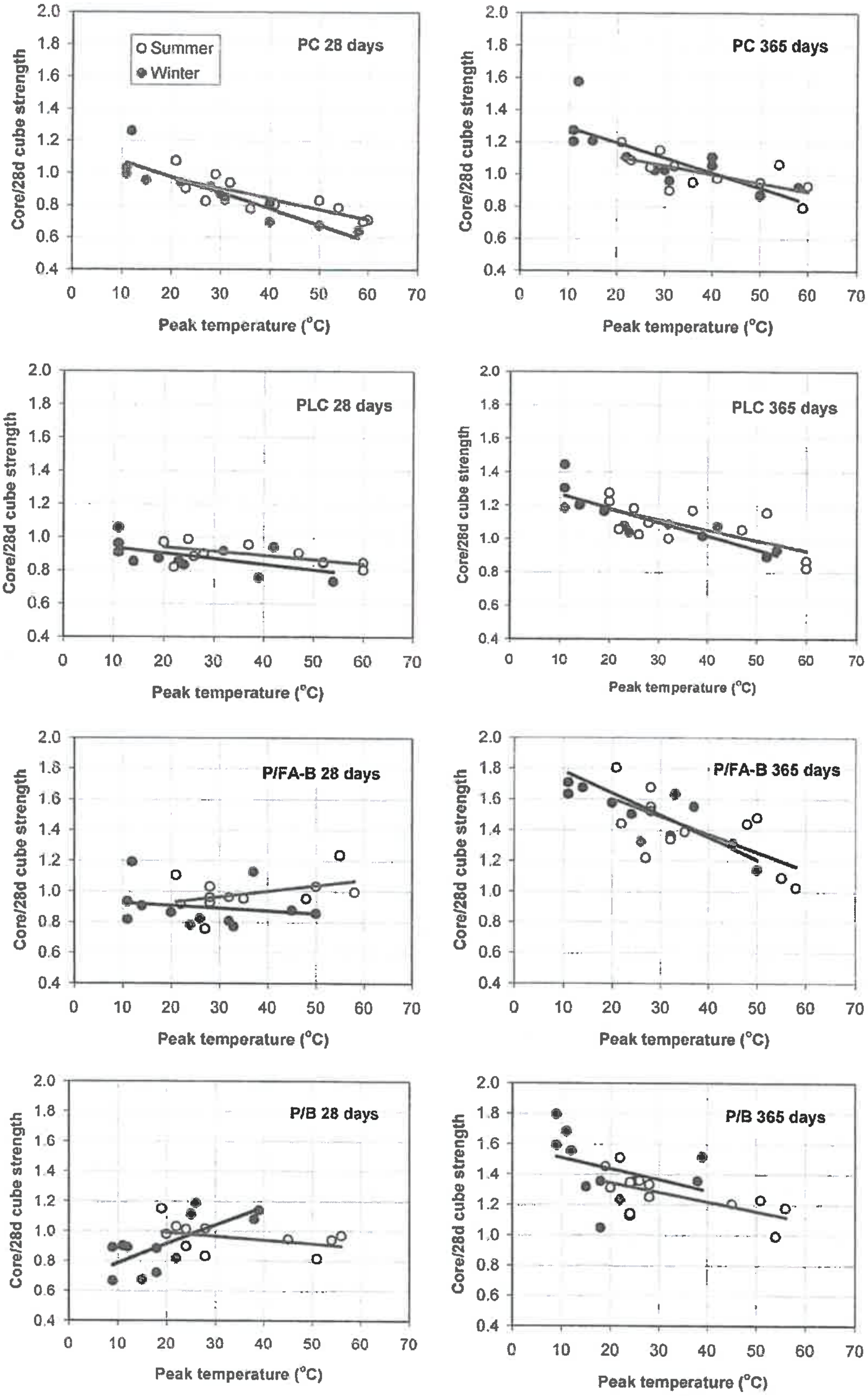

**Figure A9.7** *The relationship between peak temperature and strength as affected by the time of casting (summer v winter)*

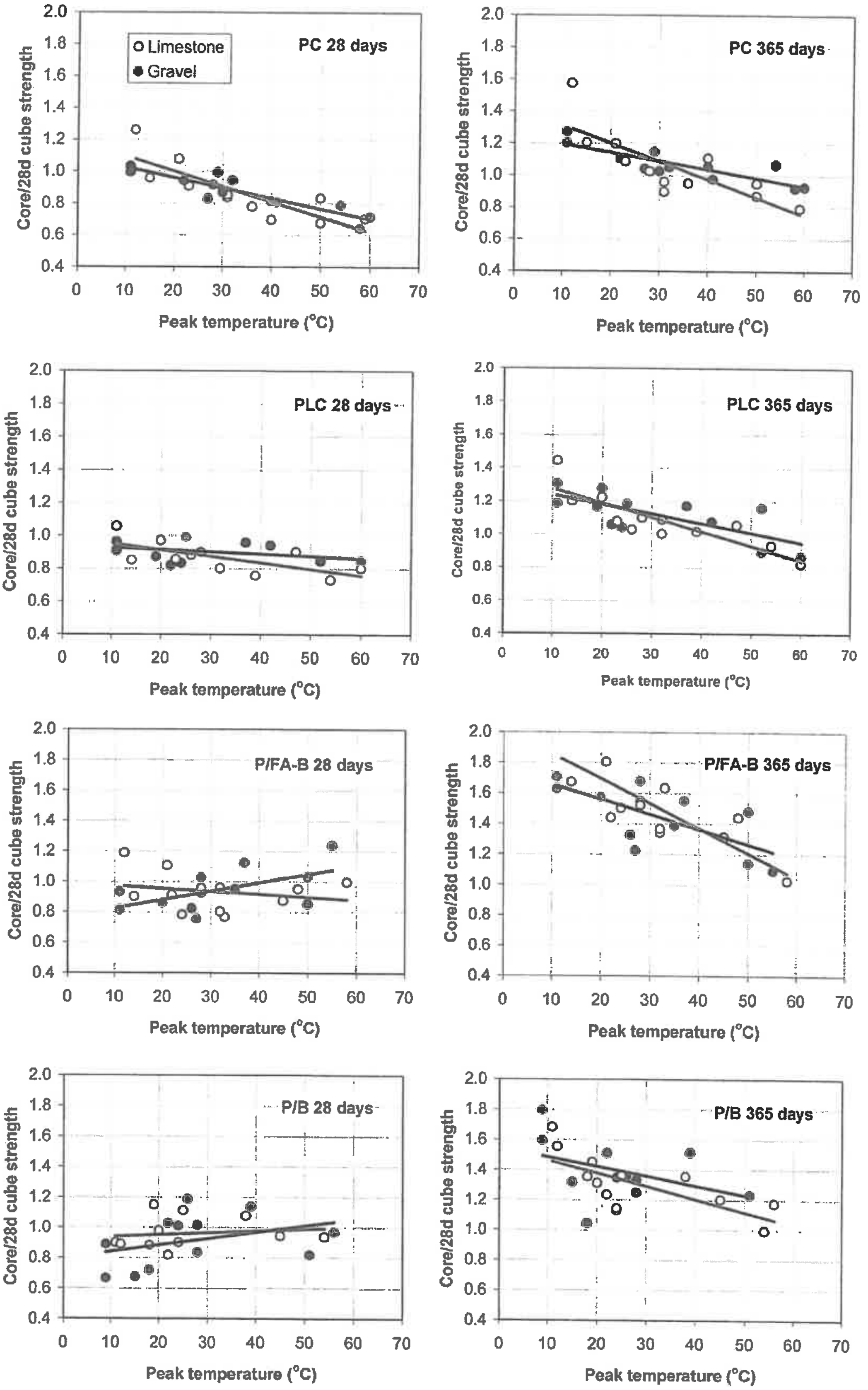

**Figure A9.8** *The relationship between peak temperature and strength as affected by the aggregate type (limestone v gravel)*

## A9.2 Durability

The influence of the early heat cycle on the durability of concrete does not appear to have been widely researched. If it is assumed that there is some correlation between durability and strength for a particular combination of constituent materials, it may be inferred from the Concrete Society study referred to in Section A9.1.2 that CEM I concrete may be adversely affected by the early thermal cycle, while concretes that contain fly ash and ggbs will benefit. However, there is not sufficient data to quantify the effect and enable its application in design.

In a study on high strength concrete containing fly ash, the influence of peak curing temperature on the Rapid Chloride Permeability was measured (Myers *et al*, 2000). An improvement was reported with increasing peak temperature up to about 88 °C. Interestingly, while there was a correlation between performance and peak temperature, no trend was observed with temperature rise. This suggests that the influence is most likely to have been related to chemical rather than physical processes.

## A9.3 Delayed ettringite formation

Delayed ettringite formation (DEF) is a delayed form of sulphate attack and occurs in concrete which has a relatively high sulfate content and which has experienced high temperature during its early hydration. The high temperature decomposes the primary ettringite which is responsible for regulating set, and this reforms later in the life of the concrete. The following guidance is given in BRE IP11/01 (BRE, 2000) in relation to the risk of DEF.

- $T_p < 60$ °C no risk
- $T_p < 70$ °C very low risk
- $T_p < 80$ °C low risk

These above limits apply to Portland cement concretes. BRE IP11/01 states that pfa at levels of > 20 per cent or ggbs at levels of > 40 per cent will prevent DEF-induced expansion in concrete subject to peak temperatures of up to 100 °C.

Hence DEF may be prevented by limiting the peak temperature achieved during the early thermal cycle. The risk of DEF may be reduced most effectively by the use of fly ash of ggbs in suitable quantities which will have the combined effect of both reducing the temperature rise and increasing the temperature at which DEF will occur.

## A9.4 Conclusions

The early-age peak temperature has a significant effect on the strength development of concrete. For concrete using CEM I the strength is impaired by the heat cycle such that at 28-days the heat cycled strength may be only 65 per cent of the standard cube strength. Concrete containing fly ash or ggbs are less adversely affected by the heat cycle and for the same class of concrete will achieve higher *in situ* strength. Hence, the same *in situ* compressive strength may be achieved with fly ash and ggbs concrete when using a lower strength class compared with CEM I concrete. For this reason it may acceptable to measure compliance at an age later than 28 days (56 days is sometimes used) which is itself equivalent to using a lower strength class. This will enable a reduction in binder content, and hence a further reduction in temperature rise and the associated risk and/or extent of early-age thermal cracking.

## A9.5 References

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## Control of cracking due to internal restraint (Wall C40 & 24C)

| Input parameters | Symbol | Unit | Value | |
|---|---|---|---|---|
| **Concrete and steel properties** | | | | |
| Section thickness | $h$ | mm | 1500 | |
| Strength class | $f_{ck}/f_{ck,cube}$ | MPa | C30/37 | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available |
| Creep factor | $K_1$ | | 0.65 | Default = 0.65 |
| Sustained load factor | $K_2$ | | 0.80 | Default = 0.8 |
| Coefficient of thermal expansion | $\alpha_c$ | $\mu\varepsilon$/°C | 10.0 | If aggregate is unknown use 12 |
| Characteristic yield strength of reinforcement | $f_{ky}$ | MPa | 500 | 500 MPa (EN1992-1-1) |
| **Early-age concrete properties** | | | | |
| Tensile strength | $f_{ct,eff}$ | MPa | 1.73 | Mean value of tensile strength, $f_{ctm}(t_c)$ |
| Elastic modulus | $E_c$ | GPa | 28.1 | Mean value of elastic modulus $E_{cm}(t_c)$ |
| Tensile strain capacity under sustained loading | $\varepsilon_{ctu}$ | $\mu\varepsilon$ | 76 | $\varepsilon_{ctu} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ |
| **Early-age strain** | | | | |
| Temperature differential | $\Delta T$ | °C | 24 | $\Delta T$ = *Peak temperature - surface temperature* |
| Free differential strain | $\Delta\varepsilon_{free}$ | $\mu\varepsilon$ | 240 | $\Delta\varepsilon_{free} = \Delta T\, \alpha_c$ |
| Restraint | $R$ | | 0.42 | |
| Restrained differential strain | $\Delta\varepsilon_r$ | $\mu\varepsilon$ | 66 | $\Delta\varepsilon_{r(est)} = R_1\, K_1\, \Delta T\, \alpha_c$ |
| Risk of early-age cracking | $\Delta\varepsilon_r/\varepsilon_{ctu}$ | | 0.86 | Low risk of early-age cracking if $\Delta\varepsilon_r / \varepsilon_{ctu} < 1$ |
| Crack-inducing differential strain | $\Delta\varepsilon_{cr}$ | $\mu\varepsilon$ | 28 | $\Delta\varepsilon_{cr} = R_1\, K_1\, \Delta T\, \alpha_c - 0.5\, \varepsilon_{ctu}$ |
| **Reinforcement details** | | | | |
| Bar diameter | $\varphi$ | mm | 35.35 | |
| Bar spacing | $S$ | mm | 150 | |
| Cover | $c$ | mm | 40 | |
| Area of steel per face per m | $A_s$ | mm$^2$ | 6543 | |
| **Early-age cracking** | | | | |
| Steel ratio for estimating $A_{s,min}$ | $f_{ctm}/f_{yk}$ | | 0.0035 | $f_{ctm}/f_{yk} = \rho_{crit}$ |
| Coefficient | $k$ | | 1.0 | |
| Coefficient | $k_c$ | | 0.5 | |
| Surface zone defining the area of concrete in the tensile zone $A_{ct}$ | $h_{s,min}$ | mm | 300 | $h_{s,min} = 0.2\, h$ |
| Minimum area of steel per face | $A_{s,min}$ | mm$^2$ | 520 | *Highlighted if* $A_s < A_{s,min}$ |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{e,ef}$ | mm | 144.1875 | $h_{e,ef} = 2.5\,(c + \varphi/2)$ *[NB* $h_{s,min}$ *and* $h_{e,ef}$ *are not the same]* |
| Steel ratio for calculating early-age crack spacing | $\rho_{p,eff}$ | | 0.04538 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{e,ef} \times 1000)$ |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | |
| **Crack spacing** | $s_{r,max}$ | mm | 613 | $s_{r,max} = 3.4\, c + 0.425\, k_1\, \varphi / \rho_{p,eff}$ |
| **Crack width** | $w_k$ | mm | 0.01 | $w_k = \Delta\varepsilon_{cr}\, S_{r,max}$ |

## Risk and control of cracking due to continuous edge restraint (Wall C40 & 24C)

| Input parameters | Symbol | Unit | Value | | CIRIA 91<br>BS8007 |
|---|---|---|---|---|---|
| **Section details and material properties** | | | | | |
| Section thickness | $h$ | mm | 1500 | | 500 |
| Strength class | $f_{ck}/f_{ck,cube}$ | MPa | C30/37 | | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available | |
| Creep factor | $K_1$ | | 0.65 | $K_1$ = 0.65 if $R$ is calculated; $K_1$ = 1 if $R$ is assumed to be 0.5 (including creep to EN1992-1-1) | 0.5 |
| Sustained load factor | $K_2$ | | 0.80 | | |
| Coefficient of thermal expansion of concrete | $\alpha_c$ | µε/°C | 10.0 | If aggregate is unknown use 12 µε / °C | 12 |
| Characteristic yield strength of reinforcement | $f_{yk}$ | MPa | 500 | 500 Mpa | 460 |
| **Early age concrete properties** | | | | | |
| Tensile strength at cracking | $f_{ctm}(t_c)$ | MPa | 1.73 | Mean value of tensile strength $f_{ctm}(t_c)$ | 1.61 |
| Elastic modulus | $E_{cm}(t_c)$ | GPa | 28.1 | Mean value of elastic modulus $E_{cm}(t_c)$ | |
| Tensile strain capacity | $\varepsilon_{ctu(ea)}$ | µε | 76 | $\varepsilon_{ctu(ea)} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ | 65 |
| **Long term concrete properties** | | | | | |
| Tensile strength | $f_{ctm}$ | MPa | 2.90 | Mean 28-day value | |
| Elastic modulus | $E_{cm}$ | GPa | 32.8 | Mean 28-day value | |
| Tensile strain capacity (sustained loading) | $\varepsilon_{ctu(lt)}$ | µε | 109 | $\varepsilon_{ctu(lt)} = [f_{ctm} / E_{cm}] \times [K_2 / K_1]$ | 130 |
| **Early-age strain** | | | | | |
| Temperature drop | $T_1$ | °C | 24 | $T_1$ = Peak temperature - mean ambient temperature | 34 |
| Autogenous shrinkage | $\varepsilon_{ca(ea)}$ | µε | 15 | EN1992-1-1 $\varepsilon_{ca(ea)} = 2.5 (f_{ck} - 10) \times (1\text{-exp}(-0.2\,t_c^{0.5})$ | |
| Free contraction | $\varepsilon_{free(ea)}$ | µε | 255 | $\varepsilon_{free(ea)} = T_1 \alpha_c + \varepsilon_{ca}$ | 408 |
| **Restrained early-age strain and risk of cracking** | | | | | |
| Restraint | $R$ | | 0.80 | *Use restraint calculator for walls or adjacent slabs; or historical data* | 1 |
| Early-age restrained contraction | $\varepsilon_{r(ea)}$ | µε | 132 | $\varepsilon_{r(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca})$ | 204 |
| Risk of early age cracking | $\varepsilon_{r(ea)}/\varepsilon_{ctu}$ | | 2.18 | Low risk of early age cracking if $\varepsilon_{r(ea)}/\varepsilon_{ctu} < 1$. | 3.14 |
| Early-age crack-inducing strain | $\varepsilon_{cr(ea)}$ | µε | 95 | $\varepsilon_{c(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca}) - 0.5\,\varepsilon_{ctu}$ | 172 |
| **Long term strain (excluding early-age strain)** | | | | | |
| Autogenous shrinkage (residual up to 28 days) | $\delta\varepsilon_{ca(lt)}$ | µε | 18 | $\delta\varepsilon_{ca(lt)} = \varepsilon_{ca(28)} - \varepsilon_{ca(ea)}$ | |
| Long term temperature change | $T_2$ | °C | 20 | *$T_2$ and $\varepsilon_{cd}$ only apply when causing differential contraction or when the sections acting integrally are subject to external restraint.* | 20 |
| Drying shrinkage | $\varepsilon_{cd}$ | µε | 150 | | 100 |
| Long term free contraction | $\varepsilon_{free(lt)}$ | µε | 368 | $\varepsilon_{free(lt)} = \delta\varepsilon_{ca} + T_2 \alpha_c + \varepsilon_{cd}$ | 340 |
| **Restrained long term strain** | | | | | |
| Restraint to long term thermal strains | $R_2$ | | 0.80 | Restraint will reduce as $E_n / E_o$ approaches 1 in the long term | 1 |
| Restraint to drying shrinkage | $R_3$ | | 0.80 | | 1 |
| Long term restrained strain | $\varepsilon_{free(lt)}$ | µε | 191 | $\varepsilon_{c(lt)} = K_1 \{R_2 T_2 \alpha_c + R_3 (\delta\varepsilon_{ca} + \varepsilon_{cd})\}$ | 170 |
| Increase in tensile strain capacity | $\delta\varepsilon_{ctu}$ | µε | 33 | $\delta\varepsilon_{ctu} = \varepsilon_{ctu(28)} - \varepsilon_{ctu(ea)}$ | 65 |
| Long term crack-inducing strain | $\varepsilon_{cr(lt)}$ | | 159 | $\varepsilon_{c(lt)} = K_1 \{R_2 T_2 \alpha_c + R_3 (\delta\varepsilon_{ca} + \varepsilon_{cd})\} - \delta\varepsilon_{ctu}$ | 105 |
| **Total strain (early-age + long term)** | | | | | |
| Free contraction | $\varepsilon_{r(total)}$ | µε | 623 | $\varepsilon_{free(total)} = \varepsilon_{free(ea)} + \varepsilon_{free(lt)}$ | 748 |
| Restrained contraction | $\varepsilon_{r(total)}$ | µε | 324 | $\varepsilon_{r(total)} = \varepsilon_{r(ea)} + \varepsilon_{r(lt)}$ | 374 |
| Crack-inducing strain | $\varepsilon_{cr(total)}$ | µε | 253 | $\varepsilon_{cr(total)} = \varepsilon_{cr(ea)} + \varepsilon_{cr(lt)}$ | 277 |
| **Reinforcement details** | | | | | |
| Bar diameter | $\varphi$ | mm | 35.35 | | 16 |
| Bar spacing | $s$ | mm | 150 | | 175 |
| Cover | $c$ | mm | 40 | | 40 |
| Area of steel per face per m | $A_s$ | mm² | 6543 | | 1149 |
| **Cracking initiated at early age strain** | | | | | |
| **Minimum area of reinforcement $A_{s,min}$** | | | | | |
| Steel ratio for early age cracking | $f_{ctm}/f_{yk}$ | | 0.00347 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0035 |
| Coefficient | $k$ | | 0.75 | $k$ = 1.0 for $h \leq$ 300mm; $k$ = 0.75 for $h \geq$ 800mm; intermediate values are interpolated | |
| Coefficient | $k_c$ | | 1 | For pure tension $k_c$ = 1 | |
| Surface zone used in calculating $A_{s,min}$ | $h_{s,min}$ | mm | 563 | $h_{s,min} = k\,k_c\,h/2$ | 250 |
| Minimum area of steel per face per m | $A_{s,min}$ | mm² | 1949 | $A_{s,min} = (h_{s,min} \times 1000)(f_{ctm} / f_{yk})$ Highlighted if $A_s < A_{s,min}$ | 875 |
| **Crack spacing and width** | | | | | |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{c,ef}$ | mm | 144.1875 | $h_{c,ef} = 2.5 (c + \varphi/2)$ *[NOTE: $h_{s,min}$ and $h_{c,ef}$ are not the same]* | 250 |
| Steel ratio for estimating crack spacing | $\rho_{p,eff}$ | | 0.04538 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{c,ef} \times 1000)$ | 0.00460 |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | EN1992-1-1 recommends $k_1$ = 0.8 but provides a factor of 0.7 where good bond cannot be guaranteed. Hence $k_1$ = 0.8/0.7 = 1.14 | 0.67 |
| Crack spacing | $S_{r,max}$ | mm | 513 | $S_{r,max} = 3.4c + 0.425\,k_1\,\varphi/\rho_{p,eff}$ | 1168 |
| Early age crack width | $w_k$ | mm | 0.05 | $w_k = \varepsilon_{c(ea)}\,S_{r,max}$ | 0.20 |
| Long term crack width | $w_k$ | mm | 0.13 | $w_k = \varepsilon_{c(total)}\,S_{r,max}$ | 0.32 |
| **Minimum reinforcement requirement for late-life cracking only** | | | | | |
| Steel ratio for late-life cracking | $f_{ctm}/f_{yk}$ | | 0.0058 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0033 |
| Minimum area of steel per face | $A_{s,min}$ | mm² | 3259 | *Highlighted if $A_s < A_{s,min}$* | 815 |

## Control of cracking due to internal restraint (Wall C60 & 37C)

| Input parameters | Symbol | Unit | Value | |
|---|---|---|---|---|
| **Concrete and steel properties** | | | | |
| Section thickness | $h$ | mm | 1500 | |
| Strength class | $f_{ck}/f_{ck,cube}$ | MPa | C50/60 | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available |
| Creep factor | $K_1$ | | 0.65 | Default = 0.65 |
| Sustained load factor | $K_2$ | | 0.80 | Default = 0.8 |
| Coefficient of thermal expansion | $\alpha_c$ | $\mu\varepsilon$/°C | 10.0 | If aggregate is unknown use 12 |
| Characteristic yield strength of reinforcement | $f_{ky}$ | MPa | 500 | 500 MPa (EN1992-1-1) |
| **Early-age concrete properties** | | | | |
| Tensile strength | $f_{ct,eff}$ | MPa | 2.44 | Mean value of tensile strength, $f_{ctm}(t_c)$ |
| Elastic modulus | $E_c$ | GPa | 32.0 | Mean value of elastic modulus $E_{cm}(t_c)$ |
| Tensile strain capacity under sustained loading | $\varepsilon_{ctu}$ | $\mu\varepsilon$ | 94 | $\varepsilon_{ctu} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ |
| **Early-age strain** | | | | |
| Temperature differential | $\Delta T$ | °C | 37 | $\Delta T$ = *Peak temperature - surface temperature* |
| Free differential strain | $\Delta\varepsilon_{free}$ | $\mu\varepsilon$ | 370 | $\Delta\varepsilon_{free} = \Delta T \alpha_c$ |
| Restraint | $R$ | | 0.42 | |
| Restrained differential strain | $\Delta\varepsilon_r$ | $\mu\varepsilon$ | 101 | $\Delta\varepsilon_{r(ea)} = R_1 K_1 \Delta T \alpha_c$ |
| Risk of early-age cracking | $\Delta\varepsilon_r/\varepsilon_{ctu}$ | | 1.08 | Low risk of early-age cracking if $\Delta\varepsilon_r / \varepsilon_{ctu} < 1$. |
| Crack-inducing differential strain | $\Delta\varepsilon_{cr}$ | $\mu\varepsilon$ | 54 | $\Delta\varepsilon_{cr} = R_1 K_1 \Delta T \alpha_c - 0.5 \varepsilon_{ctu}$ |
| **Reinforcement details** | | | | |
| Bar diameter | $\varphi$ | mm | 35.35 | |
| Bar spacing | $S$ | mm | 150 | |
| Cover | $c$ | mm | 40 | |
| Area of steel per face per m | $A_s$ | mm² | 6543 | |
| **Early-age cracking** | | | | |
| Steel ratio for estimating $A_{s,min}$ | $f_{ctm}/f_{yk}$ | | 0.0049 | $f_{ctm}/f_{yk} = \rho_{crit}$ |
| Coefficient | $k$ | | 1.0 | |
| Coefficient | $k_c$ | | 0.5 | |
| Surface zone defining the area of concrete in the tensile zone $A_{ct}$ | $h_{s,min}$ | mm | 300 | $h_{s,min} = 0.2\,h$ |
| Minimum area of steel per face | $A_{s,min}$ | mm² | 731 | *Highlighted if* $A_s < A_{s,min}$ |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{e,ef}$ | mm | 144.1875 | $h_{e,ef} = 2.5\,(c + \varphi/2)$ ***[NB h*** $_{s,min}$ ***and h*** $_{e,ef}$ ***are not the same]*** |
| Steel ratio for calculating early-age crack spacing | $\rho_{p,eff}$ | | 0.04538 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{e,ef} \times 1000)$ |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | |
| **Crack spacing** | $s_{r,max}$ | mm | 513 | $s_{r,max} = 3.4\,c + 0.425\,k_1\,\varphi / \rho_{p,eff}$ |
| **Crack width** | $w_k$ | mm | 0.03 | $w_k = \Delta\varepsilon_{cr}\,S_{r,max}$ |

## Risk and control of cracking due to continuous edge restraint (Wall C60 & 37C)

| Input parameters | Symbol | Unit | Value | | CIRIA 91 BS8007 |
|---|---|---|---|---|---|
| **Section details and material properties** | | | | | |
| Section thickness | $h$ | mm | 1500 | | 500 |
| Strength class | $f_{ck} / f_{ck.cube}$ | MPa | C50/60 | | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available | |
| Creep factor | $K_1$ | | 0.65 | $K_1$ = 0.65 if $R$ is calculated; $K_1$ = 1 if $R$ is assumed to be 0.5 (including creep to EN1992-1-1) | 0.5 |
| Sustained load factor | $K_2$ | | 0.80 | | |
| Coefficient of thermal expansion of concrete | $\alpha_c$ | με/°C | 10.0 | If aggregate is unknown use 12 με / °C | 12 |
| Characteristic yield strength of reinforcement | $f_{yk}$ | MPa | 500 | 500 Mpa | 460 |
| **Early age concrete properties** | | | | | |
| Tensile strength at cracking | $f_{ctm}(t_c)$ | MPa | 2.44 | Mean value of tensile strength $f_{ctm}(t_c)$ | 1.61 |
| Elastic modulus | $E_{cm}(t_c)$ | GPa | 32.0 | Mean value of elastic modulus $E_{cm}(t_c)$ | |
| Tensile strain capacity | $\varepsilon_{ctu(ea)}$ | με | 94 | $\varepsilon_{ctu(ea)} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ | 65 |
| **Long term concrete properties** | | | | | |
| Tensile strength | $f_{ctm}$ | MPa | 4.07 | Mean 28-day value | |
| Elastic modulus | $E_{cm}$ | GPa | 37.3 | Mean 28-day value | |
| Tensile strain capacity (sustained loading) | $\varepsilon_{ctu(lt)}$ | με | 134 | $\varepsilon_{ctu(lt)} = [f_{ctm} / E_{cm}] \times [K_2 / K_1]$ | 130 |
| **Early-age strain** | | | | | |
| Temperature drop | $T_1$ | °C | 37 | $T_1$ = Peak temperature - mean ambient temperature | 34 |
| Autogenous shrinkage | $\varepsilon_{ca(ea)}$ | με | 29 | EN1992-1-1 $\varepsilon_{ca(ea)} = 2.5\,(f_{ck} - 10) \times (1\text{-exp}(-0.2\,t_c^{0.5})$ | |
| **Free contraction** | $\varepsilon_{free(ea)}$ | με | 399 | $\varepsilon_{free(ea)} = T_1 \alpha_c + \varepsilon_{ca}$ | 408 |
| **Restrained early-age strain and risk of cracking** | | | | | |
| Restraint | $R$ | | 0.80 | *Use restraint calculator for walls or adjacent slabs; or historical data* | 1 |
| **Early-age restrained contraction** | $\varepsilon_{r(ea)}$ | με | 208 | $\varepsilon_{r(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca})$ | **204** |
| Risk of early age cracking | $\varepsilon_{r(ea)} / \varepsilon_{ctu}$ | | 2.77 | Low risk of early age cracking if $\varepsilon_{r(ea)} / \varepsilon_{ctu} < 1$. | **3.14** |
| **Early-age crack-inducing strain** | $\varepsilon_{cr(ea)}$ | με | 161 | $\varepsilon_{c(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca}) - 0.5\,\varepsilon_{ctu}$ | **172** |
| **Long term strain (excluding early-age strain)** | | | | | |
| Autogenous shrinkage (residual up to 28 days) | $\delta\varepsilon_{ca(lt)}$ | με | 36 | $\delta\varepsilon_{ca(lt)} = \varepsilon_{ca(28)} - \varepsilon_{ca(ea)}$ | |
| Long term temperature change | $T_2$ | °C | 20 | *$T_2$ and $\varepsilon_{cd}$ only apply when causing differential contraction or when the sections acting integrally are subject to external restraint.* | 20 |
| Drying shrinkage | $\varepsilon_{cd}$ | με | 150 | | 100 |
| **Long term free contraction** | $\varepsilon_{free(lt)}$ | με | 386 | $\varepsilon_{free(lt)} = \delta\varepsilon_{ca} + T_2 \alpha_c + \varepsilon_{cd}$ | 340 |
| **Restrained long term strain** | | | | | |
| Restraint to long term thermal strains | $R_2$ | | 0.80 | Restraint will reduce as $E_n / E_o$ approaches 1 in the long term | **1** |
| Restraint to drying shrinkage | $R_3$ | | 0.80 | | **1** |
| **Long term restrained strain** | $\varepsilon_{free(lt)}$ | με | 201 | $\varepsilon_{r(lt)} = K_1 \{R_2 T_2 \alpha_c + R_3 (\delta\varepsilon_{ca} + \varepsilon_{cd})\}$ | **170** |
| Increase in tensile strain capacity | $\delta\varepsilon_{ctu}$ | με | 41 | $\delta\varepsilon_{ctu} = \varepsilon_{ctu(28)} - \varepsilon_{ctu(ea)}$ | 65 |
| **Long term crack-inducing strain** | $\varepsilon_{cr(lt)}$ | | 160 | $\varepsilon_{c(lt)} = K_1 \{R_2 T_2 \alpha_c + R_3 (\delta\varepsilon_{ca} + \varepsilon_{cd})\} - \delta\varepsilon_{ctu}$ | 105 |
| **Total strain (early-age + long term)** | | | | | |
| **Free contraction** | $\varepsilon_{r(total)}$ | με | 785 | $\varepsilon_{free(total)} = \varepsilon_{free(ea)} + \varepsilon_{free(lt)}$ | 748 |
| **Restrained contraction** | $\varepsilon_{r(total)}$ | με | 408 | $\varepsilon_{r(total)} = \varepsilon_{r(ea)} + \varepsilon_{r(lt)}$ | 374 |
| **Crack-inducing strain** | $\varepsilon_{cr(total)}$ | με | 321 | $\varepsilon_{cr(total)} = \varepsilon_{cr(ea)} + \varepsilon_{cr(lt)}$ | 277 |
| **Reinforcement details** | | | | | |
| Bar diameter | $\varphi$ | mm | 35.35 | | 16 |
| Bar spacing | $s$ | mm | 150 | | 175 |
| Cover | $c$ | mm | 40 | | 40 |
| **Area of steel per face per m** | $A_s$ | mm² | **6543** | | 1149 |
| **Cracking initiated at early age strain** | | | | | |
| **Minimum area of reinforcement $A_{s,min}$** | | | | | |
| Steel ratio for early age cracking | $f_{ctm}/f_{yk}$ | | 0.00487 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0035 |
| Coefficient | $k$ | | 0.75 | $k$ = 1.0 for $h \le 300$mm; $k$ = 0.75 for $h \ge 800$mm; intermediate values are interpolated | |
| Coefficient | $k_c$ | | 1 | For pure tension $k_c = 1$ | |
| Surface zone used in calculating $A_{s,min}$ | $h_{s,min}$ | mm | 563 | $h_{s,min} = k\,k_c\,h/2$ | 250 |
| **Minimum area of steel per face per m** | $A_{s,min}$ | mm² | 2740 | $A_{s,min} = (h_{s,min} \times 1000)\,(f_{ctm} / f_{yk})$ Highlighted if $A_s < A_{s,min}$ | 875 |
| **Crack spacing and width** | | | | | |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{e,ef}$ | mm | 144.1875 | $h_{e,ef} = 2.5\,(c + \varphi/2)$ *[NOTE: $h_{s,min}$ and $h_{e,ef}$ are not the same]* | 250 |
| Steel ratio for estimating crack spacing | $\rho_{p,eff}$ | | 0.04538 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{e,ef} \times 1000)$ | 0.00460 |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | EN1992-1-1 recommends $k_1$ = 0.8 but provides a factor of 0.7 where good bond cannot be guaranteed. Hence $k_1$ = 0.8/0.7 = 1.14 | 0.67 |
| **Crack spacing** | $S_{r,max}$ | mm | 613 | $S_{r,max} = 3.4c + 0.425\,k_1\,\varphi/\rho_{p,eff}$ | 1166 |
| **Early age crack width** | $w_k$ | mm | 0.08 | $w_k = \varepsilon_{c(ea)}\,S_{r,max}$ | 0.20 |
| **Long term crack width** | $w_k$ | mm | 0.16 | $w_k = \varepsilon_{c(total)}\,S_{r,max}$ | 0.32 |
| **Minimum reinforcement requirement for late-life cracking only** | | | | | |
| Steel ratio for late-life cracking | $f_{ctm}/f_{yk}$ | | 0.0081 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0033 |
| **Minimum area of steel per face** | $A_{s,min}$ | mm² | 4581 | *Highlighted if $A_s < A_{s,min}$* | 815 |

## Control of cracking due to internal restraint (Base slab C40 & 24C)

| Input parameters | Symbol | Unit | Value | |
|---|---|---|---|---|
| **Concrete and steel properties** | | | | |
| Section thickness | $h$ | mm | 2500 | |
| Strength class | $f_{ck}/f_{ck,cube}$ | MPa | C30/37 | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available |
| Creep factor | $K_1$ | | 0.65 | Default = 0.65 |
| Sustained load factor | $K_2$ | | 0.80 | Default = 0.8 |
| Coefficient of thermal expansion | $\alpha_c$ | $\mu\varepsilon/°C$ | 10.0 | If aggregate is unknown use 12 |
| Characteristic yield strength of reinforcement | $f_{ky}$ | MPa | 500 | 500 MPa (EN1992-1-1) |
| **Early-age concrete properties** | | | | |
| Tensile strength | $f_{ct,eff}$ | MPa | 1.73 | Mean value of tensile strength, $f_{ctm}(t_c)$ |
| Elastic modulus | $E_c$ | GPa | 28.1 | Mean value of elastic modulus $E_{cm}(t_c)$ |
| Tensile strain capacity under sustained loading | $\varepsilon_{ctu}$ | $\mu\varepsilon$ | 76 | $\varepsilon_{ctu} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ |
| **Early-age strain** | | | | |
| Temperature differential | $\Delta T$ | °C | 24 | $\Delta T$ = *Peak temperature - surface temperature* |
| Free differential strain | $\Delta\varepsilon_{free}$ | $\mu\varepsilon$ | 240 | $\Delta\varepsilon_{free} = \Delta T \alpha_c$ |
| Restraint | $R$ | | 0.42 | |
| Restrained differential strain | $\Delta\varepsilon_r$ | $\mu\varepsilon$ | 66 | $\Delta\varepsilon_{r(ea)} = R_1 K_1 \Delta T \alpha_c$ |
| Risk of early-age cracking | $\Delta\varepsilon_r / \varepsilon_{ctu}$ | | 0.86 | Low risk of early-age cracking if $\Delta\varepsilon_r / \varepsilon_{ctu} < 1$ |
| Crack-inducing differential strain | $\Delta\varepsilon_{cr}$ | $\mu\varepsilon$ | 28 | $\Delta\varepsilon_{cr} = R_1 K_1 \Delta T \alpha_c - 0.5 \varepsilon_{ctu}$ |
| **Reinforcement details** | | | | |
| Bar diameter | $\varphi$ | mm | 56.57 | |
| Bar spacing | $S$ | mm | 150 | |
| Cover | $c$ | mm | 40 | |
| **Area of steel per face per m** | $A_s$ | $mm^2$ | 16756 | |
| **Early-age cracking** | | | | |
| Steel ratio for estimating $A_{s,min}$ | $f_{ctm}/f_{yk}$ | | 0.0035 | $f_{ctm}/f_{yk} = \rho_{crit}$ |
| Coefficient | $k$ | | 1.0 | |
| Coefficient | $k_c$ | | 0.5 | |
| Surface zone defining the area of concrete in the tensile zone $A_{ct}$ | $h_{s,min}$ | mm | 500 | $h_{s,min} = 0.2\ h$ |
| Minimum area of steel per face | $A_{s,min}$ | $mm^2$ | 866 | *Highlighted if* $A_s < A_{s,min}$ |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{e,ef}$ | mm | 170.7125 | $h_{e,ef} = 2.5\ (c + \varphi/2)$ ***[NB*** $h_{s,min}$ ***and*** $h_{e,ef}$ ***are not the same]*** |
| Steel ratio for calculating early-age crack spacing | $\rho_{p,eff}$ | | 0.09815 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{e,ef} \times 1000)$ |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | |
| **Crack spacing** | $S_{r,max}$ | mm | 415 | $S_{r,max} = 3.4\ c + 0.425\ k_1\ \varphi / \rho_{p,eff}$ |
| **Crack width** | $w_k$ | mm | 0.01 | $w_k = \Delta\varepsilon_{cr}\ S_{r,max}$ |

## Risk and control of cracking due to continuous edge restraint (Base slab C40 & 24C)

| Input parameters | Symbol | Unit | Value | | CIRIA 91<br>BS8007 |
|---|---|---|---|---|---|
| **Section details and material properties** | | | | | |
| Section thickness | $h$ | mm | 2500 | | 500 |
| Strength class | $f_{ck} / f_{ck,cube}$ | MPa | C30/37 | | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available | |
| Creep factor | $K_1$ | | 0.65 | $K_1$ = 0.65 if $R$ is calculated; $K_1$ = 1 if $R$ is assumed to be 0.5 (including creep to EN1992-1-1) | 0.5 |
| Sustained load factor | $K_2$ | | 0.80 | | |
| Coefficient of thermal expansion of concrete | $\alpha_c$ | µε/°C | 10.0 | If aggregate is unknown use 12 µε / °C | 12 |
| Characteristic yield strength of reinforcement | $f_{yk}$ | MPa | 500 | 500 Mpa | 460 |
| **Early age concrete properties** | | | | | |
| Tensile strength at cracking | $f_{ctm}(t_c)$ | MPa | 1.73 | Mean value of tensile strength $f_{ctm}(t_c)$ | 1.61 |
| Elastic modulus | $E_{cm}(t_o)$ | GPa | 28.1 | Mean value of elastic modulus $E_{cm}(t_c)$ | |
| Tensile strain capacity | $\varepsilon_{ctu(ea)}$ | µε | 76 | $\varepsilon_{ctu(ea)} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ | 65 |
| **Long term concrete properties** | | | | | |
| Tensile strength | $f_{ctm}$ | MPa | 2.90 | Mean 28-day value | |
| Elastic modulus | $E_{cm}$ | GPa | 32.8 | Mean 28-day value | |
| Tensile strain capacity (sustained loading) | $\varepsilon_{ctu(lt)}$ | µε | 109 | $\varepsilon_{ctu(lt)} = [f_{ctm} / E_{cm}] \times [K_2 / K_1]$ | 130 |
| **Early-age strain** | | | | | |
| Temperature drop | $T_1$ | °C | 24 | $T_1$ = Peak temperature - mean ambient temperature | 34 |
| Autogenous shrinkage | $\varepsilon_{ca(ea)}$ | µε | 15 | EN1992-1-1 $\varepsilon_{ca(ea)} = 2.5 (f_{ck} - 10) \times (1\text{-}\exp(-0.2\, t_c^{0.5})$ | |
| Free contraction | $\varepsilon_{free(ea)}$ | µε | 255 | $\varepsilon_{free(ea)} = T_1 \alpha_c + \varepsilon_{ca}$ | 408 |
| **Restrained early-age strain and risk of cracking** | | | | | |
| Restraint | $R$ | | 0.80 | *Use restraint calculator for walls or adjecent slabs; or historical data* | **1** |
| Early-age restrained contraction | $\varepsilon_{r(ea)}$ | µε | 132 | $\varepsilon_{r(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca})$ | **204** |
| Risk of early age cracking | $\varepsilon_{r(ea)}/\varepsilon_{ctu}$ | | 2.18 | Low risk of early age cracking if $\varepsilon_{r(ea)}/\varepsilon_{ctu} < 1$. | **3.14** |
| Early-age crack-inducing strain | $\varepsilon_{cr(ea)}$ | µε | 95 | $\varepsilon_{c(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca}) - 0.5\, \varepsilon_{ctu}$ | **172** |
| **Long term strain (excluding early-age strain)** | | | | | |
| Autogenous shrinkage (residual up to 28 days) | $\delta\varepsilon_{ca(lt)}$ | µε | 18 | $\delta\varepsilon_{ca(lt)} = \varepsilon_{ca(28)} - \varepsilon_{ca(ea)}$ | |
| Long term temperature change | $T_2$ | °C | 20 | *$T_2$ and $\varepsilon_{cd}$ only apply when causing differential contraction or when the sections acting integrally are subject to external restraint.* | 20 |
| Drying shrinkage | $\varepsilon_{cd}$ | µε | 150 | | 100 |
| Long term free contraction | $\varepsilon_{free(lt)}$ | µε | 368 | $\varepsilon_{free(lt)} = \delta\varepsilon_{ca} + T_2 \alpha_c + \varepsilon_{cd}$ | 340 |
| **Restrained long term strain** | | | | | |
| Restraint to long term thermal strains | $R_2$ | | 0.80 | Restraint will reduce as $E_n / E_o$ approaches 1 in the long term | 1 |
| Restraint to drying shrinkage | $R_3$ | | 0.80 | | 1 |
| Long term restrained strain | $\varepsilon_{free(lt)}$ | µε | 191 | $\varepsilon_{r(lt)} = K_1 \{R_2 T_2 \alpha_c + R_3(\delta\varepsilon_{ca} + \varepsilon_{cd})\}$ | 170 |
| Increase in tensile strain capacity | $\delta\varepsilon_{ctu}$ | µε | 33 | $\delta\varepsilon_{ctu} = \varepsilon_{ctu(28)} - \varepsilon_{ctu(ea)}$ | 65 |
| Long term crack-inducing strain | $\varepsilon_{cr(lt)}$ | | 159 | $\varepsilon_{c(lt)} = K_1 \{R_2 T_2 \alpha_c + R_3(\delta\varepsilon_{ca} + \varepsilon_{cd})\} - \delta\varepsilon_{ctu}$ | 105 |
| **Total strain (early-age + long term)** | | | | | |
| Free contraction | $\varepsilon_{r(total)}$ | µε | 623 | $\varepsilon_{free(total)} = \varepsilon_{free(ea)} + \varepsilon_{free(lt)}$ | **748** |
| Restrained contraction | $\varepsilon_{r(total)}$ | µε | 324 | $\varepsilon_{r(total)} = \varepsilon_{r(ea)} + \varepsilon_{r(lt)}$ | **374** |
| Crack-inducing strain | $\varepsilon_{cr(total)}$ | µε | 253 | $\varepsilon_{cr(total)} = \varepsilon_{cr(ea)} + \varepsilon_{cr(lt)}$ | **277** |
| **Reinforcement details** | | | | | |
| Bar diameter | $\varphi$ | mm | 56.57 | | 16 |
| Bar spacing | $s$ | mm | 150 | | 175 |
| Cover | $c$ | mm | 40 | | 40 |
| **Area of steel per face per m** | $A_s$ | mm² | 16756 | | **1149** |
| **Cracking initiated at early age strain** | | | | | |
| **Minimum area of reinforcement $A_{s,min}$** | | | | | |
| Steel ratio for early age cracking | $f_{ctm}/f_{yk}$ | | 0.00347 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0035 |
| Coefficient | $k$ | | 0.75 | $k$ = 1.0 for $h \leq$ 300mm; $k$ = 0.75 for $h \geq$ 800mm; intermediate values are interpolated | |
| Coefficient | $k_c$ | | 1 | For pure tension $k_c = 1$ | |
| Surface zone used in calculating $A_{s,min}$ | $h_{s,min}$ | mm | 938 | $h_{s,min} = k\, k_c\, h/2$ | 250 |
| **Minimum area of steel per face per m** | $A_{s,min}$ | mm² | 3249 | $A_{s,min} = (h_{s,min} \times 1000)\, (f_{ctm} / f_{yk})$ Highlighted if $A_s < A_{s,min}$ | 875 |
| **Crack spacing and width** | | | | | |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{e,ef}$ | mm | 170.7125 | $h_{e,ef} = 2.5 (c + \varphi/2)$ *[NOTE: $h_{s,min}$ and $h_{e,ef}$ are not the same]* | 250 |
| Steel ratio for estimating crack spacing | $\rho_{p,eff}$ | | 0.09815 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{e,ef} \times 1000)$ | 0.00460 |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | EN1992-1-1 recommends $k_1$ = 0.8 but provides a factor of 0.7 where good bond cannot be guaranteed. Hence $k_1$ = 0.8/0.7 = 1.14 | 0.67 |
| Crack spacing | $S_{r,max}$ | mm | 415 | $S_{r,max} = 3.4c + 0.425\, k_1\, \varphi/\rho_{p,eff}$ | 1166 |
| **Early age crack width** | $w_k$ | mm | 0.04 | $w_k = \varepsilon_{c(ea)} S_{r,max}$ | 0.20 |
| **Long term crack width** | $w_k$ | mm | 0.11 | $w_k = \varepsilon_{c(total)} S_{r,max}$ | 0.32 |
| **Minimum reinforcement requirement for late-life cracking only** | | | | | |
| Steel ratio for late-life cracking | $f_{ctm}/f_{yk}$ | | 0.0058 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0033 |
| Minimum area of steel per face | $A_{s,min}$ | mm² | 5431 | *Highlighted if $A_s < A_{s,min}$* | 815 |

## Control of cracking due to internal restraint (Base slab C60 & 35C)

| Input parameters | Symbol | Unit | Value | |
|---|---|---|---|---|
| **Concrete and steel properties** | | | | |
| Section thickness | $h$ | mm | 2500 | |
| Strength class | $f_{ck}/f_{ck,cube}$ | MPa | C50/60 | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available |
| Creep factor | $K_1$ | | 0.65 | Default = 0.65 |
| Sustained load factor | $K_2$ | | 0.80 | Default = 0.8 |
| Coefficient of thermal expansion | $\alpha_c$ | $\mu\varepsilon/°C$ | 10.0 | If aggregate is unknown use 12 |
| Characteristic yield strength of reinforcement | $f_{ky}$ | MPa | 500 | 500 MPa (EN1992-1-1) |
| **Early-age concrete properties** | | | | |
| Tensile strength | $f_{ct,eff}$ | MPa | 2.44 | Mean value of tensile strength, $f_{ctm}(t_c)$ |
| Elastic modulus | $E_c$ | GPa | 32.0 | Mean value of elastic modulus $E_{cm}(t_c)$ |
| Tensile strain capacity under sustained loading | $\varepsilon_{ctu}$ | $\mu\varepsilon$ | 94 | $\varepsilon_{ctu} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ |
| **Early-age strain** | | | | |
| Temperature differential | $\Delta T$ | °C | 35 | $\Delta T$ = *Peak temperature - surface temperature* |
| Free differential strain | $\Delta\varepsilon_{free}$ | $\mu\varepsilon$ | 350 | $\Delta\varepsilon_{free} = \Delta T\, \alpha_c$ |
| Restraint | $R$ | | 0.42 | |
| Restrained differential strain | $\Delta\varepsilon_r$ | $\mu\varepsilon$ | 96 | $\Delta\varepsilon_{r(ea)} = R_1 K_1 \Delta T\, \alpha_c$ |
| Risk of early-age cracking | $\Delta\varepsilon_r/\varepsilon_{ctu}$ | | 1.02 | Low risk of early-age cracking if $\Delta\varepsilon_r / \varepsilon_{ctu} < 1$ |
| Crack-inducing differential strain | $\Delta\varepsilon_{cr}$ | $\mu\varepsilon$ | 49 | $\Delta\varepsilon_{cr} = R_1 K_1 \Delta T\, \alpha_c - 0.5\, \varepsilon_{ctu}$ |
| **Reinforcement details** | | | | |
| Bar diameter | $\varphi$ | mm | 56.57 | |
| Bar spacing | $S$ | mm | 150 | |
| Cover | $c$ | mm | 40 | |
| Area of steel per face per m | $A_s$ | mm$^2$ | 16756 | |
| **Early-age cracking** | | | | |
| Steel ratio for estimating $A_{s,min}$ | $f_{ctm}/f_{yk}$ | | 0.0049 | $f_{ctm}/f_{yk} = \rho_{crit}$ |
| Coefficient | $k$ | | 1.0 | |
| Coefficient | $k_c$ | | 0.5 | |
| Surface zone defining the area of concrete in the tensile zone $A_{ct}$ | $h_{s,min}$ | mm | 500 | $h_{s,min} = 0.2\, h$ |
| Minimum area of steel per face | $A_{s,min}$ | mm$^2$ | 1218 | *Highlighted if* $A_s < A_{s,min}$ |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{e,ef}$ | mm | 170.7125 | $h_{e,ef} = 2.5\,(c + \varphi/2)$ *[NB* $h_{s,min}$ *and* $h_{e,ef}$ *are not the same]* |
| Steel ratio for calculating early-age crack spacing | $\rho_{p,eff}$ | | 0.09815 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{e,ef} \times 1000)$ |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | |
| **Crack spacing** | $s_{r,max}$ | mm | 415 | $s_{r,max} = 3.4\, c + 0.425\, k_1\, \varphi / \rho_{p,eff}$ |
| **Crack width** | $w_k$ | mm | 0.02 | $w_k = \Delta\varepsilon_{cr}\, S_{r,max}$ |

## Risk and control of cracking due to continuous edge restraint (Base slab C60 & 35C)

| Input parameters | Symbol | Unit | Value | | CIRIA 91 BS8007 |
|---|---|---|---|---|---|
| **Section details and material properties** | | | | | |
| Section thickness | $h$ | mm | 2500 | | 500 |
| Strength class | $f_{ck} / f_{ck,cube}$ | MPa | C50/60 | | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available | |
| Creep factor | $K_1$ | | 0.65 | $K_1$ = 0.65 if $R$ is calculated; $K_1$ = 1 if $R$ is assumed to be 0.5 (including creep to EN1992-1-1) | 0.5 |
| Sustained load factor | $K_2$ | | 0.80 | | |
| Coefficient of thermal expansion of concrete | $\alpha_c$ | με/°C | 10.0 | If aggregate is unknown use 12 με / °C | 12 |
| Characteristic yield strength of reinforcement | $f_{yk}$ | MPa | 500 | 500 Mpa | 460 |
| **Early age concrete properties** | | | | | |
| Tensile strength at cracking | $f_{ctm}(t_c)$ | MPa | 2.44 | Mean value of tensile strength $f_{ctm}(t_c)$ | 1.61 |
| Elastic modulus | $E_{cm}(t_c)$ | GPa | 32.0 . | Mean value of elastic modulus $E_{cm}(t_c)$ | |
| Tensile strain capacity | $\varepsilon_{ctu(ea)}$ | με | 94 | $\varepsilon_{ctu(ea)} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ | 65 |
| **Long term concrete properties** | | | | | |
| Tensile strength | $f_{ctm}$ | MPa | 4.07 | Mean 28-day value | |
| Elastic modulus | $E_{cm}$ | GPa | 37.3 | Mean 28-day value | |
| Tensile strain capacity (sustained loading) | $\varepsilon_{ctu(lt)}$ | με | 134 | $\varepsilon_{ctu(lt)} = [f_{ctm} / E_{cm}] \times [K_2 / K_1]$ | 130 |
| **Early-age strain** | | | | | |
| Temperature drop | $T_1$ | °C | 35 | $T_1$ = Peak temperature - mean ambient temperature | 34 |
| Autogenous shrinkage | $\varepsilon_{ca(ea)}$ | με | 29 | EN1992-1-1 $\varepsilon_{ca(ea)} = 2.5 (f_{ck} - 10) \times (1\text{-exp}(-0.2 t_c^{0.5})$ | |
| Free contraction | $\varepsilon_{free(ea)}$ | με | 379 | $\varepsilon_{free(ea)} = T_1 \alpha_c + \varepsilon_{ca}$ | 408 |
| **Restrained early-age strain and risk of cracking** | | | | | |
| Restraint | $R$ | | 0.80 | *Use restraint calculator for walls or adjacent slabs; or historical data* | 1 |
| Early-age restrained contraction | $\varepsilon_{r(ea)}$ | με | 197 | $\varepsilon_{r(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca})$ | 204 |
| Risk of early age cracking | $\varepsilon_{r(ea)} / \varepsilon_{ctu}$ | | 2.63 | Low risk of early age cracking if $\varepsilon_{r(ea)} / \varepsilon_{ctu} < 1$. | 3.14 |
| Early-age crack-inducing strain | $\varepsilon_{cr(ea)}$ | με | 150 | $\varepsilon_{c(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca}) - 0.5 \varepsilon_{ctu}$ | 172 |
| **Long term strain (excluding early-age strain)** | | | | | |
| Autogenous shrinkage (residual up to 28 days) | $\delta\varepsilon_{ca(lt)}$ | με | 36 | $\delta\varepsilon_{ca(lt)} = \varepsilon_{ca(28)} - \varepsilon_{ca(ea)}$ | |
| Long term temperature change | $T_2$ | °C | 20 | *$T_2$ and $\varepsilon_{cd}$ only apply when causing differential contraction or when the sections acting integrally are subject to external restraint.* | 20 |
| Drying shrinkage | $\varepsilon_{cd}$ | με | 150 | | 100 |
| Long term free contraction | $\varepsilon_{free(lt)}$ | με | 386 | $\varepsilon_{free(lt)} = \delta\varepsilon_{ca} + T_2 \alpha_c + \varepsilon_{cd}$ | 340 |
| **Restrained long term strain** | | | | | |
| Restraint to long term thermal strains | $R_2$ | | 0.80 | Restraint will reduce as $E_n / E_o$ approaches 1 in the long term | 1 |
| Restraint to drying shrinkage | $R_3$ | | 0.80 | | 1 |
| Long term restrained strain | $\varepsilon_{free(lt)}$ | με | 201 | $\varepsilon_{r(lt)} = K_1 \{R_2 T_2 \alpha_c + R_3(\delta\varepsilon_{ca} + \varepsilon_{cd})\}$ | 170 |
| Increase in tensile strain capacity | $\delta\varepsilon_{ctu}$ | με | 41 | $\delta\varepsilon_{ctu} = \varepsilon_{ctu(28)} - \varepsilon_{ctu(ea)}$ | 65 |
| Long term crack-inducing strain | $\varepsilon_{cr(lt)}$ | | 160 | $\varepsilon_{c(lt)} = K_1 \{R_2 T_2 \alpha_c + R_3(\delta\varepsilon_{ca} + \varepsilon_{cd})\} - \delta\varepsilon_{ctu}$ | 105 |
| **Total strain (early-age + long term)** | | | | | |
| Free contraction | $\varepsilon_{r(total)}$ | με | 765 | $\varepsilon_{free(total)} = \varepsilon_{free(ea)} + \varepsilon_{free(lt)}$ | 748 |
| Restrained contraction | $\varepsilon_{r(total)}$ | με | 398 | $\varepsilon_{r(total)} = \varepsilon_{r(ea)} + \varepsilon_{r(lt)}$ | 374 |
| Crack-inducing strain | $\varepsilon_{cr(total)}$ | με | 310 | $\varepsilon_{cr(total)} = \varepsilon_{cr(ea)} + \varepsilon_{cr(lt)}$ | 277 |
| **Reinforcement details** | | | | | |
| Bar diameter | $\varphi$ | mm | 56.57 | | 16 |
| Bar spacing | s | mm | 150 | | 175 |
| Cover | $c$ | mm | 40 | | 40 |
| Area of steel per face per m | $A_s$ | mm² | 16756 | | 1149 |
| **Cracking initiated at early age strain** | | | | | |
| **Minimum area of reinforcement $A_{s,min}$** | | | | | |
| Steel ratio for early age cracking | $f_{ctm} / f_{yk}$ | | 0.00487 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0035 |
| Coefficient | $k$ | | 0.75 | $k$ = 1.0 for $h \leq$ 300mm; $k$ = 0.75 for $h \geq$ 800mm; intermediate values are interpolated | |
| Coefficient | $k_c$ | | 1 | For pure tension $k_c = 1$ | |
| Surface zone used in calculating $A_{s,min}$ | $h_{s,min}$ | mm | 938 | $h_{s,min} = k\, k_c\, h/2$ | 250 |
| Minimum area of steel per face per m | $A_{s,min}$ | mm² | 4567 | $A_{s,min} = (h_{s,min} \times 1000) (f_{ctm} / f_{yk})$ Highlighted if $A_s < A_{s,min}$ | 875 |
| **Crack spacing and width** | | | | | |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{c,ef}$ | mm | 170.7125 | $h_{c,ef} = 2.5 (c + \varphi/2)$ [NOTE: $h_{s,min}$ and $h_{c,ef}$ are not the same] | 250 |
| Steel ratio for estimating crack spacing | $\rho_{p,eff}$ | | 0.09815 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{c,ef} \times 1000)$ | 0.00460 |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | EN1992-1-1 recommends $k_1$ = 0.8 but provides a factor of 0.7 where good bond cannot be guaranteed. Hence $k_1$ = 0.8/0.7 = 1.14 | 0.67 |
| Crack spacing | $S_{r,max}$ | mm | 415 | $S_{r,max} = 3.4c + 0.425 k_1 \varphi / \rho_{p,eff}$ | 1168 |
| Early age crack width | $w_k$ | mm | 0.06 | $w_k = \varepsilon_{c(ea)} S_{r,max}$ | 0.20 |
| Long term crack width | $w_k$ | mm | 0.13 | $w_k = \varepsilon_{cr(total)} S_{r,max}$ | 0.32 |
| **Minimum reinforcement requirement for late-life cracking only** | | | | | |
| Steel ratio for late-life cracking | $f_{ctm} / f_{yk}$ | | 0.0081 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0033 |
| Minimum area of steel per face | $A_{s,min}$ | mm² | 7634 | *Highlighted if $A_s < A_{s,min}$* | 815 |

## Control of cracking due to internal restraint (Roof slab C40 & 24C)

| Input parameters | Symbol | Unit | Value | |
|---|---|---|---|---|
| **Concrete and steel properties** | | | | |
| Section thickness | $h$ | mm | 3000 | |
| Strength class | $f_{ck}/f_{ck,cube}$ | MPa | C30/37 | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available |
| Creep factor | $K_1$ | | 0.65 | Default = 0.65 |
| Sustained load factor | $K_2$ | | 0.80 | Default = 0.8 |
| Coefficient of thermal expansion | $\alpha_c$ | $\mu\varepsilon/°C$ | 10.0 | If aggregate is unknown use 12 |
| Characteristic yield strength of reinforcement | $f_{ky}$ | MPa | 500 | 500 MPa (EN1992-1-1) |
| **Early-age concrete properties** | | | | |
| Tensile strength | $f_{ct,eff}$ | MPa | 1.73 | Mean value of tensile strength, $f_{ctm}(t_c)$ |
| Elastic modulus | $E_c$ | GPa | 28.1 | Mean value of elastic modulus $E_{cm}(t_c)$ |
| Tensile strain capacity under sustained loading | $\varepsilon_{ctu}$ | $\mu\varepsilon$ | 76 | $\varepsilon_{ctu} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ |
| **Early-age strain** | | | | |
| Temperature differential | $\Delta T$ | °C | 24 | $\Delta T$ = Peak temperature - surface temperature |
| Free differential strain | $\Delta\varepsilon_{free}$ | $\mu\varepsilon$ | 240 | $\Delta\varepsilon_{free} = \Delta T \alpha_c$ |
| Restraint | $R$ | | 0.42 | |
| Restrained differential strain | $\Delta\varepsilon_r$ | $\mu\varepsilon$ | 66 | $\Delta\varepsilon_{r(est)} = R_1 K_1 \Delta T \alpha_c$ |
| Risk of early-age cracking | $\Delta\varepsilon_r/\varepsilon_{ctu}$ | | 0.86 | Low risk of early-age cracking if $\Delta\varepsilon_r / \varepsilon_{ctu} < 1$. |
| Crack-inducing differential strain | $\Delta\varepsilon_{cr}$ | $\mu\varepsilon$ | 28 | $\Delta\varepsilon_{cr} = R_1 K_1 \Delta T \alpha_c - 0.5 \varepsilon_{ctu}$ |
| **Reinforcement details** | | | | |
| Bar diameter | $\varphi$ | mm | 56.57 | |
| Bar spacing | $S$ | mm | 150 | |
| Cover | $c$ | mm | 40 | |
| Area of steel per face per m | $A_s$ | mm$^2$ | 16756 | |
| **Early-age cracking** | | | | |
| Steel ratio for estimating $A_{s,min}$ | $f_{ctm}/f_{yk}$ | | 0.0035 | $f_{ctm}/f_{yk} = \rho_{crit}$ |
| Coefficient | $k$ | | 1.0 | |
| Coefficient | $k_c$ | | 0.5 | |
| Surface zone defining the area of concrete in the tensile zone $A_{ct}$ | $h_{s,min}$ | mm | 600 | $h_{s,min} = 0.2\,h$ |
| Minimum area of steel per face | $A_{s,min}$ | mm$^2$ | 1040 | Highlighted if $A_s < A_{s,min}$ |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{e,ef}$ | mm | 170.7125 | $h_{e,ef} = 2.5\,(c + \varphi/2)$ [NB $h_{s,min}$ and $h_{e,ef}$ are not the same] |
| Steel ratio for calculating early-age crack spacing | $\rho_{p,eff}$ | | 0.09815 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{e,ef} \times 1000)$ |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | |
| **Crack spacing** | $s_{r,max}$ | mm | 416 | $s_{r,max} = 3.4\,c + 0.425\,k_1\,\varphi / \rho_{p,eff}$ |
| **Crack width** | $w_k$ | mm | 0.01 | $w_k = \Delta\varepsilon_{cr}\,S_{r,max}$ |

## Risk and control of cracking due to continuous edge restraint (Roof slab C40 & 24C)

| Input parameters | Symbol | Unit | Value | | CIRIA 91<br>BS8007 |
|---|---|---|---|---|---|
| **Section details and material properties** | | | | | |
| Section thickness | $h$ | mm | 3000 | | 500 |
| Strength class | $f_{ck} / f_{ck,cube}$ | MPa | C30/37 | | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available | |
| Creep factor | $K_1$ | | 0.65 | $K_1$ = 0.65 if $R$ is calculated; $K_1$ = 1 if $R$ is assumed to be 0.5 (including creep to EN1992-1-1) | 0.5 |
| Sustained load factor | $K_2$ | | 0.80 | | |
| Coefficient of thermal expansion of concrete | $\alpha_c$ | με/°C | 10.0 | If aggregate is unknown use 12 με / °C | 12 |
| Characteristic yield strength of reinforcement | $f_{yk}$ | MPa | 500 | 500 Mpa | 460 |
| **Early age concrete properties** | | | | | |
| Tensile strength at cracking | $f_{ctm}(t_c)$ | MPa | 1.73 | Mean value of tensile strength $f_{ctm}(t_c)$ | 1.61 |
| Elastic modulus | $E_{cm}(t_c)$ | GPa | 28.1 | Mean value of elastic modulus $E_{cm}(t_c)$ | |
| Tensile strain capacity | $\varepsilon_{ctu(ea)}$ | με | 76 | $\varepsilon_{ctu(ea)} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ | 65 |
| **Long term concrete properties** | | | | | |
| Tensile strength | $f_{ctm}$ | MPa | 2.90 | Mean 28-day value | |
| Elastic modulus | $E_{cm}$ | GPa | 32.8 | Mean 28-day value | |
| Tensile strain capacity (sustained loading) | $\varepsilon_{ctu(lt)}$ | με | 109 | $\varepsilon_{ctu(lt)} = [f_{ctm} / E_{cm}] \times [K_2 / K_1]$ | 130 |
| **Early-age strain** | | | | | |
| Temperature drop | $T_1$ | °C | 24 | $T_1$ = Peak temperature - mean ambient temperature | 34 |
| Autogenous shrinkage | $\varepsilon_{ca(ea)}$ | με | 15 | EN1992-1-1 $\varepsilon_{ca(ea)} = 2.5 (f_{ck} - 10) \times (1\text{-exp}(-0.2 t_c^{0.5})$ | |
| Free contraction | $\varepsilon_{free(ea)}$ | με | 255 | $\varepsilon_{free(ea)} = T_1 \alpha_c + \varepsilon_{ca}$ | 408 |
| **Restrained early-age strain and risk of cracking** | | | | | |
| Restraint | $R$ | | 0.80 | *Use restraint calculator for walls or adjacent slabs; or historical data* | 1 |
| Early-age restrained contraction | $\varepsilon_{r(ea)}$ | με | 132 | $\varepsilon_{r(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca})$ | **204** |
| Risk of early age cracking | $\varepsilon_{r(ea)}/\varepsilon_{ctu}$ | | 2.18 | Low risk of early age cracking if $\varepsilon_{r(ea)}/\varepsilon_{ctu} < 1$ . | **3.14** |
| Early-age crack-inducing strain | $\varepsilon_{cr(ea)}$ | με | 95 | $\varepsilon_{cr(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca}) - 0.5 \varepsilon_{ctu}$ | **172** |
| **Long term strain (excluding early-age strain)** | | | | | |
| Autogenous shrinkage (residual up to 28 days) | $\delta\varepsilon_{ca(lt)}$ | με | 18 | $\delta\varepsilon_{ca(lt)} = \varepsilon_{ca(28)} - \varepsilon_{ca(ea)}$ | |
| Long term temperature change | $T_2$ | °C | 20 | *$T_2$ and $\varepsilon_{cd}$ only apply when causing differential contraction or when the sections acting integrally are subject to external restraint.* | 20 |
| Drying shrinkage | $\varepsilon_{cd}$ | με | 150 | | 100 |
| Long term free contraction | $\varepsilon_{free(lt)}$ | με | 368 | $\varepsilon_{free(lt)} = \delta\varepsilon_{ca} + T_2 \alpha_c + \varepsilon_{cd}$ | 340 |
| **Restrained long term strain** | | | | | |
| Restraint to long term thermal strains | $R_2$ | | 0.80 | Restraint will reduce as $E_n / E_o$ approaches 1 in the long term | 1 |
| Restraint to drying shrinkage | $R_3$ | | 0.80 | | 1 |
| Long term restrained strain | $\varepsilon_{free(lt)}$ | με | 191 | $\varepsilon_{r(lt)} = K_1 \{R_2 T_2 \alpha_c + R_3 (\delta\varepsilon_{ca} + \varepsilon_{cd})\}$ | 170 |
| Increase in tensile strain capacity | $\delta\varepsilon_{ctu}$ | με | 33 | $\delta\varepsilon_{ctu} = \varepsilon_{ctu(28)} - \varepsilon_{ctu(ea)}$ | 65 |
| Long term crack-inducing strain | $\varepsilon_{cr(lt)}$ | | 159 | $\varepsilon_{cr(lt)} = K_1 \{R_2 T_2 \alpha_c + R_3 (\delta\varepsilon_{ca} + \varepsilon_{cd})\} - \delta\varepsilon_{ctu}$ | 105 |
| **Total strain (early-age + long term)** | | | | | |
| Free contraction | $\varepsilon_{r(total)}$ | με | 623 | $\varepsilon_{free(total)} = \varepsilon_{free(ea)} + \varepsilon_{free(lt)}$ | 748 |
| Restrained contraction | $\varepsilon_{r(total)}$ | με | 324 | $\varepsilon_{r(total)} = \varepsilon_{r(ea)} + \varepsilon_{r(lt)}$ | 374 |
| Crack-inducing strain | $\varepsilon_{cr(total)}$ | με | 253 | $\varepsilon_{cr(total)} = \varepsilon_{cr(ea)} + \varepsilon_{cr(lt)}$ | 277 |
| **Reinforcement details** | | | | | |
| Bar diameter | $\varphi$ | mm | 56.57 | | 16 |
| Bar spacing | $s$ | mm | 160 | | 175 |
| Cover | $c$ | mm | 40 | | 40 |
| Area of steel per face per m | $A_s$ | mm² | 16756 | | **1149** |
| **Cracking initiated at early age strain** | | | | | |
| **Minimum area of reinforcement $A_{s,min}$** | | | | | |
| Steel ratio for early age cracking | $f_{ctm}/f_{yk}$ | | 0.00347 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0035 |
| Coefficient | $k$ | | 0.75 | $k$ = 1.0 for $h \leq$ 300mm; $k$ = 0.75 for $h \geq$ 800mm; intermediate values are interpolated | |
| Coefficient | $k_c$ | | 1 | For pure tension $k_c = 1$ | |
| Surface zone used in calculating $A_{s,min}$ | $h_{s,min}$ | mm | 1125 | $h_{s,min} = k k_c h/2$ | 250 |
| Minimum area of steel per face per m | $A_{s,min}$ | mm² | 3899 | $A_{s,min} = (h_{s,min} \times 1000) (f_{ctm} / f_{yk})$ Highlighted if $A_s < A_{s,min}$ | 875 |
| **Crack spacing and width** | | | | | |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{e,ef}$ | mm | 170.7125 | $h_{e,ef} = 2.5 (c + \varphi/2)$ *[NOTE: $h_{s,min}$ and $h_{e,ef}$ are not the same]* | 250 |
| Steel ratio for estimating crack spacing | $\rho_{p,eff}$ | | 0.09815 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{e,ef} \times 1000)$ | 0.00460 |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | EN1992-1-1 recommends $k_1$ = 0.8 but provides a factor of 0.7 where good bond cannot be guaranteed. Hence $k_1$ = 0.8/0.7 = 1.14 | 0.67 |
| Crack spacing | $S_{r,max}$ | mm | 415 | $S_{r,max} = 3.4c + 0.425 k_1 \varphi/\rho_{p,eff}$ | 1166 |
| Early age crack width | $w_k$ | mm | 0.04 | $w_k = \varepsilon_{cr(ea)} S_{r,max}$ | 0.20 |
| Long term crack width | $w_k$ | mm | 0.11 | $w_k = \varepsilon_{cr(total)} S_{r,max}$ | 0.32 |
| **Minimum reinforcement requirement for late-life cracking only** | | | | | |
| Steel ratio for late-life cracking | $f_{ctm}/f_{yk}$ | | 0.0058 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0033 |
| Minimum area of steel per face | $A_{s,min}$ | mm² | 6517 | *Highlighted if $A_s < A_{s,min}$* | 815 |

## Control of cracking due to internal restraint (Roof slab C60 & 32.3C)

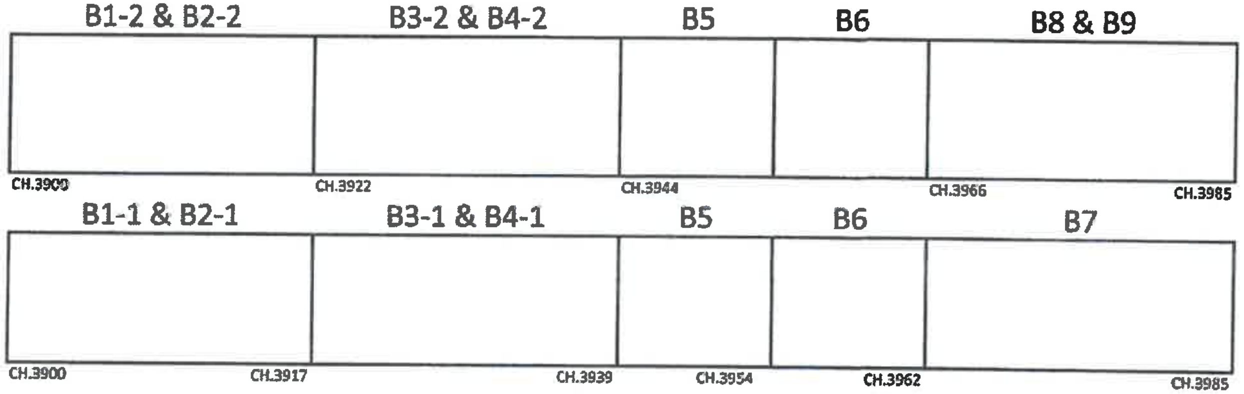
| **Input parameters** | **Symbol** | **Unit** | **Value** | |
|---|---|---|---|---|
| **Concrete and steel properties** | | | | |
| Section thickness | $h$ | mm | 3000 | |
| Strength class | $f_{ck}/f_{ck,cube}$ | MPa | C50/60 | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available |
| Creep factor | $K_1$ | | 0.65 | Default = 0.65 |
| Sustained load factor | $K_2$ | | 0.80 | Default = 0.8 |
| Coefficient of thermal expansion | $\alpha_c$ | $\mu\varepsilon/^{\circ}C$ | 10.0 | If aggregate is unknown use 12 |
| Characteristic yield strength of reinforcement | $f_{ky}$ | MPa | 500 | 500 MPa (EN1992-1-1) |
| **Early-age concrete properties** | | | | |
| Tensile strength | $f_{ct,eff}$ | MPa | 2.44 | Mean value of tensile strength, $f_{ctm}(t_c)$ |
| Elastic modulus | $E_c$ | GPa | 32.0 | Mean value of elastic modulus $E_{cm}(t_c)$ |
| Tensile strain capacity under sustained loading | $\varepsilon_{ctu}$ | με | 94 | $\varepsilon_{ctu} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ |
| **Early-age strain** | | | | |
| Temperature differential | $\Delta T$ | °C | 32.3 | $\Delta T$ = *Peak temperature - surface temperature* |
| Free differential strain | $\Delta\varepsilon_{free}$ | $\mu\varepsilon$ | 323 | $\Delta\varepsilon_{free} = \Delta T \alpha_c$ |
| Restraint | $R$ | | 0.42 | |
| Restrained differential strain | $\Delta\varepsilon_r$ | $\mu\varepsilon$ | 88 | $\Delta\varepsilon_{r(ea)} = R_1 K_1 \Delta T \alpha_c$ |
| Risk of early-age cracking | $\Delta\varepsilon_r/\varepsilon_{ctu}$ | | 0.94 | Low risk of early-age cracking if $\Delta\varepsilon_r / \varepsilon_{ctu} < 1$ |
| Crack-inducing differential strain | $\Delta\varepsilon_{cr}$ | $\mu\varepsilon$ | 41 | $\Delta\varepsilon_{cr} = R_1 K_1 \Delta T \alpha_c - 0.5 \varepsilon_{ctu}$ |
| **Reinforcement details** | | | | |
| Bar diameter | $\varphi$ | mm | 56.57 | |
| Bar spacing | $S$ | mm | 150 | |
| Cover | $c$ | mm | 40 | |
| Area of steel per face per m | $A_s$ | $mm^2$ | 16756 | |
| **Early-age cracking** | | | | |
| Steel ratio for estimating $A_{s,min}$ | $f_{ctm}/f_{yk}$ | | 0.0049 | $f_{ctm}/f_{yk} = \rho_{crit}$ |
| Coefficient | $k$ | | 1.0 | |
| Coefficient | $k_c$ | | 0.5 | |
| Surface zone defining the area of concrete in the tensile zone $A_{ct}$ | $h_{s,min}$ | mm | 600 | $h_{s,min} = 0.2 h$ |
| Minimum area of steel per face | $A_{s,min}$ | $mm^2$ | 1461 | *Highlighted if* $A_s < A_{s,min}$ |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{c,ef}$ | mm | 170.7125 | $h_{c,ef} = 2.5 (c + \varphi/2)$ *[NB* $h_{s,min}$ *and* $h_{c,ef}$ *are not the same]* |
| Steel ratio for calculating early-age crack spacing | $\rho_{p,eff}$ | | 0.09815 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{c,ef} \times 1000)$ |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | |
| **Crack spacing** | $s_{r,max}$ | mm | 415 | $s_{r,max} = 3.4 c + 0.425 k_1 \varphi / \rho_{p,eff}$ |
| **Crack width** | $w_k$ | mm | 0.02 | $w_k = \Delta\varepsilon_{cr} S_{r,max}$ |

## Risk and control of cracking due to continuous edge restraint (Roof slab C60 & 32.3C)

| Input parameters | Symbol | Unit | Value | | CIRIA 91 BS8007 |
|---|---|---|---|---|---|
| **Section details and material properties** | | | | | |
| Section thickness | $h$ | mm | 3000 | | 500 |
| Strength class | $f_{ck} / f_{ck,cube}$ | MPa | C50/60 | | |
| Age at cracking | $t_c$ | days | 3 | Assume 3 days unless more reliable information is available | |
| Creep factor | $K_1$ | | 0.65 | $K_1$ = 0.65 if $R$ is calculated; $K_1$ = 1 if $R$ is assumed to be 0.5 (including creep to EN1992-1-1) | 0.5 |
| Sustained load factor | $K_2$ | | 0.80 | | |
| Coefficient of thermal expansion of concrete | $\alpha_c$ | µε/°C | 10.0 | If aggregate is unknown use 12 µε / °C | 12 |
| Characteristic yield strength of reinforcement | $f_{yk}$ | MPa | 500 | 500 Mpa | 460 |
| **Early age concrete properties** | | | | | |
| Tensile strength at cracking | $f_{ctm}(t_c)$ | MPa | 2.44 | Mean value of tensile strength $f_{ctm}(t_c)$ | 1.61 |
| Elastic modulus | $E_{cm}(t_c)$ | GPa | 32.0 | Mean value of elastic modulus $E_{cm}(t_c)$ | |
| Tensile strain capacity | $\varepsilon_{ctu(ea)}$ | µε | 94 | $\varepsilon_{ctu(ea)} = [f_{ctm}(t_c) / E_{cm}(t_c)] \times [K_2 / K_1]$ | 65 |
| **Long term concrete properties** | | | | | |
| Tensile strength | $f_{ctm}$ | MPa | 4.07 | Mean 28-day value | |
| Elastic modulus | $E_{cm}$ | GPa | 37.3 | Mean 28-day value | |
| Tensile strain capacity (sustained loading) | $\varepsilon_{ctu(lt)}$ | µε | 134 | $\varepsilon_{ctu(lt)} = [f_{ctm} / E_{cm}] \times [K_2 / K_1]$ | 130 |
| **Early-age strain** | | | | | |
| Temperature drop | $T_1$ | °C | 32.3 | $T_1$ = Peak temperature - mean ambient temperature | 34 |
| Autogenous shrinkage | $\varepsilon_{ca(ea)}$ | µε | 29 | EN1992-1-1 $\varepsilon_{ca(ea)} = 2.5 (f_{ck} - 10) \times (1\text{-exp}(- 0.2\, t_c^{0.5})$ | |
| Free contraction | $\varepsilon_{free(ea)}$ | µε | 352 | $\varepsilon_{free(ea)} = T_1 \alpha_c + \varepsilon_{ca}$ | 408 |
| **Restrained early-age strain and risk of cracking** | | | | | |
| Restraint | $R$ | | 0.80 | *Use restraint calculator for walls or adjacent slabs; or historical data* | 1 |
| Early-age restrained contraction | $\varepsilon_{r(ea)}$ | µε | 183 | $\varepsilon_{r(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca})$ | 204 |
| Risk of early age cracking | $\varepsilon_{r(ea)} / \varepsilon_{ctu}$ | | 2.44 | Low risk of early age cracking if $\varepsilon_{r(ea)} / \varepsilon_{ctu} < 1$. | 3.14 |
| Early-age crack-inducing strain | $\varepsilon_{cr(ea)}$ | µε | 136 | $\varepsilon_{cr(ea)} = R_1 K_1 (T_1 \alpha_c + \varepsilon_{ca}) - 0.5\, \varepsilon_{ctu}$ | 172 |
| **Long term strain (excluding early-age strain)** | | | | | |
| Autogenous shrinkage (residual up to 28 days) | $\delta\varepsilon_{ca(lt)}$ | µε | 36 | $\delta\varepsilon_{ca(lt)} = \varepsilon_{ca(28)} - \varepsilon_{ca(ea)}$ | |
| Long term temperature change | $T_2$ | °C | 20 | *$T_2$ and $\varepsilon_{cd}$ only apply when causing differential contraction or when the sections acting integrally are subject to external restraint.* | 20 |
| Drying shrinkage | $\varepsilon_{cd}$ | µε | 150 | | 100 |
| Long term free contraction | $\varepsilon_{free(lt)}$ | µε | 386 | $\varepsilon_{free(lt)} = \delta\varepsilon_{ca} + T_2 \alpha_c + \varepsilon_{cd}$ | 340 |
| **Restrained long term strain** | | | | | |
| Restraint to long term thermal strains | $R_2$ | | 0.80 | Restraint will reduce as $E_n / E_o$ approaches 1 in the long term | 1 |
| Restraint to drying shrinkage | $R_3$ | | 0.80 | | 1 |
| Long term restrained strain | $\varepsilon_{free(lt)}$ | µε | 201 | $\varepsilon_{r(lt)} = K_1 (R_2 T_2 \alpha_c + R_3 (\delta\varepsilon_{ca} + \varepsilon_{cd}))$ | 170 |
| Increase in tensile strain capacity | $\delta\varepsilon_{ctu}$ | µε | 41 | $\delta\varepsilon_{ctu} = \varepsilon_{ctu(28)} - \varepsilon_{ctu(ea)}$ | 65 |
| Long term crack-inducing strain | $\varepsilon_{cr(lt)}$ | | 160 | $\varepsilon_{cr(lt)} = K_1 (R_2 T_2 \alpha_c + R_3 (\delta\varepsilon_{ca} + \varepsilon_{cd})) - \delta\varepsilon_{ctu}$ | 105 |
| **Total strain (early-age + long term)** | | | | | |
| Free contraction | $\varepsilon_{r(total)}$ | µε | 738 | $\varepsilon_{free(total)} = \varepsilon_{free(ea)} + \varepsilon_{free(lt)}$ | 748 |
| Restrained contraction | $\varepsilon_{r(total)}$ | µε | 384 | $\varepsilon_{r(total)} = \varepsilon_{r(ea)} + \varepsilon_{r(lt)}$ | 374 |
| Crack-inducing strain | $\varepsilon_{cr(total)}$ | µε | 296 | $\varepsilon_{cr(total)} = \varepsilon_{cr(ea)} + \varepsilon_{cr(lt)}$ | 277 |
| **Reinforcement details** | | | | | |
| Bar diameter | $\varphi$ | mm | 56.57 | | 16 |
| Bar spacing | $s$ | mm | 150 | | 175 |
| Cover | $c$ | mm | 40 | | 40 |
| Area of steel per face per m | $A_s$ | mm² | 16756 | | 1149 |
| **Cracking initiated at early age strain** | | | | | |
| **Minimum area of reinforcement $A_{s,min}$** | | | | | |
| Steel ratio for early age cracking | $f_{ctm} / f_{yk}$ | | 0.00487 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0035 |
| Coefficient | $k$ | | 0.75 | $k$ = 1.0 for $h \le$ 300mm; $k$ = 0.75 for $h \ge$ 800mm; intermediate values are interpolated | |
| Coefficient | $k_c$ | | 1 | For pure tension $k_c = 1$ | |
| Surface zone used in calculating $A_{s,min}$ | $h_{s,min}$ | mm | 1125 | $h_{s,min} = k\, k_c\; h/2$ | 250 |
| Minimum area of steel per face per m | $A_{s,min}$ | mm² | 5481 | $A_{s,min} = (h_{s,min} \times 1000) (f_{ctm} / f_{yk})$ Highlighted if $A_s < A_{s,min}$ | 875 |
| **Crack spacing and width** | | | | | |
| Surface zone defining the effective area of concrete in tension, $A_{c,eff}$ | $h_{e,ef}$ | mm | 170.7125 | $h_{e,ef} = 2.5 (c + \varphi/2)$ *[NOTE: $h_{s,min}$ and $h_{e,ef}$ are not the same]* | 250 |
| Steel ratio for estimating crack spacing | $\rho_{p,eff}$ | | 0.09815 | $\rho_{p,eff} = A_s / A_{c,eff} = A_s / (h_{e,ef} \times 1000)$ | 0.00460 |
| Coefficient for bond characteristics | $k_1$ | | 1.14 | EN1992-1-1 recommends $k_1$ = 0.8 but provides a factor of 0.7 where good bond cannot be guaranteed. Hence $k_1$ = 0.8/0.7 = 1.14 | 0.67 |
| Crack spacing | $S_{r,max}$ | mm | 415 | $S_{r,max} = 3.4c + 0.425\, k_1\, \varphi/\rho_{p,eff}$ | 1166 |
| Early age crack width | $w_k$ | mm | 0.06 | $w_k = \varepsilon_{cr(ea)}\, S_{r,max}$ | 0.20 |
| Long term crack width | $w_k$ | mm | 0.12 | $w_k = \varepsilon_{cr(total)}\, S_{r,max}$ | 0.32 |
| **Minimum reinforcement requirement for late-life cracking only** | | | | | |
| Steel ratio for late-life cracking | $f_{ctm} / f_{yk}$ | | 0.0081 | $f_{ctm} / f_{yk} = \rho_{crit}$ | 0.0033 |
| Minimum area of steel per face | $A_{s,min}$ | mm² | 9161 | *Highlighted if $A_s < A_{s,min}$* | 815 |

## Location of Concrete Crack at TCPWAE tunnel base slab

Update : 15/1/2016



Legend:
1-a
Item no.
Type of defect

a: uneven surface
b: grout runs
c: concrete defect
d: leakage
e: crack
o: outstanding item to be specify

🟦 Waiting for repair
🟥 Grouted
🟩 Make good
🟨 New Crack

🟦 Concrete defect

| | Location | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Item No. | B1-2 & B2-2 | Item No. | B1-1 & B2-1 | Item No. | B3-2 & B4-2 | Item No. | B3-1 & B4-1 | Item No. | B5 | Item No. | B6 | Item No. | B7 | Item No. | B8 & B9 | Remark |
| Crack length (m) | | | | | | | | | | | | | | | | | All of the crack width < 0.25mm |
| | | | | | | | | | | | | | | | | | |
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| sub total length (m): | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | |

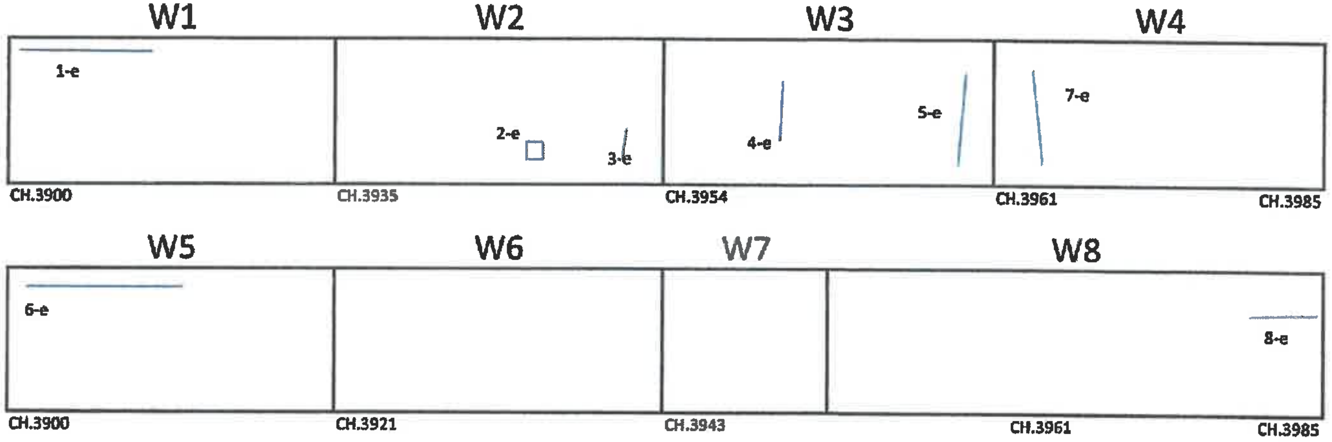
Inspected By: [redacted] [redacted]

Witnessed By: [redacted]

# Location of Concrete Crack at TCPWAE tunnel wall

Update : 15/1/2016

## East Bound



🟦 Waiting for repair
🟥 Grouted
🟩 Make good
🟧 New Crack

▇ Concrete defect

| | Location | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Item No. | W1 | Item No. | W2 | Item No. | W3 | Item No. | W4 | Item No. | W5 | Item No. | W6 | Item No. | W7 | Item No. | W8a | Item No. | W8b | Remark |
| Crack length (m) | 1 - e | 🟦 [illegible] | 2 - e | 🟦 [illegible] | 4 - e | 🟦 [illegible] | 7 - e | 🟦 [illegible] | 6-e | 🟦 [illegible] | | | | | | | 8 - e | 🟦 [illegible] | All of the crack width <0.25mm |
| | | | 3 - e | 🟦 [illegible] | 5 - e | 🟦 [illegible] | | | | | | | | | | | | | |
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| sub total length (m): | | 8.0 | | 0.9 | | 6.5 | | 1.0 | | 5.0 | | 0.0 | | 0.0 | | 0.0 | | 1.0 | |

Inspected By: [redacted]

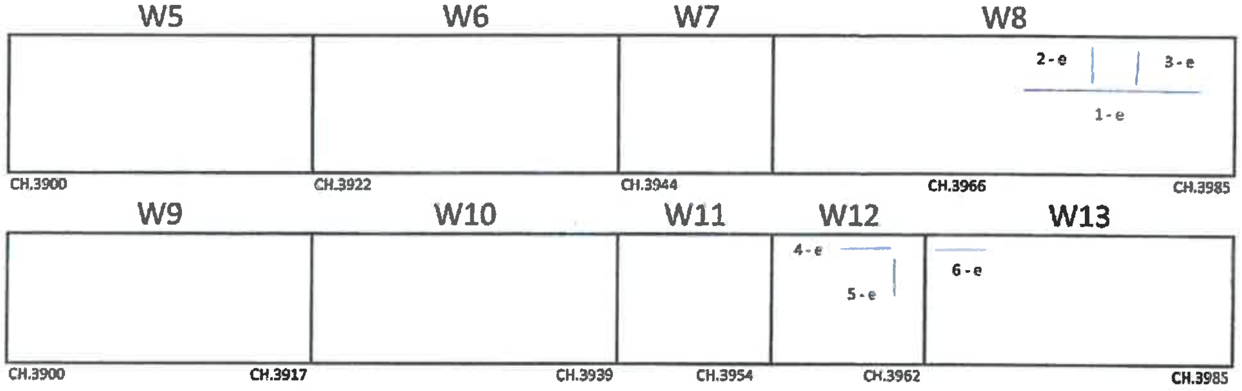
[redacted]

Witnessed By: [redacted]

## Location of Concrete Crack at TCPWAE tunnel wall

**Update :** 15/1/2016

### West Bound



Legend:
1-a ← Type of defect
Item no.

a: uneven surface
b: grout runs
c: concrete defect
d: leakage
e: crack
o: outstanding Item to be specify

🟦 Waiting for repair
🟥 Grouted
🟩 Make good
🟨 New Crack

▨ Concrete defect

| | Location | | | | | | | | | | | | | | | | | | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Item No. | W5 | Item No. | W6 | Item No. | W7 | Item No. | W8a | Item No. | W8b | Item No. | W9 | Item No. | W10 | Item No. | W11 | Item No. | W12 | Item No. | W13 | |
| Crack length (m) | | | | | | | | | 1 - e | [illegible] | | | | | | | 4 - e | [illegible] | 6 - e | [illegible] | All of the crack width < 0.25mm |
| | | | | | | | | | 2 - e | [illegible] | | | | | | | 5 - e | [illegible] | | | |
| | | | | | | | | | 3 - e | [illegible] | | | | | | | | | | | |
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| sub total length (m): | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 12.0 | | 0.0 | | 0.0 | | 0.0 | | 2.2 | | 0.5 | |

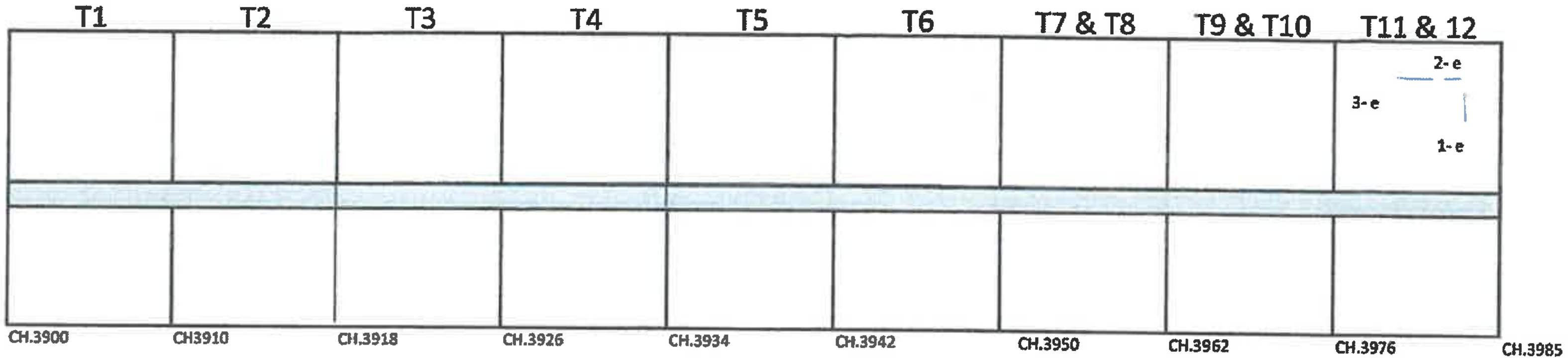
Inspected By: [redacted] [redacted]

Witnessed By: [redacted]

## Location of Concrete Crack at TCPWAE tunnel roof slab

Update : 15/1/2016

### West Bound (Roof)



🟦 Waiting for repair
🟥 Grouted
🟩 Make good
🟧 New Crack

🟦 Concrete defect
🟨 OHVD

| | Location. | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Item No. | T1 | Item No. | T2 | Item No. | T3 | Item No. | T4 | Item No. | T5 | Item No. | T6 | Item No. | T7 | Item No. | T10 | Item No. | T11 | Remark |
| Crack length (m) | | | | | | | | | | | | | | | | | 1-e | 1.0 | All of the crack width < 0.25mm |
| | | | | | | | | | | | | | | | | | 2-e | 1.0 | |
| | | | | | | | | | | | | | | | | | 3-e | 3.0 | |
| | | | | | | | | | | | | | | | | | | | |
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| sub total length (m): | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 5.0 | |

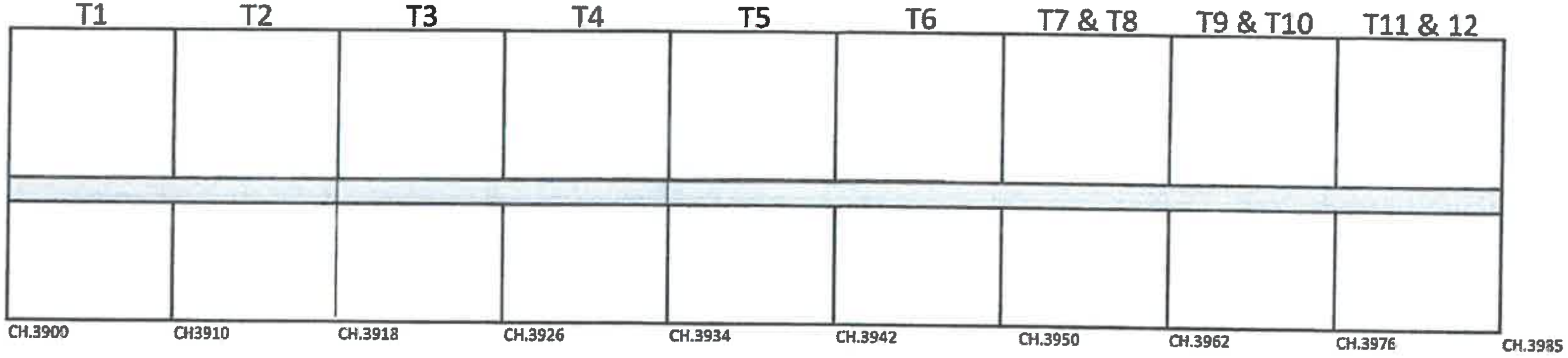
Inspected By: [redacted] [redacted]

Witnessed By: [redacted]

## Location of Concrete Crack at TCPWAE tunnel roof slab

Update : 15/1/2016

### East Bound (Roof)



🟦 Waiting for repair
🟥 Grouted
🟩 Make good
🟧 New Crack

🟪 Concrete defect
🟨 OHVD

|  | Location |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Item No. | T1 | Item No. | T2 | Item No. | T3 | Item No. | T4 | Item No. | T5 | Item No. | T6 | Item No. | T8 | Item No. | T9 | Item No. | T12 | Remark |
| Crack length (m) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | All of the crack width < 0.25mm |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| sub total length (m): |  | 0.0 |  | 0.0 |  | 0.0 |  | 0.0 |  | 0.0 |  | 0.0 |  | 0.0 |  | 0.0 |  | 0.0 |  |

Inspected By: [redacted]

Witnessed By: [redacted]

Roof slab : T1

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1175099 | 10-Jul-13 | 7-Aug-13 | 61.5 |
| 2 | CA1175114 | 10-Jul-13 | 7-Aug-13 | 64.5 |
| 3 | CA1175117 | 10-Jul-13 | 7-Aug-13 | 63.5 |
| 4 | CA1175120 | 10-Jul-13 | 7-Aug-13 | 64.5 |
| 5 | CA1175129 | 10-Jul-13 | 7-Aug-13 | 70.5 |
| 6 | CA1175144 | 10-Jul-13 | 7-Aug-13 | 71.5 |
| 7 | CA1175408 | 10-Jul-13 | 7-Aug-13 | 65.5 |
| 8 | CA1175425 | 10-Jul-13 | 7-Aug-13 | 59.5 |
| 9 | CA1175195 | 10-Jul-13 | 7-Aug-13 | 65.5 |
| 10 | CA1175198 | 10-Jul-13 | 7-Aug-13 | 65.5 |
| 11 | CA1175405 | 10-Jul-13 | 7-Aug-13 | 65.5 |
| 12 | CA1175180 | 10-Jul-13 | 7-Aug-13 | 65.5 |
| 13 | CA1175183 | 10-Jul-13 | 7-Aug-13 | 65.5 |
| 14 | CA1175186 | 10-Jul-13 | 7-Aug-13 | 66.0 |
| 15 | CA1175153 | 10-Jul-13 | 7-Aug-13 | 68.5 |
| 16 | CA1175159 | 10-Jul-13 | 7-Aug-13 | 63.5 |
| 17 | CA1175174 | 10-Jul-13 | 7-Aug-13 | 64.5 |
| 18 | CA1175100 | 10-Jul-13 | 7-Aug-13 | 62.5 |
| 19 | CA1175115 | 10-Jul-13 | 7-Aug-13 | 63.5 |
| 20 | CA1175118 | 10-Jul-13 | 7-Aug-13 | 62.5 |
| 21 | CA1175121 | 10-Jul-13 | 7-Aug-13 | 66.5 |
| 22 | CA1175130 | 10-Jul-13 | 7-Aug-13 | 70.5 |
| 23 | CA1175145 | 10-Jul-13 | 7-Aug-13 | 72.5 |
| 24 | CA1175409 | 10-Jul-13 | 7-Aug-13 | 66.5 |
| 25 | CA1175426 | 10-Jul-13 | 7-Aug-13 | 58.5 |
| 26 | CA1175196 | 10-Jul-13 | 7-Aug-13 | 67.0 |
| 27 | CA1175199 | 10-Jul-13 | 7-Aug-13 | 69.0 |
| 28 | CA1175406 | 10-Jul-13 | 7-Aug-13 | 63.5 |
| 29 | CA1175181 | 10-Jul-13 | 7-Aug-13 | 62.0 |
| 30 | CA1175184 | 10-Jul-13 | 7-Aug-13 | 69.0 |
| 31 | CA1175187 | 10-Jul-13 | 7-Aug-13 | 63.0 |
| 32 | CA1175154 | 10-Jul-13 | 7-Aug-13 | 67.5 |
| 33 | CA1175160 | 10-Jul-13 | 7-Aug-13 | 66.5 |
| 34 | CA1175175 | 10-Jul-13 | 7-Aug-13 | 62.5 |
|  |  |  |  |  |

Roof slab : T2

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1233381 | 3-Jun-13 | 1-Jul-13 | 71.0 |
| 2 | CA1233382 | 3-Jun-13 | 1-Jul-13 | 68.5 |
| 3 | CA1233387 | 3-Jun-13 | 1-Jul-13 | 65.5 |
| 4 | CA1233388 | 3-Jun-13 | 1-Jul-13 | 62.0 |
| 5 | CA1233393 | 3-Jun-13 | 1-Jul-13 | 66.5 |
| 6 | CA1233394 | 3-Jun-13 | 1-Jul-13 | 64.0 |
| 7 | CA1233372 | 3-Jun-13 | 1-Jul-13 | 67.0 |
| 8 | CA1233373 | 3-Jun-13 | 1-Jul-13 | 59.5 |
| 9 | CA1233375 | 3-Jun-13 | 1-Jul-13 | 56.5 |
| 10 | CA1233376 | 3-Jun-13 | 1-Jul-13 | 61.5 |
| 11 | CA1233378 | 3-Jun-13 | 1-Jul-13 | 70.0 |
| 12 | CA1233379 | 3-Jun-13 | 1-Jul-13 | 66.5 |
| 13 | CA1233357 | 3-Jun-13 | 1-Jul-13 | 70.0 |
| 14 | CA1233358 | 3-Jun-13 | 1-Jul-13 | 65.5 |
| 15 | CA1233366 | 3-Jun-13 | 1-Jul-13 | 69.0 |
| 16 | CA1233367 | 3-Jun-13 | 1-Jul-13 | 65.5 |
| 17 | CA1233369 | 3-Jun-13 | 1-Jul-13 | 67.0 |
| 18 | CA1233370 | 3-Jun-13 | 1-Jul-13 | 67.0 |
| 19 | CA1233348 | 3-Jun-13 | 1-Jul-13 | 68.0 |
| 20 | CA1233349 | 3-Jun-13 | 1-Jul-13 | 69.0 |
| 21 | CA1233351 | 3-Jun-13 | 1-Jul-13 | 67.5 |
| 22 | CA1233352 | 3-Jun-13 | 1-Jul-13 | 67.5 |
| 23 | CA1233354 | 3-Jun-13 | 1-Jul-13 | 69.0 |
| 24 | CA1233355 | 3-Jun-13 | 1-Jul-13 | 68.5 |
| 25 | CA1233327 | 3-Jun-13 | 1-Jul-13 | 73.5 |
| 26 | CA1233328 | 3-Jun-13 | 1-Jul-13 | 75.5 |
| 27 | CA1233330 | 3-Jun-13 | 1-Jul-13 | 73.5 |
| 28 | CA1233331 | 3-Jun-13 | 1-Jul-13 | 75.0 |
| 29 | CA1233333 | 3-Jun-13 | 1-Jul-13 | 70.0 |
| 30 | CA1233334 | 3-Jun-13 | 1-Jul-13 | 69.0 |
| 31 | CA1233315 | 3-Jun-13 | 1-Jul-13 | 70.5 |
| 32 | CA1233316 | 3-Jun-13 | 1-Jul-13 | 73.5 |
| 33 | CA1233321 | 3-Jun-13 | 1-Jul-13 | 75.0 |
| 34 | CA1233322 | 3-Jun-13 | 1-Jul-13 | 70.5 |
| 35 | CA1233324 | 3-Jun-13 | 1-Jul-13 | 69.0 |
| 36 | CA1233325 | 3-Jun-13 | 1-Jul-13 | 74.0 |
| 37 | CA1233294 | 3-Jun-13 | 1-Jul-13 | 67.0 |
| 38 | CA1233295 | 3-Jun-13 | 1-Jul-13 | 66.0 |
| 39 | CA1233303 | 3-Jun-13 | 1-Jul-13 | 67.0 |
| 40 | CA1233304 | 3-Jun-13 | 1-Jul-13 | 66.5 |
| 41 | CA1233306 | 3-Jun-13 | 1-Jul-13 | 67.0 |
| 42 | CA1233307 | 3-Jun-13 | 1-Jul-13 | 71.0 |
| 43 | CA1233285 | 3-Jun-13 | 1-Jul-13 | 70.5 |
| 44 | CA1233286 | 3-Jun-13 | 1-Jul-13 | 65.5 |

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|---|---|---|---|---|
| 45 | CA1233288 | 3-Jun-13 | 1-Jul-13 | 66.0 |
| 46 | CA1233289 | 3-Jun-13 | 1-Jul-13 | 65.5 |
| 47 | CA1233291 | 3-Jun-13 | 1-Jul-13 | 65.5 |
| 48 | CA1233292 | 3-Jun-13 | 1-Jul-13 | 67.5 |
| 49 | CA1233270 | 3-Jun-13 | 1-Jul-13 | 63.0 |
| 50 | CA1233271 | 3-Jun-13 | 1-Jul-13 | 65.0 |
| 51 | CA1233273 | 3-Jun-13 | 1-Jul-13 | 63.0 |
| 52 | CA1233274 | 3-Jun-13 | 1-Jul-13 | 68.5 |
| 53 | CA1233282 | 3-Jun-13 | 1-Jul-13 | 67.5 |
| 54 | CA1233283 | 3-Jun-13 | 1-Jul-13 | 65.5 |
| 55 | CA1233197 | 3-Jun-13 | 1-Jul-13 | 68.0 |
| 56 | CA1233198 | 3-Jun-13 | 1-Jul-13 | 67.5 |
| 57 | CA1233200 | 3-Jun-13 | 1-Jul-13 | 68.5 |
| 58 | CA1233265 | 3-Jun-13 | 1-Jul-13 | 63.5 |
| 59 | CA1233267 | 3-Jun-13 | 1-Jul-13 | 63.0 |
| 60 | CA1233268 | 3-Jun-13 | 1-Jul-13 | 63.5 |
| 61 | CA1233300 | 3-Jun-13 | 1-Jul-13 | 70.0 |
| 62 | CA1233301 | 3-Jun-13 | 1-Jul-13 | 66.5 |
| 63 | CA1233339 | 3-Jun-13 | 1-Jul-13 | 73.0 |
| 64 | CA1233340 | 3-Jun-13 | 1-Jul-13 | 73.5 |
| 65 | CA1233360 | 3-Jun-13 | 1-Jul-13 | 68.5 |
| 66 | CA1233361 | 3-Jun-13 | 1-Jul-13 | 70.0 |
| 67 | CA1233342 | 3-Jun-13 | 1-Jul-13 | 71.5 |
| 68 | CA1233343 | 3-Jun-13 | 1-Jul-13 | 69.0 |
| 69 | CA1233384 | 3-Jun-13 | 1-Jul-13 | 63.0 |
| 70 | CA1233385 | 3-Jun-13 | 1-Jul-13 | 65.5 |
| 71 | CA1233390 | 3-Jun-13 | 1-Jul-13 | 68.0 |
| 72 | CA1233391 | 3-Jun-13 | 1-Jul-13 | 67.0 |
| 73 | CA1233276 | 3-Jun-13 | 1-Jul-13 | 67.0 |
| 74 | CA1233277 | 3-Jun-13 | 1-Jul-13 | 68.0 |
| 75 | CA1233279 | 3-Jun-13 | 1-Jul-13 | 66.0 |
| 76 | CA1233280 | 3-Jun-13 | 1-Jul-13 | 65.0 |
| 77 | CA1233297 | 3-Jun-13 | 1-Jul-13 | 62.5 |
| 78 | CA1233298 | 3-Jun-13 | 1-Jul-13 | 66.5 |

Roof slab : T3

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1233038 | 6-May-13 | 3-Jun-13 | 76.0 |
| 2 | CA1233039 | 6-May-13 | 3-Jun-13 | 75.0 |
| 3 | CA1233041 | 6-May-13 | 3-Jun-13 | 73.0 |
| 4 | CA1233042 | 6-May-13 | 3-Jun-13 | 71.5 |
| 5 | CA1233045 | 6-May-13 | 3-Jun-13 | 76.0 |
| 6 | CA1233044 | 6-May-13 | 3-Jun-13 | 71.0 |
| 7 | CA1233077 | 6-May-13 | 3-Jun-13 | 70.5 |
| 8 | CA1233078 | 6-May-13 | 3-Jun-13 | 71.5 |
| 9 | CA1233083 | 6-May-13 | 3-Jun-13 | 71.5 |
| 10 | CA1233084 | 6-May-13 | 3-Jun-13 | 72.5 |
| 11 | CA1233086 | 6-May-13 | 3-Jun-13 | 65.0 |
| 12 | CA1233087 | 6-May-13 | 3-Jun-13 | 67.0 |
| 13 | CA1233050 | 6-May-13 | 3-Jun-13 | 64.5 |
| 14 | CA1233051 | 6-May-13 | 3-Jun-13 | 67.0 |
| 15 | CA1233059 | 6-May-13 | 3-Jun-13 | 66.0 |
| 16 | CA1233060 | 6-May-13 | 3-Jun-13 | 66.5 |
| 17 | CA1233062 | 6-May-13 | 3-Jun-13 | 66.5 |
| 18 | CA1233063 | 6-May-13 | 3-Jun-13 | 66.0 |
| 19 | CA1233107 | 6-May-13 | 3-Jun-13 | 67.0 |
| 20 | CA1233108 | 6-May-13 | 3-Jun-13 | 65.5 |
| 21 | CA1233110 | 6-May-13 | 3-Jun-13 | 65.0 |
| 22 | CA1233111 | 6-May-13 | 3-Jun-13 | 64.5 |
| 23 | CA1233119 | 6-May-13 | 3-Jun-13 | 68.0 |
| 24 | CA1233120 | 6-May-13 | 3-Jun-13 | 64.5 |
| 25 | CA1233011 | 6-May-13 | 3-Jun-13 | 66.5 |
| 26 | CA1233012 | 6-May-13 | 3-Jun-13 | 70.0 |
| 27 | CA1233014 | 6-May-13 | 3-Jun-13 | 67.5 |
| 28 | CA1233015 | 6-May-13 | 3-Jun-13 | 67.5 |
| 29 | CA1233017 | 6-May-13 | 3-Jun-13 | 63.0 |
| 30 | CA1233018 | 6-May-13 | 3-Jun-13 | 64.0 |
| 31 | CA1233020 | 6-May-13 | 3-Jun-13 | 65.0 |
| 32 | CA1233021 | 6-May-13 | 3-Jun-13 | 66.0 |
| 33 | CA1233032 | 6-May-13 | 3-Jun-13 | 77.5 |
| 34 | CA1233033 | 6-May-13 | 3-Jun-13 | 77.0 |
| 35 | CA1233035 | 6-May-13 | 3-Jun-13 | 72.5 |
| 36 | CA1233036 | 6-May-13 | 3-Jun-13 | 78.0 |
| 37 | CA1233068 | 6-May-13 | 3-Jun-13 | 69.0 |
| 38 | CA1233069 | 6-May-13 | 3-Jun-13 | 65.5 |
| 39 | CA1233071 | 6-May-13 | 3-Jun-13 | 66.0 |
| 40 | CA1233072 | 6-May-13 | 3-Jun-13 | 67.0 |
| 41 | CA1233074 | 6-May-13 | 3-Jun-13 | 68.0 |
| 42 | CA1233075 | 6-May-13 | 3-Jun-13 | 70.0 |
| 43 | CA1233092 | 6-May-13 | 3-Jun-13 | 61.5 |
| 44 | CA1233093 | 6-May-13 | 3-Jun-13 | 65.0 |

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|---|---|---|---|---|
| 45 | CA1233101 | 6-May-13 | 3-Jun-13 | 66.0 |
| 46 | CA1233102 | 6-May-13 | 3-Jun-13 | 67.5 |
| 47 | CA1233104 | 6-May-13 | 3-Jun-13 | 63.5 |
| 48 | CA1233105 | 6-May-13 | 3-Jun-13 | 66.0 |
| 49 | CA1233125 | 6-May-13 | 3-Jun-13 | 74.5 |
| 50 | CA1233126 | 6-May-13 | 3-Jun-13 | 74.5 |
| 51 | CA1233128 | 6-May-13 | 3-Jun-13 | 74.5 |
| 52 | CA1233129 | 6-May-13 | 3-Jun-13 | 74.0 |
| 53 | CA1233137 | 6-May-13 | 3-Jun-13 | 64.5 |
| 54 | CA1233138 | 6-May-13 | 3-Jun-13 | 59.0 |
| 55 | CA1233023 | 6-May-13 | 3-Jun-13 | 70.0 |
| 56 | CA1233024 | 6-May-13 | 3-Jun-13 | 67.0 |
| 57 | CA1233026 | 6-May-13 | 3-Jun-13 | 75.5 |
| 58 | CA1233027 | 6-May-13 | 3-Jun-13 | 71.0 |
| 59 | CA1233029 | 6-May-13 | 3-Jun-13 | 75.0 |
| 60 | CA1233030 | 6-May-13 | 3-Jun-13 | 75.5 |
| 61 | CA1233002 | 6-May-13 | 3-Jun-13 | 65.0 |
| 62 | CA1233003 | 6-May-13 | 3-Jun-13 | 66.0 |
| 63 | CA1233005 | 6-May-13 | 3-Jun-13 | 66.5 |
| 64 | CA1233006 | 6-May-13 | 3-Jun-13 | 66.5 |
| 65 | CA1233008 | 6-May-13 | 3-Jun-13 | 64.5 |
| 66 | CA1233009 | 6-May-13 | 3-Jun-13 | 67.5 |
| 67 | CA1233134 | 6-May-13 | 3-Jun-13 | 61.0 |
| 68 | CA1233135 | 6-May-13 | 3-Jun-13 | 62.0 |
| 69 | CA1233140 | 6-May-13 | 3-Jun-13 | 67.5 |
| 70 | CA1233141 | 6-May-13 | 3-Jun-13 | 60.5 |
| 71 | CA1233143 | 6-May-13 | 3-Jun-13 | 69.5 |
| 72 | CA1233144 | 6-May-13 | 3-Jun-13 | 65.0 |
| 73 | CA1233116 | 6-May-13 | 3-Jun-13 | 65.5 |
| 74 | CA1233117 | 6-May-13 | 3-Jun-13 | 65.0 |
| 75 | CA1233122 | 6-May-13 | 3-Jun-13 | 65.0 |
| 76 | CA1233123 | 6-May-13 | 3-Jun-13 | 63.5 |
| 77 | CA1233131 | 6-May-13 | 3-Jun-13 | 77.0 |
| 78 | CA1233132 | 6-May-13 | 3-Jun-13 | 76.0 |
| 79 | CA1233095 | 6-May-13 | 3-Jun-13 | 66.5 |
| 80 | CA1233096 | 6-May-13 | 3-Jun-13 | 67.5 |
| 81 | CA1233098 | 6-May-13 | 3-Jun-13 | 65.5 |
| 82 | CA1233099 | 6-May-13 | 3-Jun-13 | 65.0 |
| 83 | CA1233113 | 6-May-13 | 3-Jun-13 | 63.5 |
| 84 | CA1233114 | 6-May-13 | 3-Jun-13 | 61.5 |
| 85 | CA1233065 | 6-May-13 | 3-Jun-13 | 69.5 |
| 86 | CA1233066 | 6-May-13 | 3-Jun-13 | 69.0 |
| 87 | CA1233080 | 6-May-13 | 3-Jun-13 | 72.5 |
| 88 | CA1233081 | 6-May-13 | 3-Jun-13 | 71.0 |
| 89 | CA1233089 | 6-May-13 | 3-Jun-13 | 68.0 |
| 90 | CA1233090 | 6-May-13 | 3-Jun-13 | 68.5 |

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|---|---|---|---|---|
| 91 | CA1233047 | 6-May-13 | 3-Jun-13 | 74.0 |
| 92 | CA1233048 | 6-May-13 | 3-Jun-13 | 71.5 |
| 93 | CA1233053 | 6-May-13 | 3-Jun-13 | 66.0 |
| 94 | CA1233054 | 6-May-13 | 3-Jun-13 | 67.0 |
| 95 | CA1233056 | 6-May-13 | 3-Jun-13 | 67.0 |
| 96 | CA1233057 | 6-May-13 | 3-Jun-13 | 67.0 |

## Roof slab : T4

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1233922 | 21-May-13 | 18-Jun-13 | 64.5 |
| 2 | CA1233923 | 21-May-13 | 18-Jun-13 | 62.5 |
| 3 | CA1233925 | 21-May-13 | 18-Jun-13 | 62.0 |
| 4 | CA1233926 | 21-May-13 | 18-Jun-13 | 62.5 |
| 5 | CA1233928 | 21-May-13 | 18-Jun-13 | 61.0 |
| 6 | CA1233929 | 21-May-13 | 18-Jun-13 | 63.0 |
| 7 | CA1233931 | 21-May-13 | 18-Jun-13 | 57.5 |
| 8 | CA1233932 | 21-May-13 | 18-Jun-13 | 64.0 |
| 9 | CA1233934 | 21-May-13 | 18-Jun-13 | 59.0 |
| 10 | CA1233935 | 21-May-13 | 18-Jun-13 | 60.5 |
| 11 | CA1233937 | 21-May-13 | 18-Jun-13 | 69.0 |
| 12 | CA1233938 | 21-May-13 | 18-Jun-13 | 65.5 |
| 13 | CA1233955 | 21-May-13 | 18-Jun-13 | 74.0 |
| 14 | CA1233956 | 21-May-13 | 18-Jun-13 | 71.5 |
| 15 | CA1233958 | 21-May-13 | 18-Jun-13 | 69.0 |
| 16 | CA1233959 | 21-May-13 | 18-Jun-13 | 69.5 |
| 17 | CA1233967 | 21-May-13 | 18-Jun-13 | 71.5 |
| 18 | CA1233968 | 21-May-13 | 18-Jun-13 | 70.5 |
| 19 | CA1233940 | 21-May-13 | 18-Jun-13 | 69.0 |
| 20 | CA1233941 | 21-May-13 | 18-Jun-13 | 69.5 |
| 21 | CA1233943 | 21-May-13 | 18-Jun-13 | 71.5 |
| 22 | CA1233944 | 21-May-13 | 18-Jun-13 | 71.0 |
| 23 | CA1233952 | 21-May-13 | 18-Jun-13 | 71.5 |
| 24 | CA1233953 | 21-May-13 | 18-Jun-13 | 71.5 |
| 25 | CA1233230 | 21-May-13 | 18-Jun-13 | 76.0 |
| 26 | CA1233231 | 21-May-13 | 18-Jun-13 | 75.5 |
| 27 | CA1233236 | 21-May-13 | 18-Jun-13 | 76.5 |
| 28 | CA1233237 | 21-May-13 | 18-Jun-13 | 72.0 |
| 29 | CA1233245 | 21-May-13 | 18-Jun-13 | 76.0 |
| 30 | CA1233246 | 21-May-13 | 18-Jun-13 | 77.0 |
| 31 | CA1233215 | 21-May-13 | 18-Jun-13 | 82.5 |
| 32 | CA1233216 | 21-May-13 | 18-Jun-13 | 78.0 |
| 33 | CA1233221 | 21-May-13 | 18-Jun-13 | 76.5 |
| 34 | CA1233222 | 21-May-13 | 18-Jun-13 | 75.0 |
| 35 | CA1233227 | 21-May-13 | 18-Jun-13 | 72.5 |
| 36 | CA1233228 | 21-May-13 | 18-Jun-13 | 75.0 |
| 37 | CA1233203 | 21-May-13 | 18-Jun-13 | 64.0 |
| 38 | CA1233204 | 21-May-13 | 18-Jun-13 | 66.0 |
| 39 | CA1233209 | 21-May-13 | 18-Jun-13 | 68.0 |
| 40 | CA1233210 | 21-May-13 | 18-Jun-13 | 66.0 |
| 41 | CA1233994 | 21-May-13 | 18-Jun-13 | 69.5 |
| 42 | CA1233995 | 21-May-13 | 18-Jun-13 | 70.0 |
| 43 | CA1233970 | 21-May-13 | 18-Jun-13 | 69.5 |
| 44 | CA1233971 | 21-May-13 | 18-Jun-13 | 70.0 |

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|---|---|---|---|---|
| 45 | CA1233985 | 21-May-13 | 18-Jun-13 | 68.5 |
| 46 | CA1233986 | 21-May-13 | 18-Jun-13 | 68.5 |
| 47 | CA1233991 | 21-May-13 | 18-Jun-13 | 70.5 |
| 48 | CA1233992 | 21-May-13 | 18-Jun-13 | 70.5 |
| 49 | CA1233248 | 21-May-13 | 18-Jun-13 | 74.0 |
| 50 | CA1233249 | 21-May-13 | 18-Jun-13 | 73.0 |
| 51 | CA1233251 | 21-May-13 | 18-Jun-13 | 75.0 |
| 52 | CA1233252 | 21-May-13 | 18-Jun-13 | 75.5 |
| 53 | CA1233218 | 21-May-13 | 18-Jun-13 | 77.0 |
| 54 | CA1233219 | 21-May-13 | 18-Jun-13 | 77.0 |
| 55 | CA1233242 | 21-May-13 | 18-Jun-13 | 79.0 |
| 56 | CA1233243 | 21-May-13 | 18-Jun-13 | 77.5 |
| 57 | CA1233949 | 21-May-13 | 18-Jun-13 | 73.0 |
| 58 | CA1233950 | 21-May-13 | 18-Jun-13 | 70.5 |
| 59 | CA1233961 | 21-May-13 | 18-Jun-13 | 70.5 |
| 60 | CA1233962 | 21-May-13 | 18-Jun-13 | 71.0 |
| 61 | CA1233982 | 21-May-13 | 18-Jun-13 | 68.0 |
| 62 | CA1233983 | 21-May-13 | 18-Jun-13 | 66.5 |

Roof slab : T5

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1233502 | 10-Jun-13 | 8-Jul-13 | 71.0 |
| 2 | CA1233514 | 10-Jun-13 | 8-Jul-13 | 69.5 |
| 3 | CA1233532 | 10-Jun-13 | 8-Jul-13 | 68.5 |
| 4 | CA1233541 | 10-Jun-13 | 8-Jul-13 | 71.0 |
| 5 | CA1233501 | 10-Jun-13 | 8-Jul-13 | 70.5 |
| 6 | CA1233513 | 10-Jun-13 | 8-Jul-13 | 70.0 |
| 7 | CA1233531 | 10-Jun-13 | 8-Jul-13 | 64.5 |
| 8 | CA1233540 | 10-Jun-13 | 8-Jul-13 | 68.5 |
| 9 | CA1233402 | 10-Jun-13 | 8-Jul-13 | 65.5 |
| 10 | CA1233405 | 10-Jun-13 | 8-Jul-13 | 67.0 |
| 11 | CA1233408 | 10-Jun-13 | 8-Jul-13 | 64.5 |
| 12 | CA1233411 | 10-Jun-13 | 8-Jul-13 | 64.5 |
| 13 | CA1233417 | 10-Jun-13 | 8-Jul-13 | 64.0 |
| 14 | CA1233420 | 10-Jun-13 | 8-Jul-13 | 68.0 |
| 15 | CA1233426 | 10-Jun-13 | 8-Jul-13 | 68.5 |
| 16 | CA1233435 | 10-Jun-13 | 8-Jul-13 | 67.0 |
| 17 | CA1233441 | 10-Jun-13 | 8-Jul-13 | 70.0 |
| 18 | CA1233450 | 10-Jun-13 | 8-Jul-13 | 71.5 |
| 19 | CA1233453 | 10-Jun-13 | 8-Jul-13 | 75.0 |
| 20 | CA1233456 | 10-Jun-13 | 8-Jul-13 | 70.0 |
| 21 | CA1233465 | 10-Jun-13 | 8-Jul-13 | 73.5 |
| 22 | CA1233471 | 10-Jun-13 | 8-Jul-13 | 78.5 |
| 23 | CA1233477 | 10-Jun-13 | 8-Jul-13 | 83.0 |
| 24 | CA1233480 | 10-Jun-13 | 8-Jul-13 | 64.0 |
| 25 | CA1233483 | 10-Jun-13 | 8-Jul-13 | 65.0 |
| 26 | CA1233492 | 10-Jun-13 | 8-Jul-13 | 69.0 |
| 27 | CA1233495 | 10-Jun-13 | 8-Jul-13 | 67.5 |
| 28 | CA1233403 | 10-Jun-13 | 8-Jul-13 | 65.0 |
| 29 | CA1233406 | 10-Jun-13 | 8-Jul-13 | 65.5 |
| 30 | CA1233409 | 10-Jun-13 | 8-Jul-13 | 61.5 |
| 31 | CA1233412 | 10-Jun-13 | 8-Jul-13 | 66.5 |
| 32 | CA1233418 | 10-Jun-13 | 8-Jul-13 | 66.5 |
| 33 | CA1233421 | 10-Jun-13 | 8-Jul-13 | 66.5 |
| 34 | CA1233427 | 10-Jun-13 | 8-Jul-13 | 70.0 |
| 35 | CA1233436 | 10-Jun-13 | 8-Jul-13 | 66.5 |
| 36 | CA1233442 | 10-Jun-13 | 8-Jul-13 | 67.5 |
| 37 | CA1233451 | 10-Jun-13 | 8-Jul-13 | 71.5 |
| 38 | CA1233454 | 10-Jun-13 | 8-Jul-13 | 77.0 |
| 39 | CA1233457 | 10-Jun-13 | 8-Jul-13 | 74.5 |
| 40 | CA1233466 | 10-Jun-13 | 8-Jul-13 | 74.0 |
| 41 | CA1233472 | 10-Jun-13 | 8-Jul-13 | 80.0 |
| 42 | CA1233478 | 10-Jun-13 | 8-Jul-13 | 86.0 |
| 43 | CA1233481 | 10-Jun-13 | 8-Jul-13 | 66.5 |
| 44 | CA1233484 | 10-Jun-13 | 8-Jul-13 | 63.0 |

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|---|---|---|---|---|
| 45 | CA1233493 | 10-Jun-13 | 8-Jul-13 | 73.5 |
| 46 | CA1233496 | 10-Jun-13 | 8-Jul-13 | 67.5 |
| 47 | CA1233414 | 10-Jun-13 | 8-Jul-13 | 65.5 |
| 48 | CA1233423 | 10-Jun-13 | 8-Jul-13 | 70.5 |
| 49 | CA1233429 | 10-Jun-13 | 8-Jul-13 | 71.0 |
| 50 | CA1233468 | 10-Jun-13 | 8-Jul-13 | 72.0 |
| 51 | CA1233486 | 10-Jun-13 | 8-Jul-13 | 61.5 |
| 52 | CA1233489 | 10-Jun-13 | 8-Jul-13 | 69.0 |
| 53 | CA1233432 | 10-Jun-13 | 8-Jul-13 | 70.5 |
| 54 | CA1233438 | 10-Jun-13 | 8-Jul-13 | 68.0 |
| 55 | CA1233444 | 10-Jun-13 | 8-Jul-13 | 63.5 |
| 56 | CA1233447 | 10-Jun-13 | 8-Jul-13 | 71.0 |
| 57 | CA1233459 | 10-Jun-13 | 8-Jul-13 | 71.5 |
| 58 | CA1233462 | 10-Jun-13 | 8-Jul-13 | 76.5 |
| 59 | CA1233474 | 10-Jun-13 | 8-Jul-13 | 78.0 |
| 60 | CA1233498 | 10-Jun-13 | 8-Jul-13 | 69.0 |
| 61 | CA1233507 | 10-Jun-13 | 8-Jul-13 | 70.5 |
| 62 | CA1233510 | 10-Jun-13 | 8-Jul-13 | 70.5 |
| 63 | CA1233415 | 10-Jun-13 | 8-Jul-13 | 66.5 |
| 64 | CA1233424 | 10-Jun-13 | 8-Jul-13 | 67.5 |
| 65 | CA1233430 | 10-Jun-13 | 8-Jul-13 | 69.5 |
| 66 | CA1233469 | 10-Jun-13 | 8-Jul-13 | 76.5 |
| 67 | CA1233487 | 10-Jun-13 | 8-Jul-13 | 61.5 |
| 68 | CA1233490 | 10-Jun-13 | 8-Jul-13 | 73.5 |
| 69 | CA1233433 | 10-Jun-13 | 8-Jul-13 | 62.5 |
| 70 | CA1233439 | 10-Jun-13 | 8-Jul-13 | 68.5 |
| 71 | CA1233445 | 10-Jun-13 | 8-Jul-13 | 71.0 |
| 72 | CA1233448 | 10-Jun-13 | 8-Jul-13 | 68.5 |
| 73 | CA1233460 | 10-Jun-13 | 8-Jul-13 | 72.0 |
| 74 | CA1233463 | 10-Jun-13 | 8-Jul-13 | 78.5 |
| 75 | CA1233475 | 10-Jun-13 | 8-Jul-13 | 76.5 |
| 76 | CA1233499 | 10-Jun-13 | 8-Jul-13 | 68.0 |
| 77 | CA1233508 | 10-Jun-13 | 8-Jul-13 | 68.5 |
| 78 | CA1233511 | 10-Jun-13 | 8-Jul-13 | 75.5 |

Roof slab : T6

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1233570 | 24-Jun-13 | 22-Jul-13 | 63.5 |
| 2 | CA1233573 | 24-Jun-13 | 22-Jul-13 | 64.0 |
| 3 | CA1233597 | 24-Jun-13 | 22-Jul-13 | 64.0 |
| 4 | CA1175009 | 24-Jun-13 | 22-Jul-13 | 61.5 |
| 5 | CA1175012 | 24-Jun-13 | 22-Jul-13 | 61.5 |
| 6 | CA1175021 | 24-Jun-13 | 22-Jul-13 | 63.0 |
| 7 | CA1175027 | 24-Jun-13 | 22-Jul-13 | 62.0 |
| 8 | CA1175033 | 24-Jun-13 | 22-Jul-13 | 61.0 |
| 9 | CA1175039 | 24-Jun-13 | 22-Jul-13 | 58.5 |
| 10 | CA1175048 | 24-Jun-13 | 22-Jul-13 | 62.5 |
| 11 | CA1175057 | 24-Jun-13 | 22-Jul-13 | 65.0 |
| 12 | CA1175066 | 24-Jun-13 | 22-Jul-13 | 65.0 |
| 13 | CA1175069 | 24-Jun-13 | 22-Jul-13 | 70.5 |
| 14 | CA1175081 | 24-Jun-13 | 22-Jul-13 | 68.0 |
| 15 | CA1233571 | 24-Jun-13 | 22-Jul-13 | 62.5 |
| 16 | CA1233574 | 24-Jun-13 | 22-Jul-13 | 63.5 |
| 17 | CA1233598 | 24-Jun-13 | 22-Jul-13 | 63.5 |
| 18 | CA1175010 | 24-Jun-13 | 22-Jul-13 | 63.5 |
| 19 | CA1175013 | 24-Jun-13 | 22-Jul-13 | 62.5 |
| 20 | CA1175022 | 24-Jun-13 | 22-Jul-13 | 65.5 |
| 21 | CA1175028 | 24-Jun-13 | 22-Jul-13 | 66.0 |
| 22 | CA1175034 | 24-Jun-13 | 22-Jul-13 | 63.5 |
| 23 | CA1175040 | 24-Jun-13 | 22-Jul-13 | 56.5 |
| 24 | CA1175049 | 24-Jun-13 | 22-Jul-13 | 64.0 |
| 25 | CA1175058 | 24-Jun-13 | 22-Jul-13 | 60.5 |
| 26 | CA1175067 | 24-Jun-13 | 22-Jul-13 | 65.5 |
| 27 | CA1175070 | 24-Jun-13 | 22-Jul-13 | 69.0 |
| 28 | CA1175082 | 24-Jun-13 | 22-Jul-13 | 73.5 |
| 29 | CA1175087 | 24-Jun-13 | 22-Jul-13 | 66.5 |
| 30 | CA1175090 | 24-Jun-13 | 22-Jul-13 | 64.5 |
| 31 | CA1233549 | 24-Jun-13 | 22-Jul-13 | 68.0 |
| 32 | CA1233552 | 24-Jun-13 | 22-Jul-13 | 66.5 |
| 33 | CA1233555 | 24-Jun-13 | 22-Jul-13 | 64.0 |
| 34 | CA1233564 | 24-Jun-13 | 22-Jul-13 | 65.5 |
| 35 | CA1233567 | 24-Jun-13 | 22-Jul-13 | 68.0 |
| 36 | CA1233576 | 24-Jun-13 | 22-Jul-13 | 62.0 |
| 37 | CA1233579 | 24-Jun-13 | 22-Jul-13 | 70.5 |
| 38 | CA1233582 | 24-Jun-13 | 22-Jul-13 | 69.5 |
| 39 | CA1233588 | 24-Jun-13 | 22-Jul-13 | 66.0 |
| 40 | CA1233591 | 24-Jun-13 | 22-Jul-13 | 65.5 |
| 41 | CA1233594 | 24-Jun-13 | 22-Jul-13 | 65.0 |
| 42 | CA1175003 | 24-Jun-13 | 22-Jul-13 | 63.0 |
| 43 | CA1233558 | 24-Jun-13 | 22-Jul-13 | 65.5 |
| 44 | CA1233561 | 24-Jun-13 | 22-Jul-13 | 60.5 |

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|---|---|---|---|---|
| 45 | CA1175084 | 24-Jun-13 | 22-Jul-13 | 62.0 |
| 46 | CA1175072 | 24-Jun-13 | 22-Jul-13 | 64.0 |
| 47 | CA1175075 | 24-Jun-13 | 22-Jul-13 | 63.0 |
| 48 | CA1175078 | 24-Jun-13 | 22-Jul-13 | 66.0 |
| 49 | CA1175054 | 24-Jun-13 | 22-Jul-13 | 67.5 |
| 50 | CA1175060 | 24-Jun-13 | 22-Jul-13 | 64.0 |
| 51 | CA1175063 | 24-Jun-13 | 22-Jul-13 | 64.0 |
| 52 | CA1175042 | 24-Jun-13 | 22-Jul-13 | 59.5 |
| 53 | CA1175045 | 24-Jun-13 | 22-Jul-13 | 59.5 |
| 54 | CA1175051 | 24-Jun-13 | 22-Jul-13 | 66.0 |
| 55 | CA1175024 | 24-Jun-13 | 22-Jul-13 | 60.0 |
| 56 | CA1175030 | 24-Jun-13 | 22-Jul-13 | 62.0 |
| 57 | CA1175036 | 24-Jun-13 | 22-Jul-13 | 64.5 |
| 58 | CA1175006 | 24-Jun-13 | 22-Jul-13 | 62.5 |
| 59 | CA1175015 | 24-Jun-13 | 22-Jul-13 | 64.0 |
| 60 | CA1175018 | 24-Jun-13 | 22-Jul-13 | 61.5 |
| 61 | CA1175088 | 24-Jun-13 | 22-Jul-13 | 65.0 |
| 62 | CA1175091 | 24-Jun-13 | 22-Jul-13 | 68.5 |
| 63 | CA1233550 | 24-Jun-13 | 22-Jul-13 | 66.5 |
| 64 | CA1233553 | 24-Jun-13 | 22-Jul-13 | 63.5 |
| 65 | CA1233556 | 24-Jun-13 | 22-Jul-13 | 61.0 |
| 66 | CA1233565 | 24-Jun-13 | 22-Jul-13 | 66.5 |
| 67 | CA1233568 | 24-Jun-13 | 22-Jul-13 | 65.5 |
| 68 | CA1233577 | 24-Jun-13 | 22-Jul-13 | 65.0 |
| 69 | CA1233580 | 24-Jun-13 | 22-Jul-13 | 66.0 |
| 70 | CA1233583 | 24-Jun-13 | 22-Jul-13 | 67.9 |
| 71 | CA1233589 | 24-Jun-13 | 22-Jul-13 | 66.0 |
| 72 | CA1233592 | 24-Jun-13 | 22-Jul-13 | 65.0 |
| 73 | CA1233595 | 24-Jun-13 | 22-Jul-13 | 66.0 |
| 74 | CA1175004 | 24-Jun-13 | 22-Jul-13 | 65.0 |
| 75 | CA1233559 | 24-Jun-13 | 22-Jul-13 | 65.5 |
| 76 | CA1233562 | 24-Jun-13 | 22-Jul-13 | 66.0 |
| 77 | CA1175085 | 24-Jun-13 | 22-Jul-13 | 66.0 |
| 78 | CA1175073 | 24-Jun-13 | 22-Jul-13 | 66.5 |
| 79 | CA1175076 | 24-Jun-13 | 22-Jul-13 | 70.0 |
| 80 | CA1175079 | 24-Jun-13 | 22-Jul-13 | 67.0 |
| 81 | CA1175055 | 24-Jun-13 | 22-Jul-13 | 65.5 |
| 82 | CA1175061 | 24-Jun-13 | 22-Jul-13 | 62.5 |
| 83 | CA1175064 | 24-Jun-13 | 22-Jul-13 | 62.0 |
| 84 | CA1175043 | 24-Jun-13 | 22-Jul-13 | 59.5 |
| 85 | CA1175046 | 24-Jun-13 | 22-Jul-13 | 61.0 |
| 86 | CA1175052 | 24-Jun-13 | 22-Jul-13 | 66.0 |
| 87 | CA1175025 | 24-Jun-13 | 22-Jul-13 | 65.5 |
| 88 | CA1175031 | 24-Jun-13 | 22-Jul-13 | 65.0 |
| 89 | CA1175037 | 24-Jun-13 | 22-Jul-13 | 64.5 |
| 90 | CA1175007 | 24-Jun-13 | 22-Jul-13 | 63.5 |

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|---|---|---|---|---|
| 91 | CA1175016 | 24-Jun-13 | 22-Jul-13 | 65.0 |
| 92 | CA1175019 | 24-Jun-13 | 22-Jul-13 | 63.5 |

Roof slab : T7 &T8

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1175746 | 28-Sep-13 | 26-Oct-13 | 70.5 |
| 2 | CA1175747 | 28-Sep-13 | 26-Oct-13 | 72.0 |
| 3 | CA1175752 | 28-Sep-13 | 26-Oct-13 | 68.5 |
| 4 | CA1175753 | 28-Sep-13 | 26-Oct-13 | 69.5 |
| 5 | CA1175755 | 28-Sep-13 | 26-Oct-13 | 67.5 |
| 6 | CA1175756 | 28-Sep-13 | 26-Oct-13 | 67.0 |
| 7 | CA1175782 | 28-Sep-13 | 26-Oct-13 | 70.0 |
| 8 | CA1175783 | 28-Sep-13 | 26-Oct-13 | 70.0 |
| 9 | CA1175797 | 28-Sep-13 | 26-Oct-13 | 68.5 |
| 10 | CA1175798 | 28-Sep-13 | 26-Oct-13 | 69.0 |
| 11 | CA1233609 | 28-Sep-13 | 26-Oct-13 | 64.0 |
| 12 | CA1233610 | 28-Sep-13 | 26-Oct-13 | 63.5 |
| 13 | CA1233630 | 28-Sep-13 | 26-Oct-13 | 71.0 |
| 14 | CA1233631 | 28-Sep-13 | 26-Oct-13 | 67.5 |
| 15 | CA1233642 | 28-Sep-13 | 26-Oct-13 | 59.5 |
| 16 | CA1233643 | 28-Sep-13 | 26-Oct-13 | 62.5 |
| 17 | CA1233654 | 28-Sep-13 | 26-Oct-13 | 67.5 |
| 18 | CA1233655 | 28-Sep-13 | 26-Oct-13 | 69.5 |
| 19 | CA1233663 | 28-Sep-13 | 26-Oct-13 | 62.5 |
| 20 | CA1233664 | 28-Sep-13 | 26-Oct-13 | 63.5 |
| 21 | CA1233675 | 28-Sep-13 | 26-Oct-13 | 64.5 |
| 22 | CA1233676 | 28-Sep-13 | 26-Oct-13 | 62.5 |
| 23 | CA1233687 | 28-Sep-13 | 26-Oct-13 | 64.5 |
| 24 | CA1233688 | 28-Sep-13 | 26-Oct-13 | 64.0 |
| 25 | CA1233699 | 28-Sep-13 | 26-Oct-13 | 61.5 |
| 26 | CA1233700 | 28-Sep-13 | 26-Oct-13 | 63.0 |
| 27 | CA1233708 | 28-Sep-13 | 26-Oct-13 | 62.5 |
| 28 | CA1233709 | 28-Sep-13 | 26-Oct-13 | 58.0 |
| 29 | CA1233720 | 28-Sep-13 | 26-Oct-13 | 64.5 |
| 30 | CA1233721 | 28-Sep-13 | 26-Oct-13 | 66.0 |
| 31 | CA1233702 | 28-Sep-13 | 26-Oct-13 | 61.0 |
| 32 | CA1233703 | 28-Sep-13 | 26-Oct-13 | 62.5 |
| 33 | CA1233714 | 28-Sep-13 | 26-Oct-13 | 61.5 |
| 34 | CA1233715 | 28-Sep-13 | 26-Oct-13 | 64.5 |
| 35 | CA1233732 | 28-Sep-13 | 26-Oct-13 | 66.0 |
| 36 | CA1233733 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 37 | CA1233678 | 28-Sep-13 | 26-Oct-13 | 62.5 |
| 38 | CA1233679 | 28-Sep-13 | 26-Oct-13 | 65.5 |
| 39 | CA1233684 | 28-Sep-13 | 26-Oct-13 | 67.0 |
| 40 | CA1233685 | 28-Sep-13 | 26-Oct-13 | 64.5 |
| 41 | CA1233693 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 42 | CA1233694 | 28-Sep-13 | 26-Oct-13 | 61.5 |
| 43 | CA1233657 | 28-Sep-13 | 26-Oct-13 | 67.0 |
| 44 | CA1233658 | 28-Sep-13 | 26-Oct-13 | 68.0 |

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|---|---|---|---|---|
| 45 | CA1233666 | 28-Sep-13 | 26-Oct-13 | 63.5 |
| 46 | CA1233667 | 28-Sep-13 | 26-Oct-13 | 64.5 |
| 47 | CA1233669 | 28-Sep-13 | 26-Oct-13 | 65.5 |
| 48 | CA1233670 | 28-Sep-13 | 26-Oct-13 | 64.5 |
| 49 | CA1233603 | 28-Sep-13 | 26-Oct-13 | 65.5 |
| 50 | CA1233604 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 51 | CA1233615 | 28-Sep-13 | 26-Oct-13 | 60.0 |
| 52 | CA1233616 | 28-Sep-13 | 26-Oct-13 | 62.0 |
| 53 | CA1233618 | 28-Sep-13 | 26-Oct-13 | 61.0 |
| 54 | CA1233619 | 28-Sep-13 | 26-Oct-13 | 69.0 |
| 55 | CA1175767 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 56 | CA1175768 | 28-Sep-13 | 26-Oct-13 | 67.5 |
| 57 | CA1175785 | 28-Sep-13 | 26-Oct-13 | 65.5 |
| 58 | CA1175786 | 28-Sep-13 | 26-Oct-13 | 64.5 |
| 59 | CA1175800 | 28-Sep-13 | 26-Oct-13 | 66.0 |
| 60 | CA1233601 | 28-Sep-13 | 26-Oct-13 | 67.0 |
| 61 | CA1233734 | 28-Sep-13 | 26-Oct-13 | 62.0 |
| 62 | CA1233735 | 28-Sep-13 | 26-Oct-13 | 67.0 |
| 63 | CA1233737 | 28-Sep-13 | 26-Oct-13 | 64.0 |
| 64 | CA1233738 | 28-Sep-13 | 26-Oct-13 | 66.0 |
| 65 | CA1175758 | 28-Sep-13 | 26-Oct-13 | 64.5 |
| 66 | CA1175759 | 28-Sep-13 | 26-Oct-13 | 69.5 |
| 67 | CA1233627 | 28-Sep-13 | 26-Oct-13 | 63.5 |
| 68 | CA1233628 | 28-Sep-13 | 26-Oct-13 | 69.0 |
| 69 | CA1233633 | 28-Sep-13 | 26-Oct-13 | 70.5 |
| 70 | CA1233634 | 28-Sep-13 | 26-Oct-13 | 69.5 |
| 71 | CA1233648 | 28-Sep-13 | 26-Oct-13 | 66.0 |
| 72 | CA1233649 | 28-Sep-13 | 26-Oct-13 | 67.0 |
| 73 | CA1233735 | 28-Sep-13 | 26-Oct-13 | 61.5 |
| 74 | CA1233736 | 28-Sep-13 | 26-Oct-13 | 63.0 |
| 75 | CA1233738 | 28-Sep-13 | 26-Oct-13 | 49.5 |
| 76 | CA1233739 | 28-Sep-13 | 26-Oct-13 | 54.5 |
| 77 | CA1175716 | 28-Sep-13 | 26-Oct-13 | 63.0 |
| 78 | CA1175717 | 28-Sep-13 | 26-Oct-13 | 65.0 |
| 79 | CA1175718 | 28-Sep-13 | 26-Oct-13 | 63.0 |
| 80 | CA1175719 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 81 | CA1175720 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 82 | CA1175721 | 28-Sep-13 | 26-Oct-13 | 65.5 |
| 83 | CA1175725 | 28-Sep-13 | 26-Oct-13 | 65.0 |
| 84 | CA1175726 | 28-Sep-13 | 26-Oct-13 | 65.5 |
| 85 | CA1175728 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 86 | CA1175729 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 87 | CA1175731 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 88 | CA1175732 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 89 | CA1233723 | 28-Sep-13 | 26-Oct-13 | 65.5 |
| 90 | CA1233724 | 28-Sep-13 | 26-Oct-13 | 66.5 |

| | | | | |
|---|---|---|---|---|
| 91 | CA1233726 | 28-Sep-13 | 26-Oct-13 | 65.0 |
| 92 | CA1233727 | 28-Sep-13 | 26-Oct-13 | 65.0 |
| 93 | CA1233729 | 28-Sep-13 | 26-Oct-13 | 67.0 |
| 94 | CA1233730 | 28-Sep-13 | 26-Oct-13 | 64.5 |
| 95 | CA1233645 | 28-Sep-13 | 26-Oct-13 | 58.0 |
| 96 | CA1233646 | 28-Sep-13 | 26-Oct-13 | 67.0 |
| 97 | CA1233651 | 28-Sep-13 | 26-Oct-13 | 70.0 |
| 98 | CA1233652 | 28-Sep-13 | 26-Oct-13 | 70.0 |
| 99 | CA1233660 | 28-Sep-13 | 26-Oct-13 | 64.5 |
| 100 | CA1233661 | 28-Sep-13 | 26-Oct-13 | 70.0 |
| 101 | CA1175776 | 28-Sep-13 | 26-Oct-13 | 67.5 |
| 102 | CA1175777 | 28-Sep-13 | 26-Oct-13 | 69.5 |
| 103 | CA1175779 | 28-Sep-13 | 26-Oct-13 | 71.0 |
| 104 | CA1175780 | 28-Sep-13 | 26-Oct-13 | 72.0 |
| 105 | CA1175791 | 28-Sep-13 | 26-Oct-13 | 61.0 |
| 106 | CA1175792 | 28-Sep-13 | 26-Oct-13 | 63.0 |
| 107 | CA1233705 | 28-Sep-13 | 26-Oct-13 | 61.0 |
| 108 | CA1233706 | 28-Sep-13 | 26-Oct-13 | 60.5 |
| 109 | CA1233711 | 28-Sep-13 | 26-Oct-13 | 60.5 |
| 110 | CA1233712 | 28-Sep-13 | 26-Oct-13 | 63.0 |
| 111 | CA1233717 | 28-Sep-13 | 26-Oct-13 | 66.0 |
| 112 | CA1233718 | 28-Sep-13 | 26-Oct-13 | 66.0 |
| 113 | CA1233672 | 28-Sep-13 | 26-Oct-13 | 65.0 |
| 114 | CA1233673 | 28-Sep-13 | 26-Oct-13 | 67.5 |
| 115 | CA1233681 | 28-Sep-13 | 26-Oct-13 | 64.0 |
| 116 | CA1233682 | 28-Sep-13 | 26-Oct-13 | 66.0 |
| 117 | CA1233696 | 28-Sep-13 | 26-Oct-13 | 62.0 |
| 118 | CA1233697 | 28-Sep-13 | 26-Oct-13 | 62.5 |
| 119 | CA1233621 | 28-Sep-13 | 26-Oct-13 | 64.0 |
| 120 | CA1233622 | 28-Sep-13 | 26-Oct-13 | 67.5 |
| 121 | CA1233624 | 28-Sep-13 | 26-Oct-13 | 67.0 |
| 122 | CA1233625 | 28-Sep-13 | 26-Oct-13 | 65.5 |
| 123 | CA1233636 | 28-Sep-13 | 26-Oct-13 | 75.0 |
| 124 | CA1233637 | 28-Sep-13 | 26-Oct-13 | 59.0 |
| 125 | CA1175794 | 28-Sep-13 | 26-Oct-13 | 70.5 |
| 126 | CA1175795 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 127 | CA1233606 | 28-Sep-13 | 26-Oct-13 | 65.5 |
| 128 | CA1233607 | 28-Sep-13 | 26-Oct-13 | 64.0 |
| 129 | CA1233612 | 28-Sep-13 | 26-Oct-13 | 64.0 |
| 130 | CA1233613 | 28-Sep-13 | 26-Oct-13 | 63.5 |
| 131 | CA1175761 | 28-Sep-13 | 26-Oct-13 | 68.5 |
| 132 | CA1175762 | 28-Sep-13 | 26-Oct-13 | 70.0 |
| 133 | CA1175764 | 28-Sep-13 | 26-Oct-13 | 68.5 |
| 134 | CA1175765 | 28-Sep-13 | 26-Oct-13 | 67.5 |
| 135 | CA1175770 | 28-Sep-13 | 26-Oct-13 | 68.0 |

| | | | | |
|---|---|---|---|---|
| 136 | CA1175771 | 28-Sep-13 | 26-Oct-13 | 69.5 |
| 137 | CA1175740 | 28-Sep-13 | 26-Oct-13 | 71.5 |
| 138 | CA1175741 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 139 | CA1175743 | 28-Sep-13 | 26-Oct-13 | 72.0 |
| 140 | CA1175744 | 28-Sep-13 | 26-Oct-13 | 72.5 |
| 141 | CA1175749 | 28-Sep-13 | 26-Oct-13 | 59.0 |
| 142 | CA1175750 | 28-Sep-13 | 26-Oct-13 | 63.5 |
| 143 | CA1233690 | 28-Sep-13 | 26-Oct-13 | 59.5 |
| 144 | CA1233691 | 28-Sep-13 | 26-Oct-13 | 66.5 |
| 145 | CA1175773 | 28-Sep-13 | 26-Oct-13 | 72.5 |
| 146 | CA1175774 | 28-Sep-13 | 26-Oct-13 | 68.0 |
| 147 | CA1175788 | 28-Sep-13 | 26-Oct-13 | 60.5 |
| 148 | CA1175789 | 28-Sep-13 | 26-Oct-13 | 63.0 |
| 149 | CA1233639 | 28-Sep-13 | 26-Oct-13 | 62.0 |
| 150 | CA1233640 | 28-Sep-13 | 26-Oct-13 | 63.0 |

Roof slab : T9

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1322556 | 15-Feb-14 | 15-Mar-14 | 75.0 |
| 2 | CA1322557 | 15-Feb-14 | 15-Mar-14 | 71.5 |
| 3 | CA1322559 | 15-Feb-14 | 15-Mar-14 | 71.0 |
| 4 | CA1322560 | 15-Feb-14 | 15-Mar-14 | 71.0 |
| 5 | CA1322562 | 15-Feb-14 | 15-Mar-14 | 68.5 |
| 6 | CA1322563 | 15-Feb-14 | 15-Mar-14 | 51.0 |
| 7 | CA1322565 | 15-Feb-14 | 15-Mar-14 | 62.5 |
| 8 | CA1322566 | 15-Feb-14 | 15-Mar-14 | 61.0 |
| 9 | CA1322568 | 15-Feb-14 | 15-Mar-14 | 69.0 |
| 10 | CA1322569 | 15-Feb-14 | 15-Mar-14 | 65.0 |
| 11 | CA1322547 | 15-Feb-14 | 15-Mar-14 | 69.0 |
| 12 | CA1322548 | 15-Feb-14 | 15-Mar-14 | 68.0 |
| 13 | CA1322550 | 15-Feb-14 | 15-Mar-14 | 64.0 |
| 14 | CA1322551 | 15-Feb-14 | 15-Mar-14 | 69.0 |
| 15 | CA1322553 | 15-Feb-14 | 15-Mar-14 | 68.0 |
| 16 | CA1322554 | 15-Feb-14 | 15-Mar-14 | 68.5 |
| 17 | CA1322538 | 15-Feb-14 | 15-Mar-14 | 69.0 |
| 18 | CA1322539 | 15-Feb-14 | 15-Mar-14 | 64.5 |
| 19 | CA1322541 | 15-Feb-14 | 15-Mar-14 | 63.5 |
| 20 | CA1322542 | 15-Feb-14 | 15-Mar-14 | 66.0 |
| 21 | CA1322544 | 15-Feb-14 | 15-Mar-14 | 66.0 |
| 22 | CA1322545 | 15-Feb-14 | 15-Mar-14 | 65.5 |
| 23 | CA1322526 | 15-Feb-14 | 15-Mar-14 | 70.0 |
| 24 | CA1322527 | 15-Feb-14 | 15-Mar-14 | 70.0 |
| 25 | CA1322532 | 15-Feb-14 | 15-Mar-14 | 70.0 |
| 26 | CA1322533 | 15-Feb-14 | 15-Mar-14 | 68.5 |
| 27 | CA1322535 | 15-Feb-14 | 15-Mar-14 | 68.0 |
| 28 | CA1322536 | 15-Feb-14 | 15-Mar-14 | 66.0 |
| 29 | CA1322487 | 15-Feb-14 | 15-Mar-14 | 66.5 |
| 30 | CA1322488 | 15-Feb-14 | 15-Mar-14 | 60.0 |
| 31 | CA1322493 | 15-Feb-14 | 15-Mar-14 | 62.0 |
| 32 | CA1322494 | 15-Feb-14 | 15-Mar-14 | 65.5 |
| 33 | CA1322511 | 15-Feb-14 | 15-Mar-14 | 57.0 |
| 34 | CA1322512 | 15-Feb-14 | 15-Mar-14 | 58.5 |
| 35 | CA1322463 | 15-Feb-14 | 15-Mar-14 | 67.0 |
| 36 | CA1322464 | 15-Feb-14 | 15-Mar-14 | 63.5 |
| 37 | CA1322475 | 15-Feb-14 | 15-Mar-14 | 68.0 |
| 38 | CA1322476 | 15-Feb-14 | 15-Mar-14 | 64.5 |
| 39 | CA1322478 | 15-Feb-14 | 15-Mar-14 | 60.5 |
| 40 | CA1322479 | 15-Feb-14 | 15-Mar-14 | 67.0 |
| 41 | CA1322403 | 15-Feb-14 | 15-Mar-14 | 67.0 |
| 42 | CA1322404 | 15-Feb-14 | 15-Mar-14 | 66.5 |
| 43 | CA1322406 | 15-Feb-14 | 15-Mar-14 | 63.5 |

| | | | | |
|---|---|---|---|---|
| 44 | CA1322407 | 15-Feb-14 | 15-Mar-14 | 67.0 |
| 45 | CA1322460 | 15-Feb-14 | 15-Mar-14 | 62.5 |
| 46 | CA1322461 | 15-Feb-14 | 15-Mar-14 | 63.0 |
| 47 | CA1322514 | 15-Feb-14 | 15-Mar-14 | 58.5 |
| 48 | CA1322515 | 15-Feb-14 | 15-Mar-14 | 59.0 |
| 49 | CA1322529 | 15-Feb-14 | 15-Mar-14 | 69.0 |
| 50 | CA1322530 | 15-Feb-14 | 15-Mar-14 | 60.0 |
| 51 | CA1322484 | 15-Feb-14 | 15-Mar-14 | 64.5 |
| 52 | CA1322485 | 15-Feb-14 | 15-Mar-14 | 63.0 |
| 53 | CA1322490 | 15-Feb-14 | 15-Mar-14 | 65.0 |
| 54 | CA1322491 | 15-Feb-14 | 15-Mar-14 | 64.0 |
| 55 | CA1322505 | 15-Feb-14 | 15-Mar-14 | 65.0 |
| 56 | CA1322506 | 15-Feb-14 | 15-Mar-14 | 68.5 |
| 57 | CA1322448 | 15-Feb-14 | 15-Mar-14 | 63.0 |
| 58 | CA1322449 | 15-Feb-14 | 15-Mar-14 | 74.5 |
| 59 | CA1322466 | 15-Feb-14 | 15-Mar-14 | 64.5 |
| 60 | CA1322467 | 15-Feb-14 | 15-Mar-14 | 68.0 |
| 61 | CA1322481 | 15-Feb-14 | 15-Mar-14 | 61.5 |
| 62 | CA1322482 | 15-Feb-14 | 15-Mar-14 | 66.0 |
| 63 | CA1322427 | 15-Feb-14 | 15-Mar-14 | 75.0 |
| 64 | CA1322428 | 15-Feb-14 | 15-Mar-14 | 69.0 |
| 65 | CA1322430 | 15-Feb-14 | 15-Mar-14 | 73.0 |
| 66 | CA1322431 | 15-Feb-14 | 15-Mar-14 | 73.0 |
| 67 | CA1322436 | 15-Feb-14 | 15-Mar-14 | 69.0 |
| 68 | CA1322437 | 15-Feb-14 | 15-Mar-14 | 72.0 |
| 69 | CA1322418 | 15-Feb-14 | 15-Mar-14 | 68.5 |
| 70 | CA1322419 | 15-Feb-14 | 15-Mar-14 | 69.0 |
| 71 | CA1322421 | 15-Feb-14 | 15-Mar-14 | 73.5 |
| 72 | CA1322422 | 15-Feb-14 | 15-Mar-14 | 66.5 |
| 73 | CA1322424 | 15-Feb-14 | 15-Mar-14 | 68.5 |
| 74 | CA1322425 | 15-Feb-14 | 15-Mar-14 | 68.5 |
| 75 | CA1322409 | 15-Feb-14 | 15-Mar-14 | 67.0 |
| 76 | CA1322410 | 15-Feb-14 | 15-Mar-14 | 67.5 |
| 77 | CA1322412 | 15-Feb-14 | 15-Mar-14 | 66.5 |
| 78 | CA1322413 | 15-Feb-14 | 15-Mar-14 | 69.0 |
| 79 | CA1322415 | 15-Feb-14 | 15-Mar-14 | 64.0 |
| 80 | CA1322416 | 15-Feb-14 | 15-Mar-14 | 69.5 |
| 81 | CA1322499 | 15-Feb-14 | 15-Mar-14 | 65.0 |
| 82 | CA1322470 | 15-Feb-14 | 15-Mar-14 | 64.0 |
| 83 | CA1322502 | 15-Feb-14 | 15-Mar-14 | 65.5 |
| 84 | CA1322503 | 15-Feb-14 | 15-Mar-14 | 64.5 |
| 85 | CA1322520 | 15-Feb-14 | 15-Mar-14 | 58.0 |
| 86 | CA1322521 | 15-Feb-14 | 15-Mar-14 | 57.0 |
| 87 | CA1322433 | 15-Feb-14 | 15-Mar-14 | 62.5 |
| 88 | CA1322434 | 15-Feb-14 | 15-Mar-14 | 65.0 |
| 89 | CA1322442 | 15-Feb-14 | 15-Mar-14 | 65.0 |

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|---|---|---|---|---|
| 90 | CA1322443 | 15-Feb-14 | 15-Mar-14 | 61.5 |
| 91 | CA1322454 | 15-Feb-14 | 15-Mar-14 | 63.0 |
| 92 | CA1322455 | 15-Feb-14 | 15-Mar-14 | 63.0 |
| 93 | CA1322397 | 15-Feb-14 | 15-Mar-14 | 70.5 |
| 94 | CA1322398 | 15-Feb-14 | 15-Mar-14 | 71.0 |
| 95 | CA1322400 | 15-Feb-14 | 15-Mar-14 | 71.5 |
| 96 | CA1322401 | 15-Feb-14 | 15-Mar-14 | 71.5 |
| 97 | CA1322523 | 15-Feb-14 | 15-Mar-14 | 68.0 |
| 98 | CA1322524 | 15-Feb-14 | 15-Mar-14 | 60.5 |
| 99 | CA1322499 | 15-Feb-14 | 15-Mar-14 | 61.0 |
| 100 | CA1322500 | 15-Feb-14 | 15-Mar-14 | 65.0 |
| 101 | CA1322508 | 15-Feb-14 | 15-Mar-14 | 66.5 |
| 102 | CA1322509 | 15-Feb-14 | 15-Mar-14 | 66.5 |
| 103 | CA1322517 | 15-Feb-14 | 15-Mar-14 | 70.5 |
| 104 | CA1322518 | 15-Feb-14 | 15-Mar-14 | 69.5 |
| 105 | CA1322457 | 15-Feb-14 | 15-Mar-14 | 73.5 |
| 106 | CA1322458 | 15-Feb-14 | 15-Mar-14 | 74.0 |
| 107 | CA1322472 | 15-Feb-14 | 15-Mar-14 | 72.5 |
| 108 | CA1322473 | 15-Feb-14 | 15-Mar-14 | 70.5 |
| 109 | CA1322496 | 15-Feb-14 | 15-Mar-14 | 64.5 |
| 110 | CA1322497 | 15-Feb-14 | 15-Mar-14 | 66.0 |
| 111 | CA1322439 | 15-Feb-14 | 15-Mar-14 | 65.0 |
| 112 | CA1322440 | 15-Feb-14 | 15-Mar-14 | 68.5 |
| 113 | CA1322445 | 15-Feb-14 | 15-Mar-14 | 67.5 |
| 114 | CA1322446 | 15-Feb-14 | 15-Mar-14 | 69.5 |
| 115 | CA1322451 | 15-Feb-14 | 15-Mar-14 | 58.0 |
| 116 | CA1322452 | 15-Feb-14 | 15-Mar-14 | 69.5 |

Roof slab : T10

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1322577 | 22-Feb-14 | 22-Mar-14 | 64.0 |
| 2 | CA1322578 | 22-Feb-14 | 22-Mar-14 | 62.5 |
| 3 | CA1322580 | 22-Feb-14 | 22-Mar-14 | 61.5 |
| 4 | CA1322581 | 22-Feb-14 | 22-Mar-14 | 66.5 |
| 5 | CA1183127 | 22-Feb-14 | 22-Mar-14 | 51.5 |
| 6 | CA1183128 | 22-Feb-14 | 22-Mar-14 | 49.5 |
| 7 | CA1183082 | 22-Feb-14 | 22-Mar-14 | 57.0 |
| 8 | CA1183083 | 22-Feb-14 | 22-Mar-14 | 58.0 |
| 9 | CA1183085 | 22-Feb-14 | 22-Mar-14 | 59.5 |
| 10 | CA1183086 | 22-Feb-14 | 22-Mar-14 | 60.5 |
| 11 | CA1183094 | 22-Feb-14 | 22-Mar-14 | 59.0 |
| 12 | CA1183095 | 22-Feb-14 | 22-Mar-14 | 64.0 |
| 13 | CA1183097 | 22-Feb-14 | 22-Mar-14 | 60.0 |
| 14 | CA1183098 | 22-Feb-14 | 22-Mar-14 | 62.5 |
| 15 | CA1183100 | 22-Feb-14 | 22-Mar-14 | 62.0 |
| 16 | CA1183101 | 22-Feb-14 | 22-Mar-14 | 61.5 |
| 17 | CA1183103 | 22-Feb-14 | 22-Mar-14 | 60.5 |
| 18 | CA1183104 | 22-Feb-14 | 22-Mar-14 | 64.0 |
| 19 | CA1183106 | 22-Feb-14 | 22-Mar-14 | 64.0 |
| 20 | CA1183107 | 22-Feb-14 | 22-Mar-14 | 63.0 |
| 21 | CA1183109 | 22-Feb-14 | 22-Mar-14 | 66.0 |
| 22 | CA1183110 | 22-Feb-14 | 22-Mar-14 | 68.5 |
| 23 | CA1183133 | 22-Feb-14 | 22-Mar-14 | 67.5 |
| 24 | CA1183134 | 22-Feb-14 | 22-Mar-14 | 69.0 |
| 25 | CA1183055 | 22-Feb-14 | 22-Mar-14 | 62.0 |
| 26 | CA1183056 | 22-Feb-14 | 22-Mar-14 | 61.5 |
| 27 | CA1183058 | 22-Feb-14 | 22-Mar-14 | 60.0 |
| 28 | CA1183059 | 22-Feb-14 | 22-Mar-14 | 61.0 |
| 29 | CA1183064 | 22-Feb-14 | 22-Mar-14 | 61.5 |
| 30 | CA1183065 | 22-Feb-14 | 22-Mar-14 | 64.0 |
| 31 | CA1183067 | 22-Feb-14 | 22-Mar-14 | 58.0 |
| 32 | CA1183068 | 22-Feb-14 | 22-Mar-14 | 53.5 |
| 33 | CA1183076 | 22-Feb-14 | 22-Mar-14 | 58.5 |
| 34 | CA1183077 | 22-Feb-14 | 22-Mar-14 | 64.0 |
| 35 | CA1183079 | 22-Feb-14 | 22-Mar-14 | 62.5 |
| 36 | CA1183080 | 22-Feb-14 | 22-Mar-14 | 64.0 |
| 37 | CA1322586 | 22-Feb-14 | 22-Mar-14 | 65.0 |
| 38 | CA1322587 | 22-Feb-14 | 22-Mar-14 | 67.5 |
| 39 | CA1322589 | 22-Feb-14 | 22-Mar-14 | 70.5 |
| 40 | CA1322590 | 22-Feb-14 | 22-Mar-14 | 71.0 |
| 41 | CA1322592 | 22-Feb-14 | 22-Mar-14 | 67.0 |
| 42 | CA1322593 | 22-Feb-14 | 22-Mar-14 | 68.0 |
| 43 | CA1183013 | 22-Feb-14 | 22-Mar-14 | 67.0 |

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|---|---|---|---|---|
| 44 | CA1183014 | 22-Feb-14 | 22-Mar-14 | 66.0 |
| 45 | CA1183016 | 22-Feb-14 | 22-Mar-14 | 69.0 |
| 46 | CA1183017 | 22-Feb-14 | 22-Mar-14 | 68.5 |
| 47 | CA1183019 | 22-Feb-14 | 22-Mar-14 | 65.0 |
| 48 | CA1183020 | 22-Feb-14 | 22-Mar-14 | 51.5 |
| 49 | CA1183025 | 22-Feb-14 | 22-Mar-14 | 64.0 |
| 50 | CA1183026 | 22-Feb-14 | 22-Mar-14 | 65.5 |
| 51 | CA1183028 | 22-Feb-14 | 22-Mar-14 | 68.5 |
| 52 | CA1183029 | 22-Feb-14 | 22-Mar-14 | 67.5 |
| 53 | CA1183034 | 22-Feb-14 | 22-Mar-14 | 55.0 |
| 54 | CA1183035 | 22-Feb-14 | 22-Mar-14 | 55.0 |
| 55 | CA1183037 | 22-Feb-14 | 22-Mar-14 | 53.5 |
| 56 | CA1183038 | 22-Feb-14 | 22-Mar-14 | 52.5 |
| 57 | CA1183049 | 22-Feb-14 | 22-Mar-14 | 65.0 |
| 58 | CA1183047 | 22-Feb-14 | 22-Mar-14 | 62.5 |
| 59 | CA1183052 | 22-Feb-14 | 22-Mar-14 | 63.0 |
| 60 | CA1183053 | 22-Feb-14 | 22-Mar-14 | 61.0 |
| 61 | CA1322598 | 22-Feb-14 | 22-Mar-14 | 68.5 |
| 62 | CA1322599 | 22-Feb-14 | 22-Mar-14 | 71.0 |
| 63 | CA1183001 | 22-Feb-14 | 22-Mar-14 | 66.0 |
| 64 | CA1183002 | 22-Feb-14 | 22-Mar-14 | 70.0 |
| 65 | CA1183007 | 22-Feb-14 | 22-Mar-14 | 66.5 |
| 66 | CA1183008 | 22-Feb-14 | 22-Mar-14 | 65.5 |
| 67 | CA1183040 | 22-Feb-14 | 22-Mar-14 | 61.0 |
| 68 | CA1183041 | 22-Feb-14 | 22-Mar-14 | 61.5 |
| 69 | CA1183043 | 22-Feb-14 | 22-Mar-14 | 63.5 |
| 70 | CA1183044 | 22-Feb-14 | 22-Mar-14 | 63.5 |
| 71 | CA1183112 | 22-Feb-14 | 22-Mar-14 | 57.5 |
| 72 | CA1183113 | 22-Feb-14 | 22-Mar-14 | 62.0 |
| 73 | CA1183124 | 22-Feb-14 | 22-Mar-14 | 64.5 |
| 74 | CA1183125 | 22-Feb-14 | 22-Mar-14 | 64.5 |
| 75 | CA1322595 | 22-Feb-14 | 22-Mar-14 | 68.5 |
| 76 | CA1322596 | 22-Feb-14 | 22-Mar-14 | 67.5 |
| 77 | CA1183004 | 22-Feb-14 | 22-Mar-14 | 66.0 |
| 78 | CA1183005 | 22-Feb-14 | 22-Mar-14 | 66.5 |
| 79 | CA1183010 | 22-Feb-14 | 22-Mar-14 | 70.5 |
| 80 | CA1183011 | 22-Feb-14 | 22-Mar-14 | 69.0 |
| 81 | CA1322583 | 22-Feb-14 | 22-Mar-14 | 69.5 |
| 82 | CA1322584 | 22-Feb-14 | 22-Mar-14 | 68.0 |
| 83 | CA1183022 | 22-Feb-14 | 22-Mar-14 | 65.5 |
| 84 | CA1183023 | 22-Feb-14 | 22-Mar-14 | 64.5 |
| 85 | CA1183031 | 22-Feb-14 | 22-Mar-14 | 61.0 |
| 86 | CA1183032 | 22-Feb-14 | 22-Mar-14 | 62.0 |
| 87 | CA1183049 | 22-Feb-14 | 22-Mar-14 | 63.5 |
| 88 | CA1183050 | 22-Feb-14 | 22-Mar-14 | 65.5 |
| 89 | CA1183061 | 22-Feb-14 | 22-Mar-14 | 62.5 |

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|---|---|---|---|---|
| 90 | CA1183062 | 22-Feb-14 | 22-Mar-14 | 63.0 |
| 91 | CA1183070 | 22-Feb-14 | 22-Mar-14 | 56.5 |
| 92 | CA1183071 | 22-Feb-14 | 22-Mar-14 | 57.0 |
| 93 | CA1183073 | 22-Feb-14 | 22-Mar-14 | 58.0 |
| 94 | CA1183074 | 22-Feb-14 | 22-Mar-14 | 58.5 |
| 95 | CA1183088 | 22-Feb-14 | 22-Mar-14 | 58.5 |
| 96 | CA1183089 | 22-Feb-14 | 22-Mar-14 | 62.5 |
| 97 | CA1183091 | 22-Feb-14 | 22-Mar-14 | 60.5 |
| 98 | CA1183092 | 22-Feb-14 | 22-Mar-14 | 60.0 |
| 99 | CA1183115 | 22-Feb-14 | 22-Mar-14 | 62.5 |
| 100 | CA1183116 | 22-Feb-14 | 22-Mar-14 | 62.0 |
| 101 | CA1183118 | 22-Feb-14 | 22-Mar-14 | 56.5 |
| 102 | CA1183119 | 22-Feb-14 | 22-Mar-14 | 60.5 |
| 103 | CA1183121 | 22-Feb-14 | 22-Mar-14 | 47.5 |
| 104 | CA1183122 | 22-Feb-14 | 22-Mar-14 | 52.0 |
| 105 | CA1183130 | 22-Feb-14 | 22-Mar-14 | 53.0 |
| 106 | CA1183131 | 22-Feb-14 | 22-Mar-14 | 51.5 |

Roof slab : T11

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1183136 | 27-Feb-14 | 27-Mar-14 | 57.5 |
| 2 | CA1183137 | 27-Feb-14 | 27-Mar-14 | 56.0 |
| 3 | CA1183142 | 27-Feb-14 | 27-Mar-14 | 60.5 |
| 4 | CA1183143 | 27-Feb-14 | 27-Mar-14 | 59.5 |
| 5 | CA1183145 | 27-Feb-14 | 27-Mar-14 | 57.5 |
| 6 | CA1183146 | 27-Feb-14 | 27-Mar-14 | 62.5 |
| 7 | CA1183157 | 27-Feb-14 | 27-Mar-14 | 63.5 |
| 8 | CA1183158 | 27-Feb-14 | 27-Mar-14 | 65.5 |
| 9 | CA1183148 | 27-Feb-14 | 27-Mar-14 | 65.0 |
| 10 | CA1183149 | 27-Feb-14 | 27-Mar-14 | 64.5 |
| 11 | CA1183151 | 27-Feb-14 | 27-Mar-14 | 65.5 |
| 12 | CA1183152 | 27-Feb-14 | 27-Mar-14 | 63.0 |
| 13 | CA1183154 | 27-Feb-14 | 27-Mar-14 | 60.0 |
| 14 | CA1183155 | 27-Feb-14 | 27-Mar-14 | 63.0 |
| 15 | CA1183232 | 27-Feb-14 | 27-Mar-14 | 66.5 |
| 16 | CA1183233 | 27-Feb-14 | 27-Mar-14 | 67.5 |
| 17 | CA1183235 | 27-Feb-14 | 27-Mar-14 | 61.5 |
| 18 | CA1183236 | 27-Feb-14 | 27-Mar-14 | 61.5 |
| 19 | CA1183238 | 27-Feb-14 | 27-Mar-14 | 65.0 |
| 20 | CA1183239 | 27-Feb-14 | 27-Mar-14 | 63.0 |
| 21 | CA1183223 | 27-Feb-14 | 27-Mar-14 | 60.5 |
| 22 | CA1183224 | 27-Feb-14 | 27-Mar-14 | 61.5 |
| 23 | CA1183226 | 27-Feb-14 | 27-Mar-14 | 62.5 |
| 24 | CA1183227 | 27-Feb-14 | 27-Mar-14 | 63.0 |
| 25 | CA1183229 | 27-Feb-14 | 27-Mar-14 | 65.0 |
| 26 | CA1183230 | 27-Feb-14 | 27-Mar-14 | 64.0 |
| 27 | CA1183214 | 27-Feb-14 | 27-Mar-14 | 58.0 |
| 28 | CA1183215 | 27-Feb-14 | 27-Mar-14 | 58.5 |
| 29 | CA1183217 | 27-Feb-14 | 27-Mar-14 | 61.5 |
| 30 | CA1183218 | 27-Feb-14 | 27-Mar-14 | 60.5 |
| 31 | CA1183220 | 27-Feb-14 | 27-Mar-14 | 60.0 |
| 32 | CA1183221 | 27-Feb-14 | 27-Mar-14 | 60.5 |
| 33 | CA1183205 | 27-Feb-14 | 27-Mar-14 | 61.5 |
| 34 | CA1183206 | 27-Feb-14 | 27-Mar-14 | 62.5 |
| 35 | CA1183208 | 27-Feb-14 | 27-Mar-14 | 65.0 |
| 36 | CA1183209 | 27-Feb-14 | 27-Mar-14 | 62.5 |
| 37 | CA1183211 | 27-Feb-14 | 27-Mar-14 | 58.5 |
| 38 | CA1183212 | 27-Feb-14 | 27-Mar-14 | 59.0 |
| 39 | CA1183178 | 27-Feb-14 | 27-Mar-14 | 61.0 |
| 40 | CA1183179 | 27-Feb-14 | 27-Mar-14 | 62.0 |
| 41 | CA1183181 | 27-Feb-14 | 27-Mar-14 | 62.0 |
| 42 | CA1183182 | 27-Feb-14 | 27-Mar-14 | 62.5 |
| 43 | CA1183184 | 27-Feb-14 | 27-Mar-14 | 62.5 |

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|---|---|---|---|---|
| 44 | CA1183185 | 27-Feb-14 | 27-Mar-14 | 63.0 |
| 45 | CA1183196 | 27-Feb-14 | 27-Mar-14 | 58.0 |
| 46 | CA1183197 | 27-Feb-14 | 27-Mar-14 | 57.5 |
| 47 | CA1183199 | 27-Feb-14 | 27-Mar-14 | 62.5 |
| 48 | CA1183200 | 27-Feb-14 | 27-Mar-14 | 62.0 |
| 49 | CA1183202 | 27-Feb-14 | 27-Mar-14 | 60.5 |
| 50 | CA1183203 | 27-Feb-14 | 27-Mar-14 | 60.0 |
| 51 | CA1183187 | 27-Feb-14 | 27-Mar-14 | 59.5 |
| 52 | CA1183188 | 27-Feb-14 | 27-Mar-14 | 60.5 |
| 53 | CA1183190 | 27-Feb-14 | 27-Mar-14 | 58.0 |
| 54 | CA1183191 | 27-Feb-14 | 27-Mar-14 | 57.5 |
| 55 | CA1183193 | 27-Feb-14 | 27-Mar-14 | 59.0 |
| 56 | CA1183194 | 27-Feb-14 | 27-Mar-14 | 58.0 |
| 57 | CA1183169 | 27-Feb-14 | 27-Mar-14 | 61.0 |
| 58 | CA1183170 | 27-Feb-14 | 27-Mar-14 | 62.0 |
| 59 | CA1183172 | 27-Feb-14 | 27-Mar-14 | 62.0 |
| 60 | CA1183173 | 27-Feb-14 | 27-Mar-14 | 64.5 |
| 61 | CA1183175 | 27-Feb-14 | 27-Mar-14 | 63.5 |
| 62 | CA1183176 | 27-Feb-14 | 27-Mar-14 | 64.0 |
| 63 | CA1183160 | 27-Feb-14 | 27-Mar-14 | 62.5 |
| 64 | CA1183161 | 27-Feb-14 | 27-Mar-14 | 63.0 |
| 65 | CA1183163 | 27-Feb-14 | 27-Mar-14 | 64.5 |
| 66 | CA1183164 | 27-Feb-14 | 27-Mar-14 | 65.0 |
| 67 | CA1183166 | 27-Feb-14 | 27-Mar-14 | 62.0 |
| 68 | CA183167 | 27-Feb-14 | 27-Mar-14 | 60.5 |
| 69 | CA1183139 | 27-Feb-14 | 27-Mar-14 | 59.0 |
| 70 | CA1183140 | 27-Feb-14 | 27-Mar-14 | 58.0 |

Roof slab : T12

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1183298 | 19-Mar-14 | 16-Apr-14 | 60.5 |
| 2 | CA1183299 | 19-Mar-14 | 16-Apr-14 | 61.5 |
| 3 | CA1183301 | 19-Mar-14 | 16-Apr-14 | 57.0 |
| 4 | CA1183302 | 19-Mar-14 | 16-Apr-14 | 54.5 |
| 5 | CA1183304 | 19-Mar-14 | 16-Apr-14 | 53.0 |
| 6 | CA1183305 | 19-Mar-14 | 16-Apr-14 | 54.0 |
| 7 | CA1183289 | 19-Mar-14 | 16-Apr-14 | 61.5 |
| 8 | CA1183290 | 19-Mar-14 | 16-Apr-14 | 61.0 |
| 9 | CA1183292 | 19-Mar-14 | 16-Apr-14 | 61.5 |
| 10 | CA1183293 | 19-Mar-14 | 16-Apr-14 | 62.0 |
| 11 | CA1183295 | 19-Mar-14 | 16-Apr-14 | 61.5 |
| 12 | CA1183296 | 19-Mar-14 | 16-Apr-14 | 63.5 |
| 13 | CA1183307 | 19-Mar-14 | 16-Apr-14 | 59.5 |
| 14 | CA1183308 | 19-Mar-14 | 16-Apr-14 | 60.0 |
| 15 | CA1183310 | 19-Mar-14 | 16-Apr-14 | 52.5 |
| 16 | CA1183311 | 19-Mar-14 | 16-Apr-14 | 53.0 |
| 17 | CA1183313 | 19-Mar-14 | 16-Apr-14 | 54.0 |
| 18 | CA1183314 | 19-Mar-14 | 16-Apr-14 | 54.0 |
| 19 | CA1183316 | 19-Mar-14 | 16-Apr-14 | 61.5 |
| 20 | CA1183317 | 19-Mar-14 | 16-Apr-14 | 61.0 |
| 21 | CA1183319 | 19-Mar-14 | 16-Apr-14 | 58.5 |
| 22 | CA1183320 | 19-Mar-14 | 16-Apr-14 | 59.0 |
| 23 | CA1183322 | 19-Mar-14 | 16-Apr-14 | 58.0 |
| 24 | CA1183323 | 19-Mar-14 | 16-Apr-14 | 61.0 |
| 25 | CA1183325 | 19-Mar-14 | 16-Apr-14 | 54.0 |
| 26 | CA1183326 | 19-Mar-14 | 16-Apr-14 | 58.5 |
| 27 | CA1183328 | 19-Mar-14 | 16-Apr-14 | 58.0 |
| 28 | CA1183329 | 19-Mar-14 | 16-Apr-14 | 58.0 |

## Tunnel Wall 01

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417785 | 10-Apr-13 | 8-May-13 | 65.5 |
| 2 | CA1417786 | 10-Apr-13 | 8-May-13 | 67.0 |
| 3 | CA1417788 | 10-Apr-13 | 8-May-13 | 65.0 |
| 4 | CA1417789 | 10-Apr-13 | 8-May-13 | 66.5 |
| 5 | CA1417791 | 10-Apr-13 | 8-May-13 | 68.0 |
| 6 | CA1417792 | 10-Apr-13 | 8-May-13 | 68.5 |
| 7 | CA1233828 | 10-Apr-13 | 8-May-13 | 61.5 |
| 8 | CA1233829 | 10-Apr-13 | 8-May-13 | 60.0 |
| 9 | CA1233831 | 10-Apr-13 | 8-May-13 | 59.5 |
| 10 | CA1233832 | 10-Apr-13 | 8-May-13 | 62.5 |
| 11 | CA1233834 | 10-Apr-13 | 8-May-13 | 64.0 |
| 12 | CA1233835 | 10-Apr-13 | 8-May-13 | 65.0 |
| 13 | CA1233819 | 10-Apr-13 | 8-May-13 | 63.5 |
| 14 | CA1233820 | 10-Apr-13 | 8-May-13 | 64.5 |
| 15 | CA1233822 | 10-Apr-13 | 8-May-13 | 61.5 |
| 16 | CA1233823 | 10-Apr-13 | 8-May-13 | 61.0 |
| 17 | CA1233825 | 10-Apr-13 | 8-May-13 | 61.5 |
| 18 | CA1233826 | 10-Apr-13 | 8-May-13 | 61.5 |
| 19 | CA1233810 | 10-Apr-13 | 8-May-13 | 60.5 |
| 20 | CA1233811 | 10-Apr-13 | 8-May-13 | 60.5 |
| 21 | CA1233813 | 10-Apr-13 | 8-May-13 | 60.5 |
| 22 | CA1233814 | 10-Apr-13 | 8-May-13 | 59.0 |
| 23 | CA1233816 | 10-Apr-13 | 8-May-13 | 59.5 |
| 24 | CA1233817 | 10-Apr-13 | 8-May-13 | 60.5 |
| 25 | CA0881762 | 10-Apr-13 | 8-May-13 | 58.0 |
| 26 | CA0881763 | 10-Apr-13 | 8-May-13 | 66.5 |
| 27 | CA0881765 | 10-Apr-13 | 8-May-13 | 62.5 |
| 28 | CA0881766 | 10-Apr-13 | 8-May-13 | 63.0 |
| 29 | CA0881768 | 10-Apr-13 | 8-May-13 | 58.5 |
| 30 | CA0881769 | 10-Apr-13 | 8-May-13 | 62.5 |
| 31 | CA0881753 | 10-Apr-13 | 8-May-13 | 60.0 |
| 32 | CA0881754 | 10-Apr-13 | 8-May-13 | 63.0 |
| 33 | CA0881756 | 10-Apr-13 | 8-May-13 | 64.5 |
| 34 | CA0881757 | 10-Apr-13 | 8-May-13 | 65.0 |
| 35 | CA0881759 | 10-Apr-13 | 8-May-13 | 64.0 |
| 36 | CA0881760 | 10-Apr-13 | 8-May-13 | 60.0 |
| 37 | CA0881794 | 10-Apr-13 | 8-May-13 | 67.5 |
| 38 | CA0881795 | 10-Apr-13 | 8-May-13 | 69.0 |
| 39 | CA0881797 | 10-Apr-13 | 8-May-13 | 69.5 |
| 40 | CA0881798 | 10-Apr-13 | 8-May-13 | 67.0 |
| 41 | CA0881800 | 10-Apr-13 | 8-May-13 | 65.5 |
| 42 | CA0881801 | 10-Apr-13 | 8-May-13 | 68.0 |
| 43 | CA1233801 | 10-Apr-13 | 8-May-13 | 59.5 |

| | | | | |
|---|---|---|---|---|
| 44 | CA1233802 | 10-Apr-13 | 8-May-13 | 60.5 |
| 45 | CA1233804 | 10-Apr-13 | 8-May-13 | 62.5 |
| 46 | CA1233805 | 10-Apr-13 | 8-May-13 | 63.0 |
| 47 | CA1233807 | 10-Apr-13 | 8-May-13 | 61.5 |
| 48 | CA1233808 | 10-Apr-13 | 8-May-13 | 61.0 |

## Tunnel Wall 02

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417137 | 17-Apr-13 | 15-May-13 | 73.0 |
| 2 | CA1417138 | 17-Apr-13 | 15-May-13 | 70.5 |
| 3 | CA1417140 | 17-Apr-13 | 15-May-13 | 73.0 |
| 4 | CA1417141 | 17-Apr-13 | 15-May-13 | 74.0 |
| 5 | CA1417128 | 17-Apr-13 | 15-May-13 | 71.0 |
| 6 | CA1417129 | 17-Apr-13 | 15-May-13 | 65.5 |
| 7 | CA1417131 | 17-Apr-13 | 15-May-13 | 72.5 |
| 8 | CA1417132 | 17-Apr-13 | 15-May-13 | 68.5 |
| 9 | CA1417134 | 17-Apr-13 | 15-May-13 | 68.5 |
| 10 | CA1417135 | 17-Apr-13 | 15-May-13 | 68.5 |
| 11 | CA1417092 | 17-Apr-13 | 15-May-13 | 66.5 |
| 12 | CA1417093 | 17-Apr-13 | 15-May-13 | 74.0 |
| 13 | CA1417095 | 17-Apr-13 | 15-May-13 | 75.5 |
| 14 | CA1417096 | 17-Apr-13 | 15-May-13 | 74.0 |
| 15 | CA1417098 | 17-Apr-13 | 15-May-13 | 72.0 |
| 16 | CA1417099 | 17-Apr-13 | 15-May-13 | 73.0 |
| 17 | CA1417101 | 17-Apr-13 | 15-May-13 | 52.0 |
| 18 | CA1417102 | 17-Apr-13 | 15-May-13 | 60.0 |
| 19 | CA1417104 | 17-Apr-13 | 15-May-13 | 58.5 |
| 20 | CA1417105 | 17-Apr-13 | 15-May-13 | 66.0 |
| 21 | CA1417107 | 17-Apr-13 | 15-May-13 | 71.0 |
| 22 | CA1417108 | 17-Apr-13 | 15-May-13 | 69.5 |
| 23 | CA1417110 | 17-Apr-13 | 15-May-13 | 66.5 |
| 24 | CA1417111 | 17-Apr-13 | 15-May-13 | 63.0 |
| 25 | CA1417113 | 17-Apr-13 | 15-May-13 | 64.0 |
| 26 | CA1417114 | 17-Apr-13 | 15-May-13 | 63.0 |
| 27 | CA1417116 | 17-Apr-13 | 15-May-13 | 65.0 |
| 28 | CA1417117 | 17-Apr-13 | 15-May-13 | 71.5 |
| 29 | CA1417119 | 17-Apr-13 | 15-May-13 | 67.5 |
| 30 | CA1417120 | 17-Apr-13 | 15-May-13 | 61.0 |
| 31 | CA1417122 | 17-Apr-13 | 15-May-13 | 69.0 |
| 32 | CA1417123 | 17-Apr-13 | 15-May-13 | 70.5 |
| 33 | CA1417125 | 17-Apr-13 | 15-May-13 | 70.0 |
| 34 | CA1417126 | 17-Apr-13 | 15-May-13 | 69.0 |

## Tunnel Wall 03

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1175632 | 3-Sep-13 | 1-Oct-13 | 64.0 |
| 2 | CA1175623 | 3-Sep-13 | 1-Oct-13 | 68.0 |
| 3 | CA1175626 | 3-Sep-13 | 1-Oct-13 | 65.0 |
| 4 | CA1175629 | 3-Sep-13 | 1-Oct-13 | 65.0 |
| 5 | CA1175614 | 3-Sep-13 | 1-Oct-13 | 66.0 |
| 6 | CA1175617 | 3-Sep-13 | 1-Oct-13 | 66.0 |
| 7 | CA1175620 | 3-Sep-13 | 1-Oct-13 | 66.5 |
| 8 | CA1175633 | 3-Sep-13 | 1-Oct-13 | 66.5 |
| 9 | CA1175624 | 3-Sep-13 | 1-Oct-13 | 66.0 |
| 10 | CA1175627 | 3-Sep-13 | 1-Oct-13 | 64.0 |
| 11 | CA1175630 | 3-Sep-13 | 1-Oct-13 | 67.0 |
| 12 | CA1175615 | 3-Sep-13 | 1-Oct-13 | 63.0 |
| 13 | CA1175618 | 3-Sep-13 | 1-Oct-13 | 69.5 |
| 14 | CA1175621 | 3-Sep-13 | 1-Oct-13 | 65.0 |

Tunnel Wall 04

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1322304 | 17-Jan-14 | 14-Feb-14 | 66.0 |
| 2 | CA1322305 | 17-Jan-14 | 14-Feb-14 | 68.5 |
| 3 | CA1322307 | 17-Jan-14 | 14-Feb-14 | 68.5 |
| 4 | CA1322308 | 17-Jan-14 | 14-Feb-14 | 66.5 |
| 5 | CA1322334 | 17-Jan-14 | 14-Feb-14 | 73.0 |
| 6 | CA1322335 | 17-Jan-14 | 14-Feb-14 | 73.0 |
| 7 | CA1322337 | 17-Jan-14 | 14-Feb-14 | 75.0 |
| 8 | CA1322338 | 17-Jan-14 | 14-Feb-14 | 70.5 |
| 9 | CA1322340 | 17-Jan-14 | 14-Feb-14 | 62.5 |
| 10 | CA1322341 | 17-Jan-14 | 14-Feb-14 | 63.0 |
| 11 | CA1322343 | 17-Jan-14 | 14-Feb-14 | 64.5 |
| 12 | CA1322344 | 17-Jan-14 | 14-Feb-14 | 65.0 |
| 13 | CA1322346 | 17-Jan-14 | 14-Feb-14 | 64.0 |
| 14 | CA1322347 | 17-Jan-14 | 14-Feb-14 | 53.5 |
| 15 | CA1322349 | 17-Jan-14 | 14-Feb-14 | 64.0 |
| 16 | CA1322350 | 17-Jan-14 | 14-Feb-14 | 61.5 |
| 17 | CA1322352 | 17-Jan-14 | 14-Feb-14 | 61.0 |
| 18 | CA1322353 | 17-Jan-14 | 14-Feb-14 | 61.5 |
| 19 | CA1322355 | 17-Jan-14 | 14-Feb-14 | 71.0 |
| 20 | CA1322356 | 17-Jan-14 | 14-Feb-14 | 66.5 |
| 21 | CA1322358 | 17-Jan-14 | 14-Feb-14 | 71.0 |
| 22 | CA1322359 | 17-Jan-14 | 14-Feb-14 | 73.0 |
| 23 | CA1322361 | 17-Jan-14 | 14-Feb-14 | 66.0 |
| 24 | CA1322362 | 17-Jan-14 | 14-Feb-14 | 71.0 |
| 25 | CA1322364 | 17-Jan-14 | 14-Feb-14 | 70.0 |
| 26 | CA1322365 | 17-Jan-14 | 14-Feb-14 | 71.5 |
| 27 | CA1322367 | 17-Jan-14 | 14-Feb-14 | 65.0 |
| 28 | CA1322368 | 17-Jan-14 | 14-Feb-14 | 66.0 |
| 29 | CA1322370 | 17-Jan-14 | 14-Feb-14 | 69.5 |
| 30 | CA1322371 | 17-Jan-14 | 14-Feb-14 | 69.0 |
| 31 | CA1322373 | 17-Jan-14 | 14-Feb-14 | 60.5 |
| 32 | CA1322374 | 17-Jan-14 | 14-Feb-14 | 69.0 |
| 33 | CA1322376 | 17-Jan-14 | 14-Feb-14 | 68.5 |
| 34 | CA1322377 | 17-Jan-14 | 14-Feb-14 | 70.5 |
| 35 | CA1322379 | 17-Jan-14 | 14-Feb-14 | 68.0 |
| 36 | CA1322380 | 17-Jan-14 | 14-Feb-14 | 69.0 |
| 37 | CA1322382 | 17-Jan-14 | 14-Feb-14 | 72.5 |
| 38 | CA1322383 | 17-Jan-14 | 14-Feb-14 | 69.5 |

Tunnel Wall 05

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417831 | 27-Mar-13 | 24-Apr-13 | 65.5 |
| 2 | CA1417832 | 27-Mar-13 | 24-Apr-13 | 62.0 |
| 3 | CA1417834 | 27-Mar-13 | 24-Apr-13 | 63.0 |
| 4 | CA1417835 | 27-Mar-13 | 24-Apr-13 | 64.0 |
| 5 | CA1417837 | 27-Mar-13 | 24-Apr-13 | 64.5 |
| 6 | CA1417838 | 27-Mar-13 | 24-Apr-13 | 62.5 |
| 7 | CA1417867 | 27-Mar-13 | 24-Apr-13 | 69.5 |
| 8 | CA1417868 | 27-Mar-13 | 24-Apr-13 | 70.5 |
| 9 | CA1417870 | 27-Mar-13 | 24-Apr-13 | 63.5 |
| 10 | CA1417871 | 27-Mar-13 | 24-Apr-13 | 65.5 |
| 11 | CA1417849 | 27-Mar-13 | 24-Apr-13 | 69.0 |
| 12 | CA1417850 | 27-Mar-13 | 24-Apr-13 | 71.0 |
| 13 | CA1417852 | 27-Mar-13 | 24-Apr-13 | 69.0 |
| 14 | CA1417853 | 27-Mar-13 | 24-Apr-13 | 65.5 |
| 15 | CA1417855 | 27-Mar-13 | 24-Apr-13 | 68.5 |
| 16 | CA1417856 | 27-Mar-13 | 24-Apr-13 | 67.5 |
| 17 | CA1417858 | 27-Mar-13 | 24-Apr-13 | 66.5 |
| 18 | CA1417859 | 27-Mar-13 | 24-Apr-13 | 68.5 |
| 19 | CA1417861 | 27-Mar-13 | 24-Apr-13 | 67.0 |
| 20 | CA1417862 | 27-Mar-13 | 24-Apr-13 | 72.0 |
| 21 | CA1417864 | 27-Mar-13 | 24-Apr-13 | 70.5 |
| 22 | CA1417865 | 27-Mar-13 | 24-Apr-13 | 74.5 |
| 23 | CA1417840 | 27-Mar-13 | 24-Apr-13 | 67.0 |
| 24 | CA1417841 | 27-Mar-13 | 24-Apr-13 | 68.5 |
| 25 | CA1417843 | 27-Mar-13 | 24-Apr-13 | 70.5 |
| 26 | CA1417844 | 27-Mar-13 | 24-Apr-13 | 67.0 |
| 27 | CA1417846 | 27-Mar-13 | 24-Apr-13 | 67.5 |
| 28 | CA1417847 | 27-Mar-13 | 24-Apr-13 | 67.5 |
| 29 | CA1417822 | 27-Mar-13 | 24-Apr-13 | 64.5 |
| 30 | CA1417823 | 27-Mar-13 | 24-Apr-13 | 63.5 |
| 31 | CA1417825 | 27-Mar-13 | 24-Apr-13 | 64.0 |
| 32 | CA1417826 | 27-Mar-13 | 24-Apr-13 | 60.5 |
| 33 | CA1417828 | 27-Mar-13 | 24-Apr-13 | 62.0 |
| 34 | CA1417829 | 27-Mar-13 | 24-Apr-13 | 66.5 |
| 35 | CA1417867 | 27-Mar-13 | 24-Apr-13 | 69.5 |
| 36 | CA1417868 | 27-Mar-13 | 24-Apr-13 | 70.5 |
| 37 | CA1417870 | 27-Mar-13 | 24-Apr-13 | 63.5 |
| 38 | CA1417871 | 27-Mar-13 | 24-Apr-13 | 65.5 |

## Tunnel Wall 06

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417873 | 3-Apr-13 | 1-May-13 | 60.5 |
| 2 | CA1417874 | 3-Apr-13 | 1-May-13 | 60.0 |
| 3 | CA1417876 | 3-Apr-13 | 1-May-13 | 65.0 |
| 4 | CA1417877 | 3-Apr-13 | 1-May-13 | 64.0 |
| 5 | CA1417879 | 3-Apr-13 | 1-May-13 | 65.5 |
| 6 | CA1417880 | 3-Apr-13 | 1-May-13 | 65.5 |
| 7 | CA1417900 | 3-Apr-13 | 1-May-13 | 66.5 |
| 8 | CA1417901 | 3-Apr-13 | 1-May-13 | 65.5 |
| 9 | CA1417903 | 3-Apr-13 | 1-May-13 | 70.5 |
| 10 | CA1417904 | 3-Apr-13 | 1-May-13 | 69.0 |
| 11 | CA1417906 | 3-Apr-13 | 1-May-13 | 68.0 |
| 12 | CA1417907 | 3-Apr-13 | 1-May-13 | 68.5 |
| 13 | CA1417891 | 3-Apr-13 | 1-May-13 | 66.5 |
| 14 | CA1417892 | 3-Apr-13 | 1-May-13 | 68.0 |
| 15 | CA1417894 | 3-Apr-13 | 1-May-13 | 68.5 |
| 16 | CA1417895 | 3-Apr-13 | 1-May-13 | 65.5 |
| 17 | CA1417897 | 3-Apr-13 | 1-May-13 | 65.0 |
| 18 | CA1417898 | 3-Apr-13 | 1-May-13 | 67.5 |
| 19 | CA1417918 | 3-Apr-13 | 1-May-13 | 47.5 |
| 20 | CA1417919 | 3-Apr-13 | 1-May-13 | 48.5 |
| 21 | CA1417921 | 3-Apr-13 | 1-May-13 | 66.0 |
| 22 | CA1417922 | 3-Apr-13 | 1-May-13 | 65.5 |
| 23 | CA1417924 | 3-Apr-13 | 1-May-13 | 63.5 |
| 24 | CA1417925 | 3-Apr-13 | 1-May-13 | 63.5 |
| 25 | CA1417909 | 3-Apr-13 | 1-May-13 | 60.5 |
| 26 | CA1417910 | 3-Apr-13 | 1-May-13 | 60.0 |
| 27 | CA1417912 | 3-Apr-13 | 1-May-13 | 61.0 |
| 28 | CA1417913 | 3-Apr-13 | 1-May-13 | 61.5 |
| 29 | CA1417915 | 3-Apr-13 | 1-May-13 | 64.5 |
| 30 | CA1417916 | 3-Apr-13 | 1-May-13 | 63.0 |
| 31 | CA1417882 | 3-Apr-13 | 1-May-13 | 68.5 |
| 32 | CA1417883 | 3-Apr-13 | 1-May-13 | 67.0 |
| 33 | CA1417885 | 3-Apr-13 | 1-May-13 | 65.5 |
| 34 | CA1417886 | 3-Apr-13 | 1-May-13 | 68.0 |
| 35 | CA1417888 | 3-Apr-13 | 1-May-13 | 71.0 |
| 36 | CA1417889 | 3-Apr-13 | 1-May-13 | 72.5 |

## Tunnel Wall 07

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417164 | 23-Apr-13 | 21-May-13 | 65.5 |
| 2 | CA1417165 | 23-Apr-13 | 21-May-13 | 63.5 |
| 3 | CA1417155 | 23-Apr-13 | 21-May-13 | 60.0 |
| 4 | CA1417156 | 23-Apr-13 | 21-May-13 | 60.0 |
| 5 | CA1417158 | 23-Apr-13 | 21-May-13 | 57.5 |
| 6 | CA1417159 | 23-Apr-13 | 21-May-13 | 59.5 |
| 7 | CA1417161 | 23-Apr-13 | 21-May-13 | 55.5 |
| 8 | CA1417162 | 23-Apr-13 | 21-May-13 | 54.5 |

## Tunnel Wall 08

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1322265 | 12-Jan-14 | 9-Feb-14 | 70.0 |
| 2 | CA1322266 | 12-Jan-14 | 9-Feb-14 | 73.5 |
| 3 | CA1322268 | 12-Jan-14 | 9-Feb-14 | 72.5 |
| 4 | CA1322269 | 12-Jan-14 | 9-Feb-14 | 70.5 |
| 5 | CA1322271 | 12-Jan-14 | 9-Feb-14 | 71.5 |
| 6 | CA1322272 | 12-Jan-14 | 9-Feb-14 | 70.0 |
| 7 | CA1322274 | 12-Jan-14 | 9-Feb-14 | 72.5 |
| 8 | CA1322275 | 12-Jan-14 | 9-Feb-14 | 73.5 |
| 9 | CA1322277 | 12-Jan-14 | 9-Feb-14 | 69.0 |
| 10 | CA1322278 | 12-Jan-14 | 9-Feb-14 | 68.0 |
| 11 | CA1322280 | 12-Jan-14 | 9-Feb-14 | 69.0 |
| 12 | CA1322281 | 12-Jan-14 | 9-Feb-14 | 70.5 |
| 13 | CA1322283 | 12-Jan-14 | 9-Feb-14 | 70.5 |
| 14 | CA1322284 | 12-Jan-14 | 9-Feb-14 | 68.5 |
| 15 | CA1322286 | 12-Jan-14 | 9-Feb-14 | 71.0 |
| 16 | CA1322287 | 12-Jan-14 | 9-Feb-14 | 69.5 |
| 17 | CA1322289 | 12-Jan-14 | 9-Feb-14 | 73.5 |
| 18 | CA1322290 | 12-Jan-14 | 9-Feb-14 | 72.5 |
| 19 | CA1322292 | 12-Jan-14 | 9-Feb-14 | 71.5 |
| 20 | CA1322293 | 12-Jan-14 | 9-Feb-14 | 72.0 |
| 21 | CA1322295 | 12-Jan-14 | 9-Feb-14 | 70.0 |
| 22 | CA1322296 | 12-Jan-14 | 9-Feb-14 | 68.0 |
| 23 | CA1322298 | 12-Jan-14 | 9-Feb-14 | 69.0 |
| 24 | CA1322299 | 12-Jan-14 | 9-Feb-14 | 72.0 |
| 25 | CA1322301 | 12-Jan-14 | 9-Feb-14 | 66.5 |
| 26 | CA1322302 | 12-Jan-14 | 9-Feb-14 | 72.0 |
| 27 | CA1322328 | 12-Jan-14 | 9-Feb-14 | 70.0 |
| 28 | CA1322329 | 12-Jan-14 | 9-Feb-14 | 71.5 |
| 29 | CA1322331 | 12-Jan-14 | 9-Feb-14 | 68.5 |
| 30 | CA1322332 | 12-Jan-14 | 9-Feb-14 | 67.5 |
| 31 | CA1322310 | 12-Jan-14 | 9-Feb-14 | 66.0 |
| 32 | CA1322311 | 12-Jan-14 | 9-Feb-14 | 69.5 |
| 33 | CA1322313 | 12-Jan-14 | 9-Feb-14 | 71.5 |
| 34 | CA1322314 | 12-Jan-14 | 9-Feb-14 | 70.5 |
| 35 | CA1322316 | 12-Jan-14 | 9-Feb-14 | 70.0 |
| 36 | CA1322317 | 12-Jan-14 | 9-Feb-14 | 66.5 |
| 37 | CA1322319 | 12-Jan-14 | 9-Feb-14 | 70.5 |
| 38 | CA1322320 | 12-Jan-14 | 9-Feb-14 | 67.5 |
| 39 | CA1322322 | 12-Jan-14 | 9-Feb-14 | 73.0 |
| 40 | CA1322323 | 12-Jan-14 | 9-Feb-14 | 75.0 |
| 41 | CA1322325 | 12-Jan-14 | 9-Feb-14 | 68.0 |
| 42 | CA1322326 | 12-Jan-14 | 9-Feb-14 | 71.0 |
| 43 | CA1183364 | 12-Jan-14 | 9-Feb-14 | 47.0 |

| | | | | |
|---|---|---|---|---|
| 44 | CA1183365 | 12-Jan-14 | 9-Feb-14 | 48.0 |

## Tunnel Wall 09

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417334 | 11-Mar-13 | 8-Apr-13 | 61.0 |
| 2 | CA1417335 | 11-Mar-13 | 8-Apr-13 | 64.0 |
| 3 | CA1417337 | 11-Mar-13 | 8-Apr-13 | 62.0 |
| 4 | CA1417338 | 11-Mar-13 | 8-Apr-13 | 63.0 |
| 5 | CA1417340 | 11-Mar-13 | 8-Apr-13 | 62.0 |
| 6 | CA1417341 | 11-Mar-13 | 8-Apr-13 | 62.0 |
| 7 | CA1417352 | 11-Mar-13 | 8-Apr-13 | 64.0 |
| 8 | CA1417353 | 11-Mar-13 | 8-Apr-13 | 64.5 |
| 9 | CA1417355 | 11-Mar-13 | 8-Apr-13 | 66.0 |
| 10 | CA1417356 | 11-Mar-13 | 8-Apr-13 | 66.0 |
| 11 | CA1417358 | 11-Mar-13 | 8-Apr-13 | 62.5 |
| 12 | CA1417359 | 11-Mar-13 | 8-Apr-13 | 63.0 |
| 13 | CA1417361 | 11-Mar-13 | 8-Apr-13 | 64.5 |
| 14 | CA1417362 | 11-Mar-13 | 8-Apr-13 | 65.0 |
| 15 | CA1417364 | 11-Mar-13 | 8-Apr-13 | 62.5 |
| 16 | CA1417365 | 11-Mar-13 | 8-Apr-13 | 62.5 |
| 17 | CA1417367 | 11-Mar-13 | 8-Apr-13 | 64.0 |
| 18 | CA1417368 | 11-Mar-13 | 8-Apr-13 | 62.0 |
| 19 | CA1417370 | 11-Mar-13 | 8-Apr-13 | 64.0 |
| 20 | CA1417371 | 11-Mar-13 | 8-Apr-13 | 66.0 |
| 21 | CA1417373 | 11-Mar-13 | 8-Apr-13 | 65.5 |
| 22 | CA1417374 | 11-Mar-13 | 8-Apr-13 | 65.5 |
| 23 | CA1417376 | 11-Mar-13 | 8-Apr-13 | 64.0 |
| 24 | CA1417377 | 11-Mar-13 | 8-Apr-13 | 66.0 |
| 25 | CA1417325 | 11-Mar-13 | 8-Apr-13 | 64.5 |
| 26 | CA1417326 | 11-Mar-13 | 8-Apr-13 | 64.5 |
| 27 | CA1417328 | 11-Mar-13 | 8-Apr-13 | 64.5 |
| 28 | CA1417329 | 11-Mar-13 | 8-Apr-13 | 64.5 |
| 29 | CA1417331 | 11-Mar-13 | 8-Apr-13 | 66.5 |
| 30 | CA1417332 | 11-Mar-13 | 8-Apr-13 | 65.5 |
| 31 | CA1417343 | 11-Mar-13 | 8-Apr-13 | 65.5 |
| 32 | CA1417344 | 11-Mar-13 | 8-Apr-13 | 63.5 |
| 33 | CA1417346 | 11-Mar-13 | 8-Apr-13 | 61.5 |
| 34 | CA1417347 | 11-Mar-13 | 8-Apr-13 | 62.5 |
| 35 | CA1417349 | 11-Mar-13 | 8-Apr-13 | 61.5 |
| 36 | CA1417350 | 11-Mar-13 | 8-Apr-13 | 62.0 |
| 37 | CA1417379 | 11-Mar-13 | 8-Apr-13 | 64.5 |
| 38 | CA1417380 | 11-Mar-13 | 8-Apr-13 | 65.5 |
| 39 | CA1417382 | 11-Mar-13 | 8-Apr-13 | 69.0 |
| 40 | CA1417383 | 11-Mar-13 | 8-Apr-13 | 67.5 |

Tunnel Wall 10

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417387 | 16-Mar-13 | 13-Apr-13 | 63.5 |
| 2 | CA1417388 | 16-Mar-13 | 13-Apr-13 | 60.5 |
| 3 | CA1417390 | 16-Mar-13 | 13-Apr-13 | 66.5 |
| 4 | CA1417391 | 16-Mar-13 | 13-Apr-13 | 65.5 |
| 5 | CA1417393 | 16-Mar-13 | 13-Apr-13 | 65.5 |
| 6 | CA1417394 | 16-Mar-13 | 13-Apr-13 | 63.5 |
| 7 | CA1417443 | 16-Mar-13 | 13-Apr-13 | 59.0 |
| 8 | CA1417444 | 16-Mar-13 | 13-Apr-13 | 58.0 |
| 9 | CA1417416 | 16-Mar-13 | 13-Apr-13 | 62.0 |
| 10 | CA1417417 | 16-Mar-13 | 13-Apr-13 | 61.5 |
| 11 | CA1417419 | 16-Mar-13 | 13-Apr-13 | 62.5 |
| 12 | CA1417420 | 16-Mar-13 | 13-Apr-13 | 64.0 |
| 13 | CA1417422 | 16-Mar-13 | 13-Apr-13 | 59.0 |
| 14 | CA1417423 | 16-Mar-13 | 13-Apr-13 | 59.5 |
| 15 | CA1417425 | 16-Mar-13 | 13-Apr-13 | 61.0 |
| 16 | CA1417426 | 16-Mar-13 | 13-Apr-13 | 59.0 |
| 17 | CA1417428 | 16-Mar-13 | 13-Apr-13 | 57.0 |
| 18 | CA1417429 | 16-Mar-13 | 13-Apr-13 | 54.0 |
| 19 | CA1417431 | 16-Mar-13 | 13-Apr-13 | 56.0 |
| 20 | CA1417432 | 16-Mar-13 | 13-Apr-13 | 56.5 |
| 21 | CA1417407 | 16-Mar-13 | 13-Apr-13 | 61.5 |
| 22 | CA1417408 | 16-Mar-13 | 13-Apr-13 | 64.0 |
| 23 | CA1417410 | 16-Mar-13 | 13-Apr-13 | 62.5 |
| 24 | CA1417411 | 16-Mar-13 | 13-Apr-13 | 61.5 |
| 25 | CA1417413 | 16-Mar-13 | 13-Apr-13 | 65.5 |
| 26 | CA1417414 | 16-Mar-13 | 13-Apr-13 | 63.5 |
| 27 | CA1417434 | 16-Mar-13 | 13-Apr-13 | 62.0 |
| 28 | CA1417435 | 16-Mar-13 | 13-Apr-13 | 63.5 |
| 29 | CA1417437 | 16-Mar-13 | 13-Apr-13 | 61.5 |
| 30 | CA1417438 | 16-Mar-13 | 13-Apr-13 | 64.0 |
| 31 | CA1417440 | 16-Mar-13 | 13-Apr-13 | 58.0 |
| 32 | CA1417441 | 16-Mar-13 | 13-Apr-13 | 60.5 |

## Tunnel Wall 11

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1233862 | 26-Apr-13 | 24-May-13 | 61.5 |
| 2 | CA1233863 | 26-Apr-13 | 24-May-13 | 62.5 |
| 3 | CA1233853 | 26-Apr-13 | 24-May-13 | 69.0 |
| 4 | CA1233854 | 26-Apr-13 | 24-May-13 | 70.0 |
| 5 | CA1233856 | 26-Apr-13 | 24-May-13 | 58.5 |
| 6 | CA1233857 | 26-Apr-13 | 24-May-13 | 63.5 |
| 7 | CA1233859 | 26-Apr-13 | 24-May-13 | 64.0 |
| 8 | CA1233860 | 26-Apr-13 | 24-May-13 | 64.0 |
| 9 | CA1417197 | 26-Apr-13 | 24-May-13 | 68.5 |
| 10 | CA1417198 | 26-Apr-13 | 24-May-13 | 72.0 |
| 11 | CA1233847 | 26-Apr-13 | 24-May-13 | 71.5 |
| 12 | CA1233848 | 26-Apr-13 | 24-May-13 | 65.5 |
| 13 | CA1233850 | 26-Apr-13 | 24-May-13 | 64.5 |
| 14 | CA1233851 | 26-Apr-13 | 24-May-13 | 67.0 |
| 15 | CA1417199 | 26-Apr-13 | 24-May-13 | 67.0 |
| 16 | CA1417200 | 26-Apr-13 | 24-May-13 | 67.5 |
| 17 | CA1417191 | 26-Apr-13 | 24-May-13 | 67.5 |
| 18 | CA1417192 | 26-Apr-13 | 24-May-13 | 69.5 |
| 19 | CA1417194 | 26-Apr-13 | 24-May-13 | 66.5 |
| 20 | CA1417195 | 26-Apr-13 | 24-May-13 | 68.5 |
| 21 | CA1417176 | 26-Apr-13 | 24-May-13 | 76.0 |
| 22 | CA1417177 | 26-Apr-13 | 24-May-13 | 79.5 |
| 23 | CA1417185 | 26-Apr-13 | 24-May-13 | 76.5 |
| 24 | CA1417186 | 26-Apr-13 | 24-May-13 | 77.0 |
| 25 | CA1417188 | 26-Apr-13 | 24-May-13 | 76.5 |
| 26 | CA1417189 | 26-Apr-13 | 24-May-13 | 76.0 |

Tunnel Wall 12

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1175578 | 24-Aug-13 | 23-Aug-13 | 58.0 |
| 2 | CA1175579 | 24-Aug-13 | 23-Aug-13 | 59.0 |

## Tunnel Wall 13

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1322193 | 11-Jan-14 | 8-Feb-14 | 79.5 |
| 2 | CA1322194 | 11-Jan-14 | 8-Feb-14 | 79.5 |
| 3 | CA1322196 | 11-Jan-14 | 8-Feb-14 | 79.0 |
| 4 | CA1322197 | 11-Jan-14 | 8-Feb-14 | 78.5 |
| 5 | CA1322199 | 11-Jan-14 | 8-Feb-14 | 79.5 |
| 6 | CA1322200 | 11-Jan-14 | 8-Feb-14 | 81.5 |
| 7 | CA1322241 | 11-Jan-14 | 8-Feb-14 | 65.0 |
| 8 | CA1322242 | 11-Jan-14 | 8-Feb-14 | 63.0 |
| 9 | CA1322244 | 11-Jan-14 | 8-Feb-14 | 68.5 |
| 10 | CA1322245 | 11-Jan-14 | 8-Feb-14 | 70.0 |
| 11 | CA1322211 | 11-Jan-14 | 8-Feb-14 | 76.0 |
| 12 | CA1322212 | 11-Jan-14 | 8-Feb-14 | 74.0 |
| 13 | CA1322214 | 11-Jan-14 | 8-Feb-14 | 75.0 |
| 14 | CA1322215 | 11-Jan-14 | 8-Feb-14 | 70.5 |
| 15 | CA1322220 | 11-Jan-14 | 8-Feb-14 | 74.5 |
| 16 | CA1322221 | 11-Jan-14 | 8-Feb-14 | 74.0 |
| 17 | CA1322202 | 11-Jan-14 | 8-Feb-14 | 75.0 |
| 18 | CA1322203 | 11-Jan-14 | 8-Feb-14 | 74.0 |
| 19 | CA1322205 | 11-Jan-14 | 8-Feb-14 | 73.0 |
| 20 | CA1322206 | 11-Jan-14 | 8-Feb-14 | 73.5 |
| 21 | CA1322208 | 11-Jan-14 | 8-Feb-14 | 75.5 |
| 22 | CA1322209 | 11-Jan-14 | 8-Feb-14 | 74.5 |
| 23 | CA1322256 | 11-Jan-14 | 8-Feb-14 | 76.0 |
| 24 | CA1322257 | 11-Jan-14 | 8-Feb-14 | 77.0 |
| 25 | CA1322259 | 11-Jan-14 | 8-Feb-14 | 70.0 |
| 26 | CA1322260 | 11-Jan-14 | 8-Feb-14 | 77.5 |
| 27 | CA1322262 | 11-Jan-14 | 8-Feb-14 | 77.0 |
| 28 | CA1322263 | 11-Jan-14 | 8-Feb-14 | 70.0 |
| 29 | CA1322247 | 11-Jan-14 | 8-Feb-14 | 72.0 |
| 30 | CA1322248 | 11-Jan-14 | 8-Feb-14 | 71.0 |
| 31 | CA1322250 | 11-Jan-14 | 8-Feb-14 | 68.0 |
| 32 | CA1322251 | 11-Jan-14 | 8-Feb-14 | 72.0 |
| 33 | CA1322254 | 11-Jan-14 | 8-Feb-14 | 69.5 |
| 34 | CA1322253 | 11-Jan-14 | 8-Feb-14 | 66.5 |
| 35 | CA1322232 | 11-Jan-14 | 8-Feb-14 | 61.5 |
| 36 | CA1322233 | 11-Jan-14 | 8-Feb-14 | 61.0 |
| 37 | CA1322235 | 11-Jan-14 | 8-Feb-14 | 64.5 |
| 38 | CA1322236 | 11-Jan-14 | 8-Feb-14 | 62.5 |
| 39 | CA1322238 | 11-Jan-14 | 8-Feb-14 | 61.0 |
| 40 | CA1322239 | 11-Jan-14 | 8-Feb-14 | 64.0 |

Tunnel Wall 15B

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1233892 | 4-May-13 | 1-Jun-13 | 72.0 |
| 2 | CA1233893 | 4-May-13 | 1-Jun-13 | 75.0 |
| 3 | CA1233895 | 4-May-13 | 1-Jun-13 | 73.0 |
| 4 | CA1233896 | 4-May-13 | 1-Jun-13 | 70.0 |
| 5 | CA1233898 | 4-May-13 | 1-Jun-13 | 72.0 |
| 6 | CA1233899 | 4-May-13 | 1-Jun-13 | 72.0 |
| 7 | CA1233901 | 4-May-13 | 1-Jun-13 | 74.0 |
| 8 | CA1233902 | 4-May-13 | 1-Jun-13 | 73.5 |
| 9 | CA1233904 | 4-May-13 | 1-Jun-13 | 71.0 |
| 10 | CA1233905 | 4-May-13 | 1-Jun-13 | 73.0 |
| 11 | CA1233907 | 4-May-13 | 1-Jun-13 | 72.0 |
| 12 | CA1233908 | 4-May-13 | 1-Jun-13 | 71.5 |
| 13 | CA1233919 | 4-May-13 | 1-Jun-13 | 72.5 |
| 14 | CA1233920 | 4-May-13 | 1-Jun-13 | 74.0 |
| 15 | CA1233865 | 4-May-13 | 1-Jun-13 | 75.5 |
| 16 | CA1233866 | 4-May-13 | 1-Jun-13 | 77.0 |
| 17 | CA1233868 | 4-May-13 | 1-Jun-13 | 74.0 |
| 18 | CA1233869 | 4-May-13 | 1-Jun-13 | 74.5 |
| 19 | CA1233871 | 4-May-13 | 1-Jun-13 | 74.5 |
| 20 | CA1233872 | 4-May-13 | 1-Jun-13 | 72.5 |
| 21 | CA1233874 | 4-May-13 | 1-Jun-13 | 74.0 |
| 22 | CA1233875 | 4-May-13 | 1-Jun-13 | 74.5 |
| 23 | CA1233877 | 4-May-13 | 1-Jun-13 | 67.0 |
| 24 | CA1233878 | 4-May-13 | 1-Jun-13 | 65.0 |
| 25 | CA1233880 | 4-May-13 | 1-Jun-13 | 66.0 |
| 26 | CA1233881 | 4-May-13 | 1-Jun-13 | 63.5 |
| 27 | CA1233883 | 4-May-13 | 1-Jun-13 | 64.0 |
| 28 | CA1233884 | 4-May-13 | 1-Jun-13 | 63.5 |
| 29 | CA1233886 | 4-May-13 | 1-Jun-13 | 72.0 |
| 30 | CA1233887 | 4-May-13 | 1-Jun-13 | 71.5 |
| 31 | CA1233889 | 4-May-13 | 1-Jun-13 | 71.5 |
| 32 | CA1233890 | 4-May-13 | 1-Jun-13 | 71.0 |

Base slab - B1-1 & B2-1

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417448 | 18-Mar-13 | 15-Apr-13 | 63.0 |
| 2 | CA1417447 | 18-Mar-13 | 15-Apr-13 | 61.5 |
| 3 | CA1417446 | 18-Mar-13 | 15-Apr-13 | 62.0 |
| 4 | CA1417445 | 18-Mar-13 | 15-Apr-13 | 62.0 |
| 5 | CA1417811 | 18-Mar-13 | 15-Apr-13 | 63.0 |
| 6 | CA1417812 | 18-Mar-13 | 15-Apr-13 | 62.0 |
| 7 | CA1417814 | 18-Mar-13 | 15-Apr-13 | 61.5 |
| 8 | CA1417815 | 18-Mar-13 | 15-Apr-13 | 61.5 |
| 9 | CA1417817 | 18-Mar-13 | 15-Apr-13 | 67.0 |
| 10 | CA1417817 | 18-Mar-13 | 15-Apr-13 | 65.5 |
| 11 | CA1417542 | 18-Mar-13 | 15-Apr-13 | 68.5 |
| 12 | CA1417541 | 18-Mar-13 | 15-Apr-13 | 66.0 |
| 13 | CA1417527 | 18-Mar-13 | 15-Apr-13 | 66.0 |
| 14 | CA1417526 | 18-Mar-13 | 15-Apr-13 | 70.0 |
| 15 | CA1417808 | 18-Mar-13 | 15-Apr-13 | 61.0 |
| 16 | CA1417809 | 18-Mar-13 | 15-Apr-13 | 65.5 |
| 17 | CA1417455 | 18-Mar-13 | 15-Apr-13 | 67.0 |
| 18 | CA1417454 | 18-Mar-13 | 15-Apr-13 | 70.0 |
| 19 | CA1417452 | 18-Mar-13 | 15-Apr-13 | 66.5 |
| 20 | CA1417451 | 18-Mar-13 | 15-Apr-13 | 68.0 |
| 21 | CA1417802 | 18-Mar-13 | 15-Apr-13 | 62.0 |
| 22 | CA1417803 | 18-Mar-13 | 15-Apr-13 | 59.0 |
| 23 | CA1417464 | 18-Mar-13 | 15-Apr-13 | 69.0 |
| 24 | CA1417463 | 18-Mar-13 | 15-Apr-13 | 70.5 |
| 25 | CA1417461 | 18-Mar-13 | 15-Apr-13 | 68.5 |
| 26 | CA1417460 | 18-Mar-13 | 15-Apr-13 | 67.5 |
| 27 | CA1417458 | 18-Mar-13 | 15-Apr-13 | 71.0 |
| 28 | CA1417457 | 18-Mar-13 | 15-Apr-13 | 70.5 |
| 29 | CA1417473 | 18-Mar-13 | 15-Apr-13 | 65.0 |
| 30 | CA1417472 | 18-Mar-13 | 15-Apr-13 | 66.0 |
| 31 | CA1417470 | 18-Mar-13 | 15-Apr-13 | 66.5 |
| 32 | CA1417469 | 18-Mar-13 | 15-Apr-13 | 66.5 |
| 33 | CA1417467 | 18-Mar-13 | 15-Apr-13 | 64.0 |
| 34 | CA1417466 | 18-Mar-13 | 15-Apr-13 | 67.5 |
| 35 | CA1417557 | 18-Mar-13 | 15-Apr-13 | 68.0 |
| 36 | CA1417556 | 18-Mar-13 | 15-Apr-13 | 66.5 |
| 37 | CA1417479 | 18-Mar-13 | 15-Apr-13 | 63.5 |
| 38 | CA1417478 | 18-Mar-13 | 15-Apr-13 | 64.0 |
| 39 | CA1417476 | 18-Mar-13 | 15-Apr-13 | 65.0 |
| 40 | CA1417475 | 18-Mar-13 | 15-Apr-13 | 62.0 |
| 41 | CA1417566 | 18-Mar-13 | 15-Apr-13 | 67.5 |

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|---|---|---|---|---|
| 42 | CA1417565 | 18-Mar-13 | 15-Apr-13 | 70.5 |
| 43 | CA1417563 | 18-Mar-13 | 15-Apr-13 | 70.5 |
| 44 | CA1417562 | 18-Mar-13 | 15-Apr-13 | 72.5 |
| 45 | CA1417560 | 18-Mar-13 | 15-Apr-13 | 65.0 |
| 46 | CA1417559 | 18-Mar-13 | 15-Apr-13 | 67.0 |

Base slab - B1-2 & B2-2

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417467 | 18-Mar-13 | 15-Apr-13 | |
| 2 | CA1417466 | 18-Mar-13 | 15-Apr-13 | 64.0 |
| 3 | CA1417470 | 18-Mar-13 | 15-Apr-13 | 67.5 |
| 4 | CA1417469 | 18-Mar-13 | 15-Apr-13 | 66.5 |
| 5 | CA1417473 | 18-Mar-13 | 15-Apr-13 | 66.5 |
| 6 | CA1417472 | 18-Mar-13 | 15-Apr-13 | 65.0 |
| 7 | CA1417569 | 18-Mar-13 | 15-Apr-13 | 66.0 |
| 8 | CA1417568 | 18-Mar-13 | 15-Apr-13 | 73.5 |
| 9 | CA1417581 | 18-Mar-13 | 15-Apr-13 | 70.5 |
| 10 | CA1417580 | 18-Mar-13 | 15-Apr-13 | 65.0 |
| 11 | CA1417587 | 18-Mar-13 | 15-Apr-13 | 62.5 |
| 12 | CA1417586 | 18-Mar-13 | 15-Apr-13 | 66.5 |
| 13 | CA1417590 | 18-Mar-13 | 15-Apr-13 | 67.5 |
| 14 | CA1417589 | 18-Mar-13 | 15-Apr-13 | 67.0 |
| 15 | CA1417593 | 18-Mar-13 | 15-Apr-13 | 68.0 |
| 16 | CA1417592 | 18-Mar-13 | 15-Apr-13 | 69.5 |
| 17 | CA1417596 | 18-Mar-13 | 15-Apr-13 | 66.5 |
| 18 | CA1417595 | 18-Mar-13 | 15-Apr-13 | 67.0 |
| 19 | CA1417560 | 18-Mar-13 | 15-Apr-13 | 65.0 |
| 20 | CA1417559 | 18-Mar-13 | 15-Apr-13 | 65.0 |
| 21 | CA1417563 | 18-Mar-13 | 15-Apr-13 | 67.0 |
| 22 | CA1417562 | 18-Mar-13 | 15-Apr-13 | 70.5 |
| 23 | CA1417566 | 18-Mar-13 | 15-Apr-13 | 72.5 |
| 24 | CA1417565 | 18-Mar-13 | 15-Apr-13 | 67.5 |
| 25 | CA1417476 | 18-Mar-13 | 15-Apr-13 | 70.5 |
| 26 | CA1417475 | 18-Mar-13 | 15-Apr-13 | 65.0 |
| 27 | CA1417479 | 18-Mar-13 | 15-Apr-13 | 62.0 |
| 28 | CA1417478 | 18-Mar-13 | 15-Apr-13 | 63.5 |
| 29 | CA1417557 | 18-Mar-13 | 15-Apr-13 | 64.0 |
| 30 | CA1417556 | 18-Mar-13 | 15-Apr-13 | 68.0 |
| 31 | CA1417458 | 18-Mar-13 | 15-Apr-13 | 66.5 |
| 32 | CA1417457 | 18-Mar-13 | 15-Apr-13 | 71.0 |
| 33 | CA1417461 | 18-Mar-13 | 15-Apr-13 | 70.5 |
| 34 | CA1417460 | 18-Mar-13 | 15-Apr-13 | 68.5 |
| 35 | CA1417464 | 18-Mar-13 | 15-Apr-13 | 67.5 |
| 36 | CA1417463 | 18-Mar-13 | 15-Apr-13 | 69.0 |
| 37 | CA1417524 | 18-Mar-13 | 15-Apr-13 | 65.5 |
| 38 | CA1417523 | 18-Mar-13 | 15-Apr-13 | 66.5 |
| 39 | CA1417536 | 18-Mar-13 | 15-Apr-13 | 66.0 |
| 40 | CA1417535 | 18-Mar-13 | 15-Apr-13 | 73.5 |
| 41 | CA1417805 | 18-Mar-13 | 15-Apr-13 | 61.0 |

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|---|---|---|---|---|
| 42 | CA1417806 | 18-Mar-13 | 15-Apr-13 | 62.5 |
| 43 | CA1417452 | 18-Mar-13 | 15-Apr-13 | 66.5 |
| 44 | CA1417451 | 18-Mar-13 | 15-Apr-13 | 68.0 |
| 45 | CA1417455 | 18-Mar-13 | 15-Apr-13 | 67.0 |
| 46 | CA1417454 | 18-Mar-13 | 15-Apr-13 | 70.0 |
| 47 | CA1417802 | 18-Mar-13 | 15-Apr-13 | 62.0 |

Base slab - B3-2 & B4-2

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417725 | 25-Mar-13 | 22-Apr-13 | 58.5 |
| 2 | CA1417726 | 25-Mar-13 | 22-Apr-13 | 59.0 |
| 3 | CA1417728 | 25-Mar-13 | 22-Apr-13 | 58.0 |
| 4 | CA1417729 | 25-Mar-13 | 22-Apr-13 | 60.5 |
| 5 | CA1417731 | 25-Mar-13 | 22-Apr-13 | 63.0 |
| 6 | CA1417732 | 25-Mar-13 | 22-Apr-13 | 60.0 |
| 7 | CA1417665 | 25-Mar-13 | 22-Apr-13 | 74.5 |
| 8 | CA1417666 | 25-Mar-13 | 22-Apr-13 | 74.5 |
| 9 | CA1417671 | 25-Mar-13 | 22-Apr-13 | 74.5 |
| 10 | CA1417672 | 25-Mar-13 | 22-Apr-13 | 72.0 |
| 11 | CA1417680 | 25-Mar-13 | 22-Apr-13 | 73.0 |
| 12 | CA1417681 | 25-Mar-13 | 22-Apr-13 | 75.0 |
| 13 | CA1417686 | 25-Mar-13 | 22-Apr-13 | 70.5 |
| 14 | CA1417687 | 25-Mar-13 | 22-Apr-13 | 71.0 |
| 15 | CA1417695 | 25-Mar-13 | 22-Apr-13 | 75.0 |
| 16 | CA1417696 | 25-Mar-13 | 22-Apr-13 | 73.0 |
| 17 | CA1417698 | 25-Mar-13 | 22-Apr-13 | 69.0 |
| 18 | CA1417699 | 25-Mar-13 | 22-Apr-13 | 71.0 |
| 19 | CA1417704 | 25-Mar-13 | 22-Apr-13 | 73.0 |
| 20 | CA1417705 | 25-Mar-13 | 22-Apr-13 | 73.5 |
| 21 | CA1417707 | 25-Mar-13 | 22-Apr-13 | 72.5 |
| 22 | CA1417708 | 25-Mar-13 | 22-Apr-13 | 75.5 |
| 23 | CA1417710 | 25-Mar-13 | 22-Apr-13 | 69.5 |
| 24 | CA1417711 | 25-Mar-13 | 22-Apr-13 | 75.5 |
| 25 | CA1417713 | 25-Mar-13 | 22-Apr-13 | 69.0 |
| 26 | CA1417714 | 25-Mar-13 | 22-Apr-13 | 69.0 |
| 27 | CA1417719 | 25-Mar-13 | 22-Apr-13 | 73.0 |
| 28 | CA1417720 | 25-Mar-13 | 22-Apr-13 | 73.0 |
| 29 | CA1417722 | 25-Mar-13 | 22-Apr-13 | 58.5 |
| 30 | CA1417723 | 25-Mar-13 | 22-Apr-13 | 73.5 |
| 31 | CA1417734 | 25-Mar-13 | 22-Apr-13 | 64.5 |
| 32 | CA1417735 | 25-Mar-13 | 22-Apr-13 | 65.0 |
| 33 | CA1417737 | 25-Mar-13 | 22-Apr-13 | 64.5 |
| 34 | CA1417738 | 25-Mar-13 | 22-Apr-13 | 66.0 |
| 35 | CA1417740 | 25-Mar-13 | 22-Apr-13 | 59.5 |
| 36 | CA1417741 | 25-Mar-13 | 22-Apr-13 | 65.0 |
| 37 | CA1417743 | 25-Mar-13 | 22-Apr-13 | 69.0 |
| 38 | CA1417744 | 25-Mar-13 | 22-Apr-13 | 62.5 |
| 39 | CA1417752 | 25-Mar-13 | 22-Apr-13 | 73.0 |
| 40 | CA1417753 | 25-Mar-13 | 22-Apr-13 | 70.5 |
| 41 | CA1417755 | 25-Mar-13 | 22-Apr-13 | 73.0 |
| 42 | CA1417756 | 25-Mar-13 | 22-Apr-13 | 71.5 |

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|---|---|---|---|---|
| 43 | CA1417761 | 25-Mar-13 | 22-Apr-13 | 74.0 |
| 44 | CA1417762 | 25-Mar-13 | 22-Apr-13 | 71.0 |
| 45 | CA1417767 | 25-Mar-13 | 22-Apr-13 | 74.0 |
| 46 | CA1417768 | 25-Mar-13 | 22-Apr-13 | 73.5 |
| 47 | CA1417770 | 25-Mar-13 | 22-Apr-13 | 66.5 |
| 48 | CA1417771 | 25-Mar-13 | 22-Apr-13 | 67.5 |
| 49 | CA1417674 | 25-Mar-13 | 22-Apr-13 | 72.5 |
| 50 | CA1417675 | 25-Mar-13 | 22-Apr-13 | 74.5 |
| 51 | CA1417677 | 25-Mar-13 | 22-Apr-13 | 69.0 |
| 52 | CA1417678 | 25-Mar-13 | 22-Apr-13 | 73.5 |
| 53 | CA1417746 | 25-Mar-13 | 22-Apr-13 | 68.0 |
| 54 | CA1417747 | 25-Mar-13 | 22-Apr-13 | 63.5 |
| 55 | CA1417602 | 25-Mar-13 | 22-Apr-13 | 57.0 |
| 56 | CA1417603 | 25-Mar-13 | 22-Apr-13 | 57.0 |
| 57 | CA1417605 | 25-Mar-13 | 22-Apr-13 | 57.5 |
| 58 | CA1417606 | 25-Mar-13 | 22-Apr-13 | 58.5 |
| 59 | CA1417608 | 25-Mar-13 | 22-Apr-13 | 59.0 |
| 60 | CA1417609 | 25-Mar-13 | 22-Apr-13 | 55.5 |
| 61 | CA1417668 | 25-Mar-13 | 22-Apr-13 | 73.0 |
| 62 | CA1417669 | 25-Mar-13 | 22-Apr-13 | 76.0 |
| 63 | CA1417764 | 25-Mar-13 | 22-Apr-13 | 70.5 |
| 64 | CA1417765 | 25-Mar-13 | 22-Apr-13 | 71.0 |
| 65 | CA1417779 | 25-Mar-13 | 22-Apr-13 | 69.5 |
| 66 | CA1417780 | 25-Mar-13 | 22-Apr-13 | 69.5 |
| 67 | CA1417782 | 25-Mar-13 | 22-Apr-13 | 70.0 |
| 68 | CA1417783 | 25-Mar-13 | 22-Apr-13 | 70.5 |
| 69 | CA1417629 | 25-Mar-13 | 22-Apr-13 | 59.5 |
| 70 | CA1417630 | 25-Mar-13 | 22-Apr-13 | 63.5 |
| 71 | CA1417632 | 25-Mar-13 | 22-Apr-13 | 61.0 |
| 72 | CA1417633 | 25-Mar-13 | 22-Apr-13 | 59.0 |
| 73 | CA1417635 | 25-Mar-13 | 22-Apr-13 | 60.5 |
| 74 | CA1417636 | 25-Mar-13 | 22-Apr-13 | 57.0 |
| 75 | CA1417641 | 25-Mar-13 | 22-Apr-13 | 63.5 |
| 76 | CA1417642 | 25-Mar-13 | 22-Apr-13 | 67.0 |
| 77 | CA1417644 | 25-Mar-13 | 22-Apr-13 | 64.0 |
| 78 | CA1417645 | 25-Mar-13 | 22-Apr-13 | 67.0 |
| 79 | CA1417650 | 25-Mar-13 | 22-Apr-13 | 65.0 |
| 80 | CA1417651 | 25-Mar-13 | 22-Apr-13 | 64.5 |
| 81 | CA1417653 | 25-Mar-13 | 22-Apr-13 | 62.0 |
| 82 | CA1417654 | 25-Mar-13 | 22-Apr-13 | 63.0 |
| 83 | CA1417656 | 25-Mar-13 | 22-Apr-13 | 63.5 |
| 84 | CA1417657 | 25-Mar-13 | 22-Apr-13 | 62.5 |
| 85 | CA1417659 | 25-Mar-13 | 22-Apr-13 | 65.5 |
| 86 | CA1417660 | 25-Mar-13 | 22-Apr-13 | 74.0 |
| 87 | CA1417620 | 25-Mar-13 | 22-Apr-13 | 57.0 |
| 88 | CA1417621 | 25-Mar-13 | 22-Apr-13 | 63.0 |

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|---|---|---|---|---|
| 89 | CA1417623 | 25-Mar-13 | 22-Apr-13 | 57.5 |
| 90 | CA1417624 | 25-Mar-13 | 22-Apr-13 | 61.5 |
| 91 | CA1417626 | 25-Mar-13 | 22-Apr-13 | 56.5 |
| 92 | CA1417627 | 25-Mar-13 | 22-Apr-13 | 58.5 |

Base slab - B3-1 & B4-1

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417244 | 7-Mar-13 | 4-Apr-13 | 65.0 |
| 2 | CA1417245 | 7-Mar-13 | 4-Apr-13 | 63.0 |
| 3 | CA1417250 | 7-Mar-13 | 4-Apr-13 | 64.5 |
| 4 | CA1417251 | 7-Mar-13 | 4-Apr-13 | 64.0 |
| 5 | CA1417259 | 7-Mar-13 | 4-Apr-13 | 67.0 |
| 6 | CA1417260 | 7-Mar-13 | 4-Apr-13 | 66.0 |
| 7 | CA1417220 | 7-Mar-13 | 4-Apr-13 | 64.5 |
| 8 | CA1417221 | 7-Mar-13 | 4-Apr-13 | 62.0 |
| 9 | CA1417226 | 7-Mar-13 | 4-Apr-13 | 68.0 |
| 10 | CA1417227 | 7-Mar-13 | 4-Apr-13 | 65.0 |
| 11 | CA1417229 | 7-Mar-13 | 4-Apr-13 | 75.0 |
| 12 | CA1417230 | 7-Mar-13 | 4-Apr-13 | 70.5 |
| 13 | CA1417211 | 7-Mar-13 | 4-Apr-13 | 61.5 |
| 14 | CA1417212 | 7-Mar-13 | 4-Apr-13 | 60.5 |
| 15 | CA1417214 | 7-Mar-13 | 4-Apr-13 | 62.5 |
| 16 | CA1417215 | 7-Mar-13 | 4-Apr-13 | 65.5 |
| 17 | CA1417217 | 7-Mar-13 | 4-Apr-13 | 63.5 |
| 18 | CA1417218 | 7-Mar-13 | 4-Apr-13 | 61.5 |
| 19 | CA1417202 | 7-Mar-13 | 4-Apr-13 | 65.0 |
| 20 | CA1417203 | 7-Mar-13 | 4-Apr-13 | 65.5 |
| 21 | CA1417205 | 7-Mar-13 | 4-Apr-13 | 61.5 |
| 22 | CA1417206 | 7-Mar-13 | 4-Apr-13 | 63.0 |
| 23 | CA1417208 | 7-Mar-13 | 4-Apr-13 | 66.0 |
| 24 | CA1417209 | 7-Mar-13 | 4-Apr-13 | 67.0 |
| 25 | CA1417301 | 7-Mar-13 | 4-Apr-13 | 66.5 |
| 26 | CA1417302 | 7-Mar-13 | 4-Apr-13 | 67.5 |
| 27 | CA1417304 | 7-Mar-13 | 4-Apr-13 | 69.5 |
| 28 | CA1417305 | 7-Mar-13 | 4-Apr-13 | 70.0 |
| 29 | CA1417310 | 7-Mar-13 | 4-Apr-13 | 66.5 |
| 30 | CA1417311 | 7-Mar-13 | 4-Apr-13 | 68.0 |
| 31 | CA1417274 | 7-Mar-13 | 4-Apr-13 | 66.0 |
| 32 | CA1417275 | 7-Mar-13 | 4-Apr-13 | 63.0 |
| 33 | CA1417277 | 7-Mar-13 | 4-Apr-13 | 66.5 |
| 34 | CA1417278 | 7-Mar-13 | 4-Apr-13 | 64.5 |
| 35 | CA1417280 | 7-Mar-13 | 4-Apr-13 | 67.5 |
| 36 | CA1417281 | 7-Mar-13 | 4-Apr-13 | 67.5 |
| 37 | CA1417232 | 7-Mar-13 | 4-Apr-13 | 74.0 |
| 38 | CA1417233 | 7-Mar-13 | 4-Apr-13 | 76.0 |
| 39 | CA1417238 | 7-Mar-13 | 4-Apr-13 | 65.5 |
| 40 | CA1417239 | 7-Mar-13 | 4-Apr-13 | 68.5 |
| 41 | CA1417241 | 7-Mar-13 | 4-Apr-13 | 63.0 |

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|---|---|---|---|---|
| 42 | CA1417242 | 7-Mar-13 | 4-Apr-13 | 65.0 |
| 43 | CA1417283 | 7-Mar-13 | 4-Apr-13 | 69.5 |
| 44 | CA1417284 | 7-Mar-13 | 4-Apr-13 | 66.5 |
| 45 | CA1417292 | 7-Mar-13 | 4-Apr-13 | 66.0 |
| 46 | CA1417293 | 7-Mar-13 | 4-Apr-13 | 67.0 |
| 47 | CA1417295 | 7-Mar-13 | 4-Apr-13 | 64.5 |
| 48 | CA1417296 | 7-Mar-13 | 4-Apr-13 | 68.0 |
| 49 | CA1417253 | 7-Mar-13 | 4-Apr-13 | 65.5 |
| 50 | CA1417254 | 7-Mar-13 | 4-Apr-13 | 65.0 |
| 51 | CA1417256 | 7-Mar-13 | 4-Apr-13 | 63.0 |
| 52 | CA1417257 | 7-Mar-13 | 4-Apr-13 | 64.0 |
| 53 | CA1417268 | 7-Mar-13 | 4-Apr-13 | 66.5 |
| 54 | CA1417269 | 7-Mar-13 | 4-Apr-13 | 67.0 |
| 55 | CA1417307 | 7-Mar-13 | 4-Apr-13 | 68.0 |
| 56 | CA1417308 | 7-Mar-13 | 4-Apr-13 | 66.5 |
| 57 | CA1417319 | 7-Mar-13 | 4-Apr-13 | 66.0 |
| 58 | CA1417320 | 7-Mar-13 | 4-Apr-13 | 67.5 |
| 59 | CA1417322 | 7-Mar-13 | 4-Apr-13 | 64.5 |
| 60 | CA1417323 | 7-Mar-13 | 4-Apr-13 | 63.5 |
| 61 | CA1417223 | 7-Mar-13 | 4-Apr-13 | 69.5 |
| 62 | CA1417224 | 7-Mar-13 | 4-Apr-13 | 69.5 |
| 63 | CA1417235 | 7-Mar-13 | 4-Apr-13 | 63.5 |
| 64 | CA1417236 | 7-Mar-13 | 4-Apr-13 | 62.0 |
| 65 | CA1417247 | 7-Mar-13 | 4-Apr-13 | 65.0 |
| 66 | CA1417248 | 7-Mar-13 | 4-Apr-13 | 63.5 |
| 67 | CA1417313 | 7-Mar-13 | 4-Apr-13 | 64.0 |
| 68 | CA1417314 | 7-Mar-13 | 4-Apr-13 | 63.5 |
| 69 | CA1417316 | 7-Mar-13 | 4-Apr-13 | 65.0 |
| 70 | CA1417317 | 7-Mar-13 | 4-Apr-13 | 65.5 |
| 71 | CA1417286 | 7-Mar-13 | 4-Apr-13 | 67.0 |
| 72 | CA1417287 | 7-Mar-13 | 4-Apr-13 | 66.0 |
| 73 | CA1417289 | 7-Mar-13 | 4-Apr-13 | 65.0 |
| 74 | CA1417290 | 7-Mar-13 | 4-Apr-13 | 67.0 |
| 75 | CA1417298 | 7-Mar-13 | 4-Apr-13 | 68.0 |
| 76 | CA1417299 | 7-Mar-13 | 4-Apr-13 | 64.0 |
| 77 | CA1417262 | 7-Mar-13 | 4-Apr-13 | 66.5 |
| 78 | CA1417263 | 7-Mar-13 | 4-Apr-13 | 68.5 |
| 79 | CA1417265 | 7-Mar-13 | 4-Apr-13 | 71.5 |
| 80 | CA1417266 | 7-Mar-13 | 4-Apr-13 | 70.5 |
| 81 | CA1417271 | 7-Mar-13 | 4-Apr-13 | 67.0 |
| 82 | CA1417272 | 7-Mar-13 | 4-Apr-13 | 68.5 |

Base slab - B5

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1417984 | 8-Apr-13 | 6-May-13 | 73.5 |
| 2 | CA1417985 | 8-Apr-13 | 6-May-13 | 72.0 |
| 3 | CA1417987 | 8-Apr-13 | 6-May-13 | 71.5 |
| 4 | CA1417988 | 8-Apr-13 | 6-May-13 | 69.5 |
| 5 | CA1417993 | 8-Apr-13 | 6-May-13 | 75.0 |
| 6 | CA1417994 | 8-Apr-13 | 6-May-13 | 74.5 |
| 7 | CA1417002 | 8-Apr-13 | 6-May-13 | 68.0 |
| 8 | CA1417003 | 8-Apr-13 | 6-May-13 | 72.0 |
| 9 | CA1417005 | 8-Apr-13 | 6-May-13 | 73.0 |
| 10 | CA1417006 | 8-Apr-13 | 6-May-13 | 74.0 |
| 11 | CA1417996 | 8-Apr-13 | 6-May-13 | 72.5 |
| 12 | CA1417997 | 8-Apr-13 | 6-May-13 | 73.5 |
| 13 | CA1417011 | 8-Apr-13 | 6-May-13 | 72.5 |
| 14 | CA1417012 | 8-Apr-13 | 6-May-13 | 72.0 |
| 15 | CA1417014 | 8-Apr-13 | 6-May-13 | 68.5 |
| 16 | CA1417015 | 8-Apr-13 | 6-May-13 | 68.0 |
| 17 | CA1417017 | 8-Apr-13 | 6-May-13 | 69.5 |
| 18 | CA1417018 | 8-Apr-13 | 6-May-13 | 71.0 |
| 19 | CA1417020 | 8-Apr-13 | 6-May-13 | 69.0 |
| 20 | CA1417021 | 8-Apr-13 | 6-May-13 | 67.0 |
| 21 | CA1417023 | 8-Apr-13 | 6-May-13 | 69.5 |
| 22 | CA1417024 | 8-Apr-13 | 6-May-13 | 67.0 |
| 23 | CA1417029 | 8-Apr-13 | 6-May-13 | 68.0 |
| 24 | CA1417030 | 8-Apr-13 | 6-May-13 | 69.5 |
| 25 | CA1417945 | 8-Apr-13 | 6-May-13 | 72.0 |
| 26 | CA1417946 | 8-Apr-13 | 6-May-13 | 72.5 |
| 27 | CA1417948 | 8-Apr-13 | 6-May-13 | 71.0 |
| 28 | CA1417949 | 8-Apr-13 | 6-May-13 | 75.5 |
| 29 | CA1417951 | 8-Apr-13 | 6-May-13 | 72.0 |
| 30 | CA1417952 | 8-Apr-13 | 6-May-13 | 73.0 |
| 31 | CA1417966 | 8-Apr-13 | 6-May-13 | 65.0 |
| 32 | CA1417967 | 8-Apr-13 | 6-May-13 | 64.5 |
| 33 | CA1417972 | 8-Apr-13 | 6-May-13 | 71.0 |
| 34 | CA1417973 | 8-Apr-13 | 6-May-13 | 70.0 |
| 35 | CA1417975 | 8-Apr-13 | 6-May-13 | 70.0 |
| 36 | CA1417976 | 8-Apr-13 | 6-May-13 | 69.5 |
| 37 | CA1417954 | 8-Apr-13 | 6-May-13 | 61.0 |
| 38 | CA1417955 | 8-Apr-13 | 6-May-13 | 66.5 |
| 39 | CA1417957 | 8-Apr-13 | 6-May-13 | 65.5 |
| 40 | CA1417958 | 8-Apr-13 | 6-May-13 | 62.5 |
| 41 | CA1417963 | 8-Apr-13 | 6-May-13 | 65.5 |
| 42 | CA1417964 | 8-Apr-13 | 6-May-13 | 67.0 |

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|---|---|---|---|---|
| 43 | CA1417068 | 8-Apr-13 | 6-May-13 | 72.0 |
| 44 | CA1417069 | 8-Apr-13 | 6-May-13 | 56.5 |
| 45 | CA1417077 | 8-Apr-13 | 6-May-13 | 65.5 |
| 46 | CA1417078 | 8-Apr-13 | 6-May-13 | 69.5 |
| 47 | CA1417053 | 8-Apr-13 | 6-May-13 | 46.0 |
| 48 | CA1417054 | 8-Apr-13 | 6-May-13 | 46.5 |
| 49 | CA1417056 | 8-Apr-13 | 6-May-13 | 48.0 |
| 50 | CA1417057 | 8-Apr-13 | 6-May-13 | 41.0 |
| 51 | CA1417062 | 8-Apr-13 | 6-May-13 | 44.5 |
| 52 | CA1417063 | 8-Apr-13 | 6-May-13 | 46.0 |
| 53 | CA1417032 | 8-Apr-13 | 6-May-13 | 68.0 |
| 54 | CA1417033 | 8-Apr-13 | 6-May-13 | 70.0 |
| 55 | CA1417038 | 8-Apr-13 | 6-May-13 | 68.5 |
| 56 | CA1417039 | 8-Apr-13 | 6-May-13 | 68.5 |
| 57 | CA1417041 | 8-Apr-13 | 6-May-13 | 68.5 |
| 58 | CA1417042 | 8-Apr-13 | 6-May-13 | 70.5 |

Base slab - B6

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1175470 | 5-Aug-13 | 2-Sep-13 | 60.0 |
| 2 | CA1175479 | 5-Aug-13 | 2-Sep-13 | 66.0 |
| 3 | CA1175494 | 5-Aug-13 | 2-Sep-13 | 59.0 |
| 4 | CA1175521 | 5-Aug-13 | 2-Sep-13 | 60.0 |
| 5 | CA1175542 | 5-Aug-13 | 2-Sep-13 | 64.5 |
| 6 | CA1175471 | 5-Aug-13 | 2-Sep-13 | 57.5 |
| 7 | CA1175480 | 5-Aug-13 | 2-Sep-13 | 63.5 |
| 8 | CA1175495 | 5-Aug-13 | 2-Sep-13 | 58.5 |
| 9 | CA1175522 | 5-Aug-13 | 2-Sep-13 | 59.5 |
| 10 | CA1175543 | 5-Aug-13 | 2-Sep-13 | 60.5 |
| 11 | CA1175452 | 5-Aug-13 | 2-Sep-13 | 57.5 |
| 12 | CA1175464 | 5-Aug-13 | 2-Sep-13 | 54.5 |
| 13 | CA1175473 | 5-Aug-13 | 2-Sep-13 | 58.5 |
| 14 | CA1175515 | 5-Aug-13 | 2-Sep-13 | 65.5 |
| 15 | CA1175524 | 5-Aug-13 | 2-Sep-13 | 58.5 |
| 16 | CA1175527 | 5-Aug-13 | 2-Sep-13 | 58.0 |
| 17 | CA1175539 | 5-Aug-13 | 2-Sep-13 | 57.0 |
| 18 | CA1175545 | 5-Aug-13 | 2-Sep-13 | 58.5 |
| 19 | CA1175446 | 5-Aug-13 | 2-Sep-13 | 57.0 |
| 20 | CA1175476 | 5-Aug-13 | 2-Sep-13 | 61.5 |
| 21 | CA1175485 | 5-Aug-13 | 2-Sep-13 | 58.5 |
| 22 | CA1175488 | 5-Aug-13 | 2-Sep-13 | 58.5 |
| 23 | CA1175449 | 5-Aug-13 | 2-Sep-13 | 55.0 |
| 24 | CA1175500 | 5-Aug-13 | 2-Sep-13 | 63.0 |
| 25 | CA1175503 | 5-Aug-13 | 2-Sep-13 | 59.5 |
| 26 | CA1175509 | 5-Aug-13 | 2-Sep-13 | 65.0 |
| 27 | CA1175453 | 5-Aug-13 | 2-Sep-13 | 57.5 |
| 28 | CA1175465 | 5-Aug-13 | 2-Sep-13 | 55.5 |
| 29 | CA1175474 | 5-Aug-13 | 2-Sep-13 | 59.0 |
| 30 | CA1175516 | 5-Aug-13 | 2-Sep-13 | 67.5 |
| 31 | CA1175525 | 5-Aug-13 | 2-Sep-13 | 57.5 |
| 32 | CA1175528 | 5-Aug-13 | 2-Sep-13 | 57.0 |
| 33 | CA1175540 | 5-Aug-13 | 2-Sep-13 | 57.0 |
| 34 | CA1175546 | 5-Aug-13 | 2-Sep-13 | 60.5 |
| 35 | CA1175447 | 5-Aug-13 | 2-Sep-13 | 52.5 |
| 36 | CA1175477 | 5-Aug-13 | 2-Sep-13 | 65.0 |
| 37 | CA1175486 | 5-Aug-13 | 2-Sep-13 | 60.0 |
| 38 | CA1175489 | 5-Aug-13 | 2-Sep-13 | 60.0 |
| 39 | CA1175450 | 5-Aug-13 | 2-Sep-13 | 57.0 |
| 40 | CA1175501 | 5-Aug-13 | 2-Sep-13 | 60.0 |
| 41 | CA1175504 | 5-Aug-13 | 2-Sep-13 | 59.5 |
| 42 | CA1175510 | 5-Aug-13 | 2-Sep-13 | 68.0 |

|  |  |  |  |  |
|---|---|---|---|---|
| 43 | CA1175452 | 5-Aug-13 | 2-Sep-13 | 57.5 |
| 44 | CA1175464 | 5-Aug-13 | 2-Sep-13 | 54.5 |
| 45 | CA1175473 | 5-Aug-13 | 2-Sep-13 | 58.5 |
| 46 | CA1175515 | 5-Aug-13 | 2-Sep-13 | 65.5 |
| 47 | CA1175524 | 5-Aug-13 | 2-Sep-13 | 58.5 |
| 48 | CA1175527 | 5-Aug-13 | 2-Sep-13 | 58.0 |
| 49 | CA1175446 | 5-Aug-13 | 2-Sep-13 | 57.0 |
| 50 | CA1175539 | 5-Aug-13 | 2-Sep-13 | 57.0 |
| 51 | CA1175545 | 5-Aug-13 | 2-Sep-13 | 58.5 |
| 52 | CA1175476 | 5-Aug-13 | 2-Sep-13 | 61.5 |
| 53 | CA1175485 | 5-Aug-13 | 2-Sep-13 | 58.5 |
| 54 | CA1175488 | 5-Aug-13 | 2-Sep-13 | 58.5 |
| 55 | CA1175449 | 5-Aug-13 | 2-Sep-13 | 55.0 |
| 56 | CA1175500 | 5-Aug-13 | 2-Sep-13 | 63.0 |
| 57 | CA1175503 | 5-Aug-13 | 2-Sep-13 | 59.5 |
| 58 | CA1175509 | 5-Aug-13 | 2-Sep-13 | 65.0 |
| 59 | CA1175453 | 5-Aug-13 | 2-Sep-13 | 57.5 |
| 60 | CA1175465 | 5-Aug-13 | 2-Sep-13 | 55.5 |
| 61 | CA1175474 | 5-Aug-13 | 2-Sep-13 | 59.0 |
| 62 | CA1175516 | 5-Aug-13 | 2-Sep-13 | 67.5 |
| 63 | CA1175525 | 5-Aug-13 | 2-Sep-13 | 57.5 |
| 64 | CA1175528 | 5-Aug-13 | 2-Sep-13 | 57.0 |
| 65 | CA1175447 | 5-Aug-13 | 2-Sep-13 | 52.5 |
| 66 | CA1175540 | 5-Aug-13 | 2-Sep-13 | 57.0 |
| 67 | CA1175546 | 5-Aug-13 | 2-Sep-13 | 60.5 |
| 68 | CA1175477 | 5-Aug-13 | 2-Sep-13 | 65.0 |
| 69 | CA1175486 | 5-Aug-13 | 2-Sep-13 | 60.0 |
| 70 | CA1175489 | 5-Aug-13 | 2-Sep-13 | 60.0 |
| 71 | CA1175450 | 5-Aug-13 | 2-Sep-13 | 57.0 |
| 72 | CA1175501 | 5-Aug-13 | 2-Sep-13 | 60.0 |
| 73 | CA1175504 | 5-Aug-13 | 2-Sep-13 | 59.5 |
| 74 | CA1175510 | 5-Aug-13 | 2-Sep-13 | 68.0 |

Base slab - B7

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1322013 | 27-Dec-13 | 24-Jan-14 | 58.5 |
| 2 | CA1322017 | 27-Dec-13 | 24-Jan-14 | 62.0 |
| 3 | CA1175981 | 27-Dec-13 | 24-Jan-14 | 56.5 |
| 4 | CA1175977 | 27-Dec-13 | 24-Jan-14 | 72.0 |
| 5 | CA1175978 | 27-Dec-13 | 24-Jan-14 | 71.0 |
| 6 | CA1175980 | 27-Dec-13 | 24-Jan-14 | 54.5 |
| 7 | CA1175990 | 27-Dec-13 | 24-Jan-14 | 51.0 |
| 8 | CA1322004 | 27-Dec-13 | 24-Jan-14 | 59.5 |
| 9 | CA1322005 | 27-Dec-13 | 24-Jan-14 | 56.0 |
| 10 | CA1175959 | 27-Dec-13 | 24-Jan-14 | 71.5 |
| 11 | CA1175960 | 27-Dec-13 | 24-Jan-14 | 72.5 |
| 12 | CA175962 | 27-Dec-13 | 24-Jan-14 | 61.5 |
| 13 | CA1175963 | 27-Dec-13 | 24-Jan-14 | 73.5 |
| 14 | CA1175965 | 27-Dec-13 | 24-Jan-14 | 74.5 |
| 15 | CA1175966 | 27-Dec-13 | 24-Jan-14 | 72.5 |
| 16 | CA1175968 | 27-Dec-13 | 24-Jan-14 | 73.0 |
| 17 | CA1175969 | 27-Dec-13 | 24-Jan-14 | 72.0 |
| 18 | CA1175971 | 27-Dec-13 | 24-Jan-14 | 72.5 |
| 19 | CA1175972 | 27-Dec-13 | 24-Jan-14 | 69.5 |
| 20 | CA1175974 | 27-Dec-13 | 24-Jan-14 | 78.0 |
| 21 | CA1175975 | 27-Dec-13 | 24-Jan-14 | 76.0 |
| 22 | CA1175926 | 27-Dec-13 | 24-Jan-14 | 74.5 |
| 23 | CA1175927 | 27-Dec-13 | 24-Jan-14 | 72.5 |
| 24 | CA1175932 | 27-Dec-13 | 24-Jan-14 | 71.0 |
| 25 | CA1175933 | 27-Dec-13 | 24-Jan-14 | 72.5 |
| 26 | CA1175938 | 27-Dec-13 | 24-Jan-14 | 60.5 |
| 27 | CA1175939 | 27-Dec-13 | 24-Jan-14 | 58.5 |
| 28 | CA1175872 | 27-Dec-13 | 24-Jan-14 | 58.5 |
| 29 | CA1175873 | 27-Dec-13 | 24-Jan-14 | 58.0 |
| 30 | CA1175875 | 27-Dec-13 | 24-Jan-14 | 60.0 |
| 31 | CA1175876 | 27-Dec-13 | 24-Jan-14 | 58.5 |
| 32 | CA1175878 | 27-Dec-13 | 24-Jan-14 | 60.0 |
| 33 | CA1175879 | 27-Dec-13 | 24-Jan-14 | 56.0 |
| 34 | CA1175881 | 27-Dec-13 | 24-Jan-14 | 58.5 |
| 35 | CA1175882 | 27-Dec-13 | 24-Jan-14 | 59.0 |
| 36 | CA1175884 | 27-Dec-13 | 24-Jan-14 | 60.0 |
| 37 | CA1175885 | 27-Dec-13 | 24-Jan-14 | 59.0 |
| 38 | CA1175887 | 27-Dec-13 | 24-Jan-14 | 57.0 |
| 39 | CA1175888 | 27-Dec-13 | 24-Jan-14 | 55.5 |
| 40 | CA1175911 | 27-Dec-13 | 24-Jan-14 | 60.5 |
| 41 | CA1175912 | 27-Dec-13 | 24-Jan-14 | 58.0 |

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|---|---|---|---|---|
| 42 | CA1175917 | 27-Dec-13 | 24-Jan-14 | 78.5 |
| 43 | CA1175918 | 27-Dec-13 | 24-Jan-14 | 78.0 |
| 44 | CA1175923 | 27-Dec-13 | 24-Jan-14 | 66.0 |
| 45 | CA1175924 | 27-Dec-13 | 24-Jan-14 | 76.5 |
| 46 | CA1175893 | 27-Dec-13 | 24-Jan-14 | 60.5 |
| 47 | CA1175894 | 27-Dec-13 | 24-Jan-14 | 57.0 |
| 48 | CA1175899 | 27-Dec-13 | 24-Jan-14 | 59.0 |
| 49 | CA1175900 | 27-Dec-13 | 24-Jan-14 | 59.0 |
| 50 | CA1175905 | 27-Dec-13 | 24-Jan-14 | 57.5 |
| 51 | CA1175906 | 27-Dec-13 | 24-Jan-14 | 57.0 |
| 52 | CA1175944 | 27-Dec-13 | 24-Jan-14 | 63.5 |
| 53 | CA1175945 | 27-Dec-13 | 24-Jan-14 | 64.0 |
| 54 | CA1175950 | 27-Dec-13 | 24-Jan-14 | 60.0 |
| 55 | CA1175951 | 27-Dec-13 | 24-Jan-14 | 59.5 |
| 56 | CA1175956 | 27-Dec-13 | 24-Jan-14 | 60.0 |
| 57 | CA1175957 | 27-Dec-13 | 24-Jan-14 | 60.5 |
| 58 | CA1322010 | 27-Dec-13 | 24-Jan-14 | 58.0 |
| 59 | CA1322011 | 27-Dec-13 | 24-Jan-14 | 60.0 |
| 60 | CA1175982 | 27-Dec-13 | 24-Jan-14 | 57.0 |
| 61 | CA1175983 | 27-Dec-13 | 24-Jan-14 | 76.5 |
| 62 | CA1175985 | 27-Dec-13 | 24-Jan-14 | 73.0 |
| 63 | CA1175986 | 27-Dec-13 | 24-Jan-14 | 74.0 |
| 64 | CA1175988 | 27-Dec-13 | 24-Jan-14 | 73.0 |
| 65 | CA1175989 | 27-Dec-13 | 24-Jan-14 | 54.0 |
| 66 | CA1175908 | 27-Dec-13 | 24-Jan-14 | 57.0 |
| 67 | CA1175909 | 27-Dec-13 | 24-Jan-14 | 59.0 |
| 68 | CA1175914 | 27-Dec-13 | 24-Jan-14 | 68.5 |
| 69 | CA1175915 | 27-Dec-13 | 24-Jan-14 | 70.0 |
| 70 | CA1175920 | 27-Dec-13 | 24-Jan-14 | 74.0 |
| 71 | CA1175921 | 27-Dec-13 | 24-Jan-14 | 78.0 |
| 72 | CA1175890 | 27-Dec-13 | 24-Jan-14 | 60.0 |
| 73 | CA1175891 | 27-Dec-13 | 24-Jan-14 | 57.5 |
| 74 | CA1175896 | 27-Dec-13 | 24-Jan-14 | 62.0 |
| 75 | CA1175897 | 27-Dec-13 | 24-Jan-14 | 60.5 |
| 76 | CA1175902 | 27-Dec-13 | 24-Jan-14 | 59.5 |
| 77 | CA1175903 | 27-Dec-13 | 24-Jan-14 | 57.0 |
| 78 | CA1322007 | 27-Dec-13 | 24-Jan-14 | 62.0 |
| 79 | CA1322008 | 27-Dec-13 | 24-Jan-14 | 60.0 |
| 80 | CA1175929 | 27-Dec-13 | 24-Jan-14 | 69.0 |
| 81 | CA1175930 | 27-Dec-13 | 24-Jan-14 | 71.5 |
| 82 | CA1175935 | 27-Dec-13 | 24-Jan-14 | 57.5 |
| 83 | CA1175936 | 27-Dec-13 | 24-Jan-14 | 63.0 |
| 84 | CA1175941 | 27-Dec-13 | 24-Jan-14 | 57.5 |
| 85 | CA1175942 | 27-Dec-13 | 24-Jan-14 | 59.0 |
| 86 | CA1175947 | 27-Dec-13 | 24-Jan-14 | 71.0 |
| 87 | CA1175948 | 27-Dec-13 | 24-Jan-14 | 63.0 |

| | | | | |
|---|---|---|---|---|
| 88 | CA1175953 | 27-Dec-13 | 24-Jan-14 | 61.0 |
| 89 | CA1175954 | 27-Dec-13 | 24-Jan-14 | 60.0 |
| 90 | CA1175992 | 27-Dec-13 | 24-Jan-14 | 56.5 |
| 91 | CA1175993 | 27-Dec-13 | 24-Jan-14 | 56.5 |
| 92 | CA1175995 | 27-Dec-13 | 24-Jan-14 | 53.0 |
| 93 | CA1175996 | 27-Dec-13 | 24-Jan-14 | 52.0 |
| 94 | CA1175998 | 27-Dec-13 | 24-Jan-14 | 57.0 |
| 95 | CA1175999 | 27-Dec-13 | 24-Jan-14 | 56.0 |
| 96 | CA1322001 | 27-Dec-13 | 24-Jan-14 | 56.0 |
| 97 | CA1322002 | 27-Dec-13 | 24-Jan-14 | 54.5 |

Base slab - B8 & B9

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1322154 | 4-Jan-14 | 1-Feb-14 | 70.5 |
| 2 | CA1322155 | 4-Jan-14 | 1-Feb-14 | 66.5 |
| 3 | CA1322157 | 4-Jan-14 | 1-Feb-14 | 69.0 |
| 4 | CA1322158 | 4-Jan-14 | 1-Feb-14 | 68.5 |
| 5 | CA1322160 | 4-Jan-14 | 1-Feb-14 | 64.5 |
| 6 | CA1322161 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 7 | CA1322163 | 4-Jan-14 | 1-Feb-14 | 70.5 |
| 8 | CA1322164 | 4-Jan-14 | 1-Feb-14 | 66.5 |
| 9 | CA1322166 | 4-Jan-14 | 1-Feb-14 | 69.0 |
| 10 | CA1322167 | 4-Jan-14 | 1-Feb-14 | 68.5 |
| 11 | CA1322184 | 4-Jan-14 | 1-Feb-14 | 64.5 |
| 12 | CA1322185 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 13 | CA1322115 | 4-Jan-14 | 1-Feb-14 | 64.5 |
| 14 | CA1322116 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 15 | CA1322118 | 4-Jan-14 | 1-Feb-14 | 57.0 |
| 16 | CA1322119 | 4-Jan-14 | 1-Feb-14 | 55.5 |
| 17 | CA1322121 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 18 | CA1322122 | 4-Jan-14 | 1-Feb-14 | 63.0 |
| 19 | CA1322124 | 4-Jan-14 | 1-Feb-14 | 63.0 |
| 20 | CA1322125 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 21 | CA1322127 | 4-Jan-14 | 1-Feb-14 | 64.5 |
| 22 | CA1322128 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 23 | CA1322130 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 24 | CA1322131 | 4-Jan-14 | 1-Feb-14 | 62.5 |
| 25 | CA1322133 | 4-Jan-14 | 1-Feb-14 | 67.0 |
| 26 | CA1322134 | 4-Jan-14 | 1-Feb-14 | 68.5 |
| 27 | CA1322136 | 4-Jan-14 | 1-Feb-14 | 66.5 |
| 28 | CA1322137 | 4-Jan-14 | 1-Feb-14 | 65.5 |
| 29 | CA1322139 | 4-Jan-14 | 1-Feb-14 | 59.5 |
| 30 | CA1322140 | 4-Jan-14 | 1-Feb-14 | 60.0 |
| 31 | CA1322142 | 4-Jan-14 | 1-Feb-14 | 64.5 |
| 32 | CA1322143 | 4-Jan-14 | 1-Feb-14 | 63.0 |
| 33 | CA1322145 | 4-Jan-14 | 1-Feb-14 | 66.0 |
| 34 | CA1322146 | 4-Jan-14 | 1-Feb-14 | 61.5 |
| 35 | CA1322148 | 4-Jan-14 | 1-Feb-14 | 64.0 |
| 36 | CA1322149 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 37 | CA1322151 | 4-Jan-14 | 1-Feb-14 | 66.5 |
| 38 | CA1322152 | 4-Jan-14 | 1-Feb-14 | 62.5 |
| 39 | CA1322169 | 4-Jan-14 | 1-Feb-14 | 65.5 |
| 40 | CA1322170 | 4-Jan-14 | 1-Feb-14 | 65.5 |
| 41 | CA1322172 | 4-Jan-14 | 1-Feb-14 | 66.0 |
| 42 | CA1322173 | 4-Jan-14 | 1-Feb-14 | 65.5 |

| | | | | |
|---|---|---|---|---|
| 43 | CA1322175 | 4-Jan-14 | 1-Feb-14 | 61.5 |
| 44 | CA1322176 | 4-Jan-14 | 1-Feb-14 | 61.5 |
| 45 | CA1322178 | 4-Jan-14 | 1-Feb-14 | 66.0 |
| 46 | CA1322179 | 4-Jan-14 | 1-Feb-14 | 64.5 |
| 47 | CA1322181 | 4-Jan-14 | 1-Feb-14 | 67.5 |
| 48 | CA1322182 | 4-Jan-14 | 1-Feb-14 | 67.0 |
| 49 | CA1322187 | 4-Jan-14 | 1-Feb-14 | 68.5 |
| 50 | CA1322188 | 4-Jan-14 | 1-Feb-14 | 63.0 |
| 51 | CA1322091 | 4-Jan-14 | 1-Feb-14 | 65.5 |
| 52 | CA1322092 | 4-Jan-14 | 1-Feb-14 | 65.5 |
| 53 | CA1322094 | 4-Jan-14 | 1-Feb-14 | 66.0 |
| 54 | CA1322095 | 4-Jan-14 | 1-Feb-14 | 67.5 |
| 55 | CA1322097 | 4-Jan-14 | 1-Feb-14 | 65.5 |
| 56 | CA1322098 | 4-Jan-14 | 1-Feb-14 | 65.0 |
| 57 | CA1322100 | 4-Jan-14 | 1-Feb-14 | 61.5 |
| 58 | CA1322101 | 4-Jan-14 | 1-Feb-14 | 64.0 |
| 59 | CA1322103 | 4-Jan-14 | 1-Feb-14 | 62.5 |
| 60 | CA1322104 | 4-Jan-14 | 1-Feb-14 | 61.0 |
| 61 | CA1322106 | 4-Jan-14 | 1-Feb-14 | 62.0 |
| 62 | CA1322107 | 4-Jan-14 | 1-Feb-14 | 66.5 |
| 63 | CA1322109 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 64 | CA1322110 | 4-Jan-14 | 1-Feb-14 | 61.0 |
| 65 | CA1322112 | 4-Jan-14 | 1-Feb-14 | 62.5 |
| 66 | CA1322113 | 4-Jan-14 | 1-Feb-14 | 64.5 |
| 67 | CA1322109 | 4-Jan-14 | 1-Feb-14 | 65.5 |
| 68 | CA1322020 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 69 | CA1322022 | 4-Jan-14 | 1-Feb-14 | 67.0 |
| 70 | CA1322023 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 71 | CA1322025 | 4-Jan-14 | 1-Feb-14 | 62.5 |
| 72 | CA1322026 | 4-Jan-14 | 1-Feb-14 | 66.0 |
| 73 | CA1322028 | 4-Jan-14 | 1-Feb-14 | 62.5 |
| 74 | CA1322029 | 4-Jan-14 | 1-Feb-14 | 64.5 |
| 75 | CA1322031 | 4-Jan-14 | 1-Feb-14 | 64.5 |
| 76 | CA1322032 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 77 | CA1322034 | 4-Jan-14 | 1-Feb-14 | 63.5 |
| 78 | CA1322035 | 4-Jan-14 | 1-Feb-14 | 61.5 |
| 79 | CA1322037 | 4-Jan-14 | 1-Feb-14 | 63.0 |
| 80 | CA1322038 | 4-Jan-14 | 1-Feb-14 | 65.0 |
| 81 | CA1322040 | 4-Jan-14 | 1-Feb-14 | 67.5 |
| 82 | CA1322041 | 4-Jan-14 | 1-Feb-14 | 66.5 |
| 83 | CA1322043 | 4-Jan-14 | 1-Feb-14 | 66.5 |
| 84 | CA1322044 | 4-Jan-14 | 1-Feb-14 | 61.0 |
| 85 | CA1322046 | 4-Jan-14 | 1-Feb-14 | 61.0 |
| 86 | CA1322047 | 4-Jan-14 | 1-Feb-14 | 60.5 |
| 87 | CA1322049 | 4-Jan-14 | 1-Feb-14 | 62.5 |
| 88 | CA1322050 | 4-Jan-14 | 1-Feb-14 | 63.0 |

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|---|---|---|---|---|
| 89 | CA1322052 | 4-Jan-14 | 1-Feb-14 | 60.0 |
| 90 | CA1322053 | 4-Jan-14 | 1-Feb-14 | 65.0 |
| 91 | CA1322055 | 4-Jan-14 | 1-Feb-14 | 62.0 |
| 92 | CA1322056 | 4-Jan-14 | 1-Feb-14 | 64.0 |
| 93 | CA1322058 | 4-Jan-14 | 1-Feb-14 | 62.0 |
| 94 | CA1322059 | 4-Jan-14 | 1-Feb-14 | 64.5 |
| 95 | CA1322061 | 4-Jan-14 | 1-Feb-14 | 62.0 |
| 96 | CA1322062 | 4-Jan-14 | 1-Feb-14 | 61.5 |
| 97 | CA1322064 | 4-Jan-14 | 1-Feb-14 | 62.5 |
| 98 | CA1322065 | 4-Jan-14 | 1-Feb-14 | 62.5 |
| 99 | CA1322067 | 4-Jan-14 | 1-Feb-14 | 59.0 |
| 100 | CA1322068 | 4-Jan-14 | 1-Feb-14 | 62.5 |
| 101 | CA1322070 | 4-Jan-14 | 1-Feb-14 | 62.0 |
| 102 | CA1322071 | 4-Jan-14 | 1-Feb-14 | 65.0 |
| 103 | CA1322073 | 4-Jan-14 | 1-Feb-14 | 51.5 |
| 104 | CA1322074 | 4-Jan-14 | 1-Feb-14 | 54.0 |
| 105 | CA1322076 | 4-Jan-14 | 1-Feb-14 | 51.5 |
| 106 | CA1322077 | 4-Jan-14 | 1-Feb-14 | 54.0 |
| 107 | CA1322079 | 4-Jan-14 | 1-Feb-14 | 59.0 |
| 108 | CA1322080 | 4-Jan-14 | 1-Feb-14 | 58.5 |
| 109 | CA1322082 | 4-Jan-14 | 1-Feb-14 | 63.0 |
| 110 | CA1322083 | 4-Jan-14 | 1-Feb-14 | 60.5 |
| 111 | CA1322085 | 4-Jan-14 | 1-Feb-14 | 63.0 |
| 112 | CA1322086 | 4-Jan-14 | 1-Feb-14 | 64.0 |
| 113 | CA1322088 | 4-Jan-14 | 1-Feb-14 | 64.0 |
| 114 | CA1322089 | 4-Jan-14 | 1-Feb-14 | 62.0 |

## Shaft A Reinstatement - Roof Slab

| No. | Concrete Cube No. | Date of Cast | Date of Test | Test Result (Mean Compressive strength) (Mpa) |
|---|---|---|---|---|
| 1 | CA1852809 | 23-Nov-15 | 21-Dec-15 | 73.5 |
| 2 | CA1852810 | 23-Nov-15 | 21-Dec-15 | 74.5 |
| 3 | CA1852813 | 23-Nov-15 | 21-Dec-15 | 75.0 |
| 4 | CA1852814 | 23-Nov-15 | 21-Dec-15 | 72.5 |
| 5 | CA1852817 | 23-Nov-15 | 21-Dec-15 | 74.0 |
| 6 | CA1852818 | 23-Nov-15 | 21-Dec-15 | 73.0 |
| 7 | CA1852821 | 23-Nov-15 | 21-Dec-15 | 75.0 |
| 8 | CA1852822 | 23-Nov-15 | 21-Dec-15 | 74.5 |
| 9 | CA1852825 | 23-Nov-15 | 21-Dec-15 | 78.5 |
| 10 | CA1852826 | 23-Nov-15 | 21-Dec-15 | 82.0 |
| 11 | CA1852829 | 23-Nov-15 | 21-Dec-15 | 68.5 |
| 12 | CA1852830 | 23-Nov-15 | 21-Dec-15 | 80.5 |
| 13 | CA1852833 | 23-Nov-15 | 21-Dec-15 | 74.0 |
| 14 | CA1852834 | 23-Nov-15 | 21-Dec-15 | 76.0 |