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# IN VITRO EVALUATION OF ACIDIC SOLUBILITY OF SIX DIFFERENT ORTHODONTIC BAND CEMENTS

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**CONTENTS**

## 2. ABBREVIATIONS

ADA : American Dental Association

HEMA : Hydroxyethylmethacrylate

MCGIC : Multi cure glass ionomer cement

UBLC : Ultra band lok cement

BLC : Band-LoK cement

TBC : Transbond plus

MRLC : MR LOCK LC

GIC : Glass ionomer cement

ZPC : Zinc phosphate cement

PCC : Polycarboxylate cement

SD : Standard deviation

D : Difference

P : Probability

nm : Nanometer

mm : Millimeter

cm : Centimeter

% : Percentage

Fig : Figure

Gm : Gram

MPa : Mega pascal ($N/mm^2$)

μm : Micrometer

min : Minutes

Max : Maximum

Min : Minimum

# 1. ÖZET


**Altı Ortodontık Bant Simanlarının Çözünürlüğün Incelenmesi**

**Amaç:** Bu Çalışmanın amacı; iki farklı pH' ta hazırlanan laktik asıt tampon solüsyonunda 6 farklı yapıştırma simanının asidık erozyonunu değerlendirmektir.

**Meto:** Araştırmada kullanılan 6 farklı yapıştırma simanının (1 adet çinko fosfat siman, Heraeus Kulzer, ve 5 farklı hybrid simanlar, 1 adet Multıcure cam iyonomer sıman, 3M Unitek Monrovia ABD ; 1 adet Ultra band-lok, Reliance Ortho, ABD ; 1 adet Transpond plus ligth cure band adhesive, 3M Unitek Monrovia ABD ; 1 adet MR LOCK LC vısible ligth cure band cement, American ortho,Sheboygan,ABD ; 1 adet Band loK orthodontıc cement, Reliance Ortho, ABD) erozyon miktarı, simanların PMMA içerisine yerleştirilip, iki farklı pH ta (pH 2.74 ve 4.0) 0.1 M sodum laktat/ laktik asıt tampon solüsyonuna daldırıldıtan sonra oluşnsiman kaybının derinliği ölçülerek bildirildi.ölçümler simanların solüyona daldırılmasını takip eden 1, 2, 3, 4, 5, 6. ve 7 günlerinde dijital mikrometre ile yapıldı. Sonuçlar varyans analizi, Tukey's test ve Newman-keuls test kullanılarak istatistiksel olarak değerlendirildi.

**Bulgular:** yapıştırma simanlarının 7 gündeki çözünürlük sonuçları(µm) aşağıdaki tabloda verilmektedir.

| pH | ZPC | MCGIC | UBLC | MRLC | TPC | BLC |
|---|---|---|---|---|---|---|
| 2.74 | 534.67 | -16 | -18.43 | -15.40 | -7.95 | -18.27 |
| 4.0 | 238.55 | -0.83 | -13.85 | -8.33 | -6.47 | -18.17 |

Siman tipi, pH seviyesi, zaman ve aralarındaki ilişkinin siman kaybındaki etkileri istatistiksel olarak anlamlı bulundu($p<0.05$).

**Sonuç:** Çinko fosfat simanlar için, zamana karşı erezyonda lineer bir ilişki saptanmış ve her iki asit ortamında yüksek erezyon görülmüştür. Ancak hibrid simanların hiç birisi derinlik kaybı göstermemiş, tam tersine su absorpsiyonu nedeniyle higroskopik ekspansiyona uğramışlardır.

## 2. SUMMARY

**In vitro Evaluation of Acidic solubility of six different orthodontic band cements**

**Objectives:** The aim of this study was to evaluate acidic erosion of 6 different orthodontic band cements immersed in lactic acid buffer solutions under 2 different pH storage media.

**Methods:** The erosion of 6 dental cements, a zinc phosphate cement (Phosphate Cement, Heraeus Kulzer), and 5 different types of hybrid cements multi-cure glass ionomer cement (3M Unitek Monrovia.USA), Ultra band-LoK (Reliance Ortho. USA), Transbond plus light cure band adhesive (3M Unitek Monrovia. USA), MR LOCK LC visible light cure band cement (American Ortho. Sheboygan. USA), and Band LoK orthodontic cement (Reliance Ortho. USA). were evaluated by measuring the depth loss of the cement after placement in a cylindrical cavity (hole) in standard acrylic blocks and immersion in 0.1 M aqueous sodium lactate/lactic acid buffer (pH =2.74 and 4.0). The depth loss was measured by a digital dial gauge micrometer, at 1, 2, 3, 4, 5, 6, and 7 days following immersion. The data was analyzed by repeated measures analysis of variance (ANOVA), Tukey's Multiple Comparison Test, and Newman-Keuls Multiple Comparison Test

**Results:** The depth losses (in µm) at 7 days are given below:

| pH | ZPC | MCGIC | UBLC | MRLC | TPC | BLC |
|---|---|---|---|---|---|---|
| 2.74 | 534.67 | -16 | -18.43 | -15.40 | -7.95 | -18.27 |
| 4.0 | 238.55 | -0.83 | -13.85 | -8.33 | -6.47 | -18.17 |

Type of the cement, pH level, time, and their interactions all had statistically significant effects on depth loss ($p<0.05$).

**Conclusions:** A linear relationship for erosion against time was observed for zinc phosphate cement, and showed higher erosion for both acid conditions, whereas hybrid cements did not show a depth loss but rather hygroscopic expansion due to water sorption.

# 3. INTRODUCTION

One of the most important properties which determine the durability of the luting cements in the mouth is their resistance against dissolution (70, 71). In general 3 different mechanisms of cement degradation have been described: dissolution, erosion and mechanical wear. The cement matrix is destroyed either by simple dissolution in oral fluids or by chemical degradation as a result of an acidic or alkaline environment. Any loosely bond debris would be removed during normal function in the oral environment exposing a fresh cement surface to attack (78.129). The erosion behavior in the mouth, in which there exist organic acids and inorganic electrolytes, is a complex phenomenon since the fluid flow cause a degree of erosion as well as dissolution. Also, the cement around the margin of the restoration is in stagnation area and therefore subjected to a pH lower than 7 through the action of bacterial plaque or sugars to produce, in particular lactic acid. There are many situations in which plague build-up can lead to low pH and intake of acid food may play a role in erosion process (5, 78, 39).

There are at least 3 methods that can be used to evaluate the erosion of dental material. One is a simple gravimetric method which is not suitable for water-based material, because it is difficult to determine the effect of inherent water within the material, and also it is specified in the ISO standard for resin-based material which contains no water (48, 94, 86,142). Another method is to measure the residual weight of a solution in which the cement has been immersed, after evaporating of water, this method is commonly used in laboratory test of solubility and disintegration, and is specified in ISO standard for root canal sealing material. The third method is to measure the depth loss of the cement in a cavity filled with cement, and employs a jet of aqueous acid impinging on the surface of the cement to cause loss by combined chemical and mechanical action. The method employs depth loss of cement to quantify erosion and enable material comparisons to be made.

This is a slight variation on the method proposed originally by Beech and Bandyopadhyay who proposed weight loss measurements (5). However, the test has proved difficult to be used routinely as the equipment is not readily available and the speed of the liquid jet is difficult to control.

Walls et al proposed a new eroding method in which the specimen was subjected to intermitted erosion cycling, which involved immersing alternately in 0.1 M sodium lactate/lactic acid buffer at pH 4.0 and distilled water at pH 5.5 in order to remove loose surface debris and depth loss was recorded using a profilometer (129).

Nomoto and McCabe recently introduce a new method, which was a simplification of both jet erosion test and the test described by Wall et al; the loss of material during erosion in acidic media was measured by recording the depth of the cement in a cavity, using a dial gauge. they concluded that the result of their study correlated with those obtained using a jet erosion test and published data on clinical performance. Thus, acid erosion test was suitable for standardization purpose (86).

The introduction of new adhesive techniques and material to be used in restorative dentistry also led the development of new dental cements with improved bond strengths such as new composites and hybrid cements. Since the number of both clinical and laboratory studies regarding their performance are limited for these recently introduced luting cements, little information is available also for their erosion behavior (23).

The aim of this current study is to evaluate acidic erosion of 6 different orthodontic band cements; Zinc phosphate, Multi-Cure Glass Ionomer Orthodontic Band Cement , Band-LoK Fluoride Releasing Orthodontic Band Cement , MR-look Orthodontic Band Cement, Ultra Band-LoK Cement and Transbond-plus Light cure Band Adhesive in lactic acid buffer solution under two different pH storage mediums using the recent test method described by Nomoto and McCabe (86).

# 4. LITERATURE REVIW

## 4.1. Dental cements

Dental cements used as restorative material have low strength compared with those of resin-based composites and amalgam, but they can be used for low stress area. Regardless of their inferior strength, they can possess many desirable characteristics that justify their use in up to 60% of all restoration (102).

Although restorative cements are used for temporary and long-term restoration, they are also required for application. For example, before placement of a restoration, the pulp may have been irritated or damaged from variety of sources, such as caries and cavity preparation. To protect the pulp against further trauma, thermal-insulating bases are often placed under metallic restoration, and pulp-capping agent and cavity liners are placed on prepared tooth surfaces that are close to the pulp chamber. Cavity liners such as cavity varnish and dentin bonding agent can also protect pulp tissue against the effect of certain components of restorative material and against microleakage. Some fluoride-containing cement can be used as fissure sealant, root canal sealants, and core buildups for restoration of broken-down teeth (101).

The most obvious use of dental cements is for permanently retaining metal inlays, crowns, and bridges to tooth structure. Cements used in this manner are called Luting agents because they lute, or adhere, one surface to another.

Other uses of dental cements include the bonding of orthodontic appliances to the teeth and cementing pins and posts to retain restorations (73).

### 4.1.1 Development of dental cements

Although certain cements for special purposes consist of one or two pastes, dental cements are most frequently formed when one mixes together a powder and liquid (108, 101, 102).

Zinc phosphate cement has been used in dentistry as a luting agent to secure cast restoration for about 130 year. Originally concocted by Peirce in 1879 (105).This cement consists of a powder and liquid respectively zinc oxide and phosphoric acid.

Around 1903 silicate cement was introduced for anterior filling.

Historically there was no real development in dental cements for nearly a century (105).

In 1968, however, a new kind of cement was produced by D.C. Smith using zinc oxide as powder and polycarboxylic acid as liquid component. The result is the so- called polyacrylate cement (115).

Glass ionomer cements were invented in the late 1960s in the laboratory of the government chemist in Great Britain and first reported on by Wilson, Kent in 1971 (17, 136).

### 4.1.2 Classification of dental cements materials

Some dental cements are supplied in two components: a powder and a liquid. They are generally classified according to their chemical formulation as presented in table (4.1). With the exception of calcium hydroxide and resin products, most cement set by an acid-base reaction. The liquids are usually acid solutions, and the powders are basic formulations that consist of either glass or metallic oxides. The American Dental Association Specification for the various cements further classify certain of cements as type I and type II on the basic of their properties, and thus their intended use. For example, type I zinc phosphate cement is" fine grain" cement (small particles size intended for cementation of precision fitting castings).

The type II zinc phosphate cement is" medium grain" cement and is recommended for all other uses. (I.e. thermal insulating base and cementation of orthodontic bands) (10, 102).

**Table 4.1 Classification of the luting cement**

| cement | Principle uses | Secondary uses |
|---|---|---|
| Zinc phosphate | Luting agent for restorations and orthodontic appliances | Intermediate restorations; thermal insulating bases |
| Zinc Oxide-eugenol | Temporary and intermediate restorations<br>Temporary and permanent luting agent for restorations; thermal insulating bases; cavity liners; pulp capping | Root canal restorations<br>Periodontal surgical dressing |
| Polycarboxylate | Luting agent for restorations; thermal- insulating bases | Luting agent for orthodontic appliances; Intermediate restorations |
| Silicate | Anterior restorations | |
| Silicophosphate | Luting agent for restorations | Luting agent for orthodontic appliances; Intermediate restorations |
| Glass ionomer | Anterior restorations; Luting agent for restorations and orthodontic appliances; cavity liners | Pit and fissure sealant; thermal-insulating bases |
| Metal-modified glass ionomers | Conservative posterior restorations; core buildups | |
| Resin | Luting agent for restorations and orthodontic appliances | Temporary restorations |
| Calcium hydroxide | Pulp capping agent; thermal-insulating base | |

### 4.1.3 Chief constituents and general reaction

With the exception of calcium hydroxide and resin materials the setting reaction are those of an acid, a base (89, 101).

Cements are formulated as powders, liquids. The powders are amphoteric or basic (proton acceptors) and the liquids are acids or (proton donors). On mixing the two together a viscous paste is formed, which subsequently hardness to a solid mass (15, 18).

A cement forming reaction is the interaction between an acid and base, the product of which is a gel-salt. Equation for such reaction can be written in a simplified general form: (15, 18)

$$MO + H_2A = MA + H_2O$$

(Proton acceptor) (Proton donor) gel-salt

$$MO\ x\ SiO_2 + H_2A = MA + x\ SiO_2 + H_2O$$

(Proton acceptor) (Proton donor) gel-salt

Set cements are heterogeneous; only part of the powder reacts with the liquids, and the final set material is composed of a core of unreacted powder surrounded by a matrix of reaction products, i.e. the gel-salt (15).

The similarities between the compositions of the cements should be obvious. It should be apparent that a mixing and matching of powders and liquids has taken place to produce the many different types of dental luting cements. The chart in table (4.2) should help to clarify cement compositions.

**Table 4.2 Simplifying the composition of dental cements**

| Liquids | Powders | |
|---|---|---|
| | Silicate glass | Zinc oxide |
| Phosphoric acid | Silicate cement | Zinc phosphate |
| Polyacrylic acid | Glass ionomer | Polycarboxylate |
| Eugenol | ----------------- | Zinc oxide eugenol |
| Dimethacrylate monomers | Resin | ----------------------- |

### 4.1.4 General properties of the luting cements

Luting cement should have some mechanical, physical and biological properties that make them more suitable to serve under occlusion forces for years in casting procedure (11) and long time life in orthodontic banding without failure

According to ADA specification NO .8 the mechanical and physical properties of the luting cement should have the following values.

**Table 4.3 Mechanical and physical properties**

| Luting cement | Setting time (min) | Compressive strength 24.H MPa | Film thickness µm | Solubility in $H_2O$ (%in 24 hours) |
|---|---|---|---|---|
| *********** | 5 Min<br>9 Max | 68.7 | 25 | 0.01-0.2 % |

#### 4.1.4.1 Setting time

The setting time of the cement must be accurately controlled. If the cement set too fast, the viscosity increases so rapidly that is impossible to seat the casting or bands fully (36). In other hand if the setting time is too long, chair time would be prolonged unduly. Therefore it's obvious that matrix formation must be sufficiently slow that adequate working time is provided (36). Setting time is usually measured with 1 pound (4.5 Nt) Gilmore needle at a temperature of 37 ºC and a relative humidity of 100%.

Setting time defined as the time elapsing from the start of mixing until the point of the needle no longer penetrates the surface of the cement when the needle is gently lowered onto it (15, 36).

Setting time is affected by many factors some of them are under the control of the dental assistant and dentist and other are related to manufacturing process (36).

The composition of sintering temperature of the powder and the composition of the liquid as well as the size of the powder particles which are related to manufacturing process undoubtedly are factors in control of the setting time. The higher the sintering temperature, the more slowly the cement set. And larger the particle size of the powder, the less rapid is the reaction because decrease surface contact of the powder with the liquid (102).

In a sense mixing temperature, mixing time and powder and liquid ration which are under the control of dentist is also factors in control of setting time (18, 36).

The lower the temperature during mixing, the longer is the setting time and the longer the mixing time, within particular limits, the longer is the setting time.

The more liquid employed in ratio to the powder, the slower is the setting time.

Mixing temperature can be regulated by the temperature of the mixing slab.

Generally, it is desirable to increase the setting time to be certain that sufficient time is available for manipulation of the cement; and so that the maximal amount of powder can be incorporated until the desires consistency is reached. For this reason, the mixing slab is cooled, and not to be cooled below the dew point of environment; otherwise, moisture collects on the slab and the properties may be affected (36, 89).

Lengthening the setting time by the use of a lower powder-liquid ration is to be avoided because of adverse effect on the strength and solubility (36, 103).

**4.1.4.2 Film thickness**

In general film thickness of the luting cement should be sufficiently thin so that it dose not interfere with the fit of the appliances

The thickness of the cement film and the fit of the appliance are determined to an extent by some factors such as viscosity of the cement, temperature of the cement, cementation pressure and the shape of the tooth surface

According to ADA specification no 8, the maximum thickness for type I zinc phosphate cement is 25 micrometer (designed for the casting of precision appliances and other used) and the maximum film thickness for type II zinc phosphate cement is 40 micrometer ( designed for cementation of orthodontic bands and other non precision appliances).

The viscosity of the cement is of great importance, heaver the viscosity, the greater the film thickness will be, and the less complete the seating of the appliances may be (1, 101).

Film thickness of Polycarboxylate cement is slightly higher than that of zinc phosphate cement but is well within clinical limits. And film thickness of glass ionomer cement is similar to that of zinc phosphate cement.

The film thickness of resin based cements is greater because of heaver viscosity of the resin cements during mixing.

**4.1.4.3 Resistance**

Resistance is one of the important factors in the selection of the luting cements because cements should be resist over years in the oral cavity and under occlusion forces (102).

Large term clinical observation demonstrate that zinc phosphate cement have a sufficient resistance in the mouth.

Zinc Polycarboxylate cement show high tensile strength, plastic deformation more suitable than zinc phosphate cement whereas compressive strength is considerably lower than zinc phosphate cement.

Since their high mechanical properties glass ionomer cement has a better resistance in the oral cavity fluids and under occlusion forces than zinc phosphate cement and polycarboxylate cement.

The compressive and tensile strength of glass ionomer cements are acceptable. And unless glass ionomer cement contaminate with moisture in early period, their compressive strength increase to approximately to

200 MPa because of the silica net formation. But in early period, moisture contamination spoils the mechanical properties of the cement.

There are many studies about the resistance of resin modified glass ionomer cement and polyacid resin cement (102). These cements usually have different properties of both cement that they are made. They found that proportional limit, strain and compressive strength are usually high in conventional glass ionomer cement and low in resin cement.

Resin cements are the cement group that has the highest mechanical properties. Their tension and compressive strength are very high due to the filler contents and 50 to 70 % of weight is composed of glass and silica particles.

**4.1.4.4 Plastic deformation**

One of the important factors for long term clinical success of the cement is the strain of the cement. The forces (orthodontic, chewing) are applied on the bands as well as the restoration; usually these forces are under the ultimate strain (i.e. the cement layer will deform elastically or plastically) this deformation may cause microleakage between the appliance (bands or restoration) and the tooth surface, penetration of bacteria into tooth surface which lead to caries or secondary caries underneath the appliance and finally lead to appliance failure (133).

Zinc phosphate cement and glass ionomer cement have hard and breakable formation, their elastic modulus is high and they are break under compression before plastic deformation while Polycarboxylate cement, resin modified glass ionomer cement and resin cement have permanent deformation before they break.

Most of the values listed in the table (4.4) are taken from a variety of sources; therefore, they are representative of typical cement. Naturally, some variation occurs in properties from one brand to another. However, it should be emphasized that the differences induced by manipulative variables are usually much greater than are those inherent between brands.

**Table 4.4 Physical and mechanical properties of luting cement**

| Luting cement | Setting Time min | Film Thickness μm | Compressive strength MPa | Tensile strength MPa | Elastic modulus Gpa |
|---|---|---|---|---|---|
| Zinc phosphate Cement | 5-9 | 25-35 | 96-133 | 3.1-4.5 | 9.3-13.4 |
| Polycarboxylate Cement | 5-9 | 21-48 | 57-99 | 3.6-6.3 | 4.0-4.7 |
| Glass ionomer Cement | 6-8 | 22-24 | 86.2-266 | 4.2-5.3 | 3.5-6.4 |
| Hybrid cement | 5.5-6 | 10-60 | 58-126 | 13-24 | 2.5-7.8 |
| Resin cement | 3-10 | 10-60 | 65.5-265 | 4-37 | 4.4-6.5 |

### 4.1.5 Ideal requirements of luting cements

There were certain criteria that we look for in ideal cement, as we said previously cement had different functions one was for luting purposes, the second is for restoration or base, and the third is for liners. For luting cements there were certain criteria we looked for in term of ideal. (12, 19, 28, 36, 41,101, 102).

The cement should have a certain compressive strength because the retention of crown, inlay, or bands is directly related to the compressive strength.

All cements should have film thickness of 25 micrometer. If they don't it may be too thick

It should not cause harm to the pulp and adjacent gingival tissues

It should easy to manipulation

Should have long working time with rapid set at oral temperature

Should have high proportional limit

Adhesion to tooth structure and metals

Should have anticariogenic properties

Translucency and radiopacity

### 4.1.6 Luting cements

In dentistry uses of dental cements as a luting agents are employed mainly for two major purposes:

1- To secure cast restoration in fixed prosthodontic and to retain orthodontic bands and appliances in position.

2- To serve as a restorative material either alone or with other materials.

Uses of luting cements for fixed prosthodontic purposes, require preparation of the tooth surface (i.e. 1.5 to 2 mm of enamel and dentin must be removed to create space in which the cement is placed. So the most important aims of the luting cements in fixed prosthodontic are to prevent the bacteria and oral fluids from penetration to the prepared surface and insulate thermal conduction as well as retention of the preparation by filling the gap between the tooth surface and the restoration (70). While in orthodontic, the preparation of tooth surface is eliminated (no need to remove any enamel or dentin) the cements are placed directly on the teeth. However the most important aim of luting cements is to retain the bands in position without failure and white spots.

The following cements are the most often used luting cements in fixed prosthodontic as well as in orthodontic (18, 25, 73, 91, 142).

1-Zinc phosphate cements

2-Zinc Polycarboxylate cements

3-Glass ionomer cements

4-Hybrid ionomer cements

A-Resin modified glass ionomer cements

B-Polyacid modified resin cements

5-Resin cement

#### 4.1.6.1 Zinc phosphate cements

Zinc phosphate cement is the oldest of the luting cements; it has been used in dentistry to secure cast restoration for about 125 years (18, 36). And because zinc phosphate cement is the one that has the longest “track record” it serve as a standard with which newer cements can be compared although the properties of zinc phosphate cement are not ideal. The cement is manufactured in two forms. The type I form is used for luting castings, and the type II form is used for all other applications. The only difference between the two is the size of zinc oxide particles. The type I cement has smaller particles that enable the cement to flow out into thin (less than 25µm) layers between a casting and the tooth. The type II form contains larger particles and can routinely achieve a film thickness of 40 µm. the zinc phosphate cements used for base have the same composition as those used for luting, with the only difference being the consistency to which they are mixed.

**Composition**

Zinc phosphate cement is powder and liquid system. The principle ingredient of the powder is zinc oxide 90%, magnesium oxide, silicon dioxide, bismuth trioxide and other minor ingredients are used in some products to alter the working characteristics and final properties of the mixing cement (36, 102). The magnesium oxide in quantities usually of about 2-10 % is added to zinc oxide to reduce the temperature of the calcinations process, and give the cement white color, and silicon dioxide is inactive filler in the powder and during manufacture aids in the calcinations process (36). In some products tannin fluoride may be added to provide a source of fluoride ions.

**Liquid**

Zinc phosphate liquid is produced by the addition of aluminum and some time zinc or their compounds to an orthophosphoric acid solution (18, 36, 101). It contains 45-60 % phosphoric acid and 30-35 % water. The water content of the liquid is established by manufacture and it should be maintained, otherwise the chemical equilibrium may be disturbed.

Either loss or gain of water from the liquid impairs the physical and mechanical properties of the resultant cement. With repeated opening of the bottle over a period of time the water-acid ration of the remaining liquid may be altered (36).

Insufficient water in the liquid is often evidenced by formation of crystals on the wall of the bottle, or general cloudiness but if the water is absorbed by the liquid no change in the appearance can be observed. However, with the air conditioned offices of today evaporation of water is more likely to occur than is imbibitions (18, 36).

**Table 4.5 A typical formulation of zinc phosphate powder and liquid. (15, 18, 89)**

| composition | Weight (%) |
|---|---|
| Powder | 90.2 |
| ZnO | 8.2 |
| MgO | 1.4 |
| Si2O3 | 0.1 |
| Bi2O2 | 0.1 |
| Misc.BaO,Ba2SO4,CaO | |
| Liquid | 38,2 |
| H3PO4 (free acid) | 16.2 |
| H3PO4 (combined with AL and Zn) | 2,5 |
| Al | 7.1 |
| Zn | 36.0 |
| H2O | |

**Chemistry of setting**

When zinc oxide powder is mixed with phosphoric acid, a solid substance is rapidly formed with considerable evolution of heat. However, the zinc oxide is heat treated so as to reduce its activity (36).

The set zinc phosphate cement is essentially a hydrated amorphous network of zinc phosphate that surrounds incompletely dissolved (unreacted) particles of zinc oxide (28).

**Properties**

For a given brand of material, the properties are a function of the powder/liquid ratio. For a given cement consistency, the higher the powder/liquid ratio, the better the strength properties and the lower the solubility and free acidity.

At room temperature (21 Cº to 23 Cº) the working time for most brands at luting consistency is 3 to 6 minutes; the setting time is 5 to 14 minutes.

At the recommended powder/liquid ratio (2.5 to 3.5g/mL), the compressive strength of the set zinc phosphate cement is 80 to 110 MPa (11.000 to16.000 psi) after 24 hours. The tensile strength is much lower than the compressive strength, 5 to 7 MPa (700 to 900psi)

**4.1.6.2 Zinc Polycarboxylate cement**

Polycarboxylate or polyacrylate cements was the first system developed with a potential for adhesion to the tooth structure (36).

**Composition**

Polycarboxylate cements are powder and liquid system or single system cements. The liquid is an aqueous solution of polyacrylic acid and copolymer the powder is similar in composition to that used with zinc phosphate cement, principally zinc oxide with some magnesium oxide (36).

Stannic oxide may be substituted for magnesium oxide and it also contain small quantities of stannous fluoride, and other salts that modify the setting time and enhance the manipulation characteristics (36).The most important additive is stannous fluoride, which increase the strength of the cement and also act as a source of fluoride which well may impart anticariogenic properties of the cement (18, 28, 36).

**Chemistry of setting**

When the powder and liquid are combined the cement forming mechanism is thought to be a reaction of zinc ions with polyacrylic acid via the carboxyl group. The zinc can also react with the carboxyl group of adjacent polyacrylic acid chain so that an ionically cross-linked structure is formed (36). Thus the set cement consists of zinc oxide particles dispersed in a structure less matrix of zinc polycarboxylate.

In the single system polycarboxylate cement the polycacrylic acid is dried and the powdered acid is mixed with water, the polyacrylic acid goes into solution and the setting proceeds as described for conventional powder and liquid system (36).

**Properties**

The recommended powder/liquid ratio at luting consistency for most brands of polycarboxylate cement is about 1.5:1 by weight. The working time is 2.5 to 3.5 minutes at room temperature, and the setting time is 6 to 9 minutes at 37 ºC. As with other cements, working time can be substantially increased by mixing the material on a cold slab and by refrigerating the powder.

At cementing consistency, the compressive strength of these materials is in the range of 55 to 85 MPa (8.000 to 12.000 psi), and the tensile strength is 8 to 12 MPa (1.100 to 1.700 psi).

#### 4.1.6.3 Glass ionomer cements

Glass ionomer cement was developed in 1968 and introduced to dental profession in 1972. In the early version glass ionomer cement had several undesirable characteristics that made this cement not a very popular one on its early years. Then considerable researches have been carried over the last 20 year and dental profession has benefited with an improved physical properties and better handling characteristics of the material.

Glass ionomer cements are used in a variety of application, including liners, bases, sealants, restorative, and luting agents (36).

There are two type of glass ionomer cement:

Type I glass ionomer cements are fine grained and hence are suitable for cementation of castings in fixed prosthodontic and orthodontic bands in orthodontic field.

Type II glass ionomer cements are designed for use as a restorative material (18, 28, 36, 102).

Glass ionomer cements are chemically combined to enamel and dentin and have ability to release fluoride with highly physical and mechanical properties

**Composition**

They are supplied as a powder and liquid or as a powder that is mixed with water. The liquid typically is a 47.5 % solution of 2:1 Polyacrylic acid / itaconic acid copolymer. The itaconic acid reduce the viscosity of the liquid and also make it more resistant to gelation, it also contain a small amount of tartaric acid in the range of 5 % which improves the working and setting characteristics (36).

The powder is finely ground calcium fluoroaluminosilicate glass.

The nominal composition of calcium fluoroaluminosilicate glass used in powder of glass ionomer cement showing in the table (4.6).

**Table 4.6 Composition of glass ionomer cement powder**

| Ingredient | Percentage % |
|---|---|
| SiO2 | 29.0 |
| Al2O2 | 16.6 |
| CaF2 | 34.3 |
| AlF3 | 7.3 |
| NaF | 3.0 |
| AlPO4 | 9.9 |

**Chemistry of setting**

When the powder and liquid are mixed to form a paste, the glass is attacked by the acid and Al, Ca, and Na ions are liberated, as is fluoride, probably in the form of complexes. Calcium and, eventually, aluminum polysalts form, which crosslink the polyanion. The salts hydrate to form a gel matrix and the unreacted glass particle is cheated by silica gel that arises from removal of cations from the surface of the particles (18, 28, 36, 89, 101, 102).

Thus the set cement consists of an agglomeration of unreacted powder particles surrounded by a silica gel which is held together in amorphous matrix of hydrated calcium and aluminum polysalts (36).

**Properties**

For the luting materials, the setting time is in the range of 6 to 9 minutes. The lining material set in 4 to 5 minutes, and the restorative materials set in 3 to 4 minutes. Materials that are light-cured set in approximately 30 seconds when exposed to a visible light source. Also for a luting materials, the compressive strength increases over 24 hours to 90 to 140 MPa (13.000 to 20.000 psi) depending on the brand. The tensile strength increase similarly to 6 to 8 MPa (900 to 1.100 psi)

**4.1.6.4 Hybrid ionomer cements**

Resin cements and glass ionomer cements are widely used in recent years due to their high physical and mechanical properties. However, the disadvantage of glass ionomer cement such as their sensitivity to moisture in the early periods and the disadvantage of the resin cements such as polymerization shrinkage and non fluoride release limit their clinical use (18).

For this reason many researches have been done to improving hybrid cement which contains both resin cement and glass ionomer cement in different proportion to eliminate the disadvantage and to combine the advantage (18).

As the result of these researches studies, many product are marketed in recent years

These products divided into two groups (18).

1-Resin modified glass ionomer cement

2- Compomers

**4.1.6.4.1 Resin modified glass ionomer cement**

This cement is obtained by addition of water soluble resin monomer into liquid of traditional glass ionomer cement. Thus, the goal of this process is to decrease the sensitivity against water and increase the resistance of glass ionomer cement (18).

**Composition**

Powder is composed of fluoroaluminosilicate glass particles. Liquid contain methylacrylate resin, polyacid, HEMA, and water.

**Chemistry of setting**

Setting reaction begins with polymerization of methacrylate group and maturation of the cement is completed as acid-base reaction (18).

**4.1.6.4.2 Compomers**

They are recently introduced products marketed as a new class of dental materials. These materials are said to provide the combined benefits of composites (the "comp" in their name) and glass ionomers ("omer"). Based on a critical review of the literature, the author argues that "compomers" do not represent a new class of dental materials but are merely a marketing name given to a dental composite.

They are also called Poly acid modified resin cement (36).

They are essentially resin composites that contain additional acidic monomers similar to glass ionomers. These materials, like composites in structure and physical properties and unlike resin-modified glass ionomers, do not contain water in their formulation, however. They are anhydrous. Therefore, Compomers are more similar to composites than to glass ionomers.

**Composition**

It is contain composite resin fillers and fluoroaluminosilicate glass. Unlike glass ionomer cement but it is related to resin cements.

**Chemistry of setting**

First reaction starts with the polymerization of methacrylate group, and usually activated by 468 nm wave length light. Unless there is water, the acid dose not reacts with glass surfaces. So acid-base reaction dose not start until water is absorbed. It is suggested that acid-base reaction take place between acidic group of polymer and the basal glass particles.

#### 4.1.6.5 Resin Cement

The resin cements were first developed in the early 1950s for use as crown and bridge luting agents but had high polymerization shrinkage and excessive leakage because of their low percentage filler content. They also exhibited a pronounced color shift due to high residual amine levels.

Modern products have better physical properties (e.g. less shrinkage, leakage, and color shift) because they are more highly filled and have lower residual amine levels. Resin cements are either visible light-activated, chemically-activated, or dual activated (both visible light- and chemically-activated).

Visible light-activated cements are generally reserved for the luting of cast ceramic, porcelain, and resin composite veneers or for other light-transmitting restorations that are thin enough (i.e., 1.5 mm thick) to transmit light. The chemically activated forms are used for the cementation of resin-bonded fixed partial dentures; thick (i.e., 2.5 mm thick) cast ceramic, porcelain, and resin composite restorations; and metal restorations. Dual-activated resin cements are used for luting thin to moderately thick (i.e., from 1.5 mm to 2.5 mm thick) cast ceramic, porcelain, and resin composite restorations where light penetration may be limited.

These cements may be of clinical benefit in providing increased retention for restorations when minimal retention form exists because several studies have found these cements to be more retentive than zinc phosphate, glass-ionomer, and conventional resin cements.

## 4.2 Literature review of in vitro and in vivo solubility of the dental luting cements

Orthodontic treatment with fixed appliances utilizes luting materials to effect stable attachment of brackets and bands during tooth movement. A common clinical problem is demineralization, or caries, under or around the brackets or bands, particularly in caries-prone younger patients

Probably the property of greatest clinical significance is the solubility and the disintegration of the cement. This property is one of the most important considerations in the use and selection of any dental material.
In fact, solubility of the cement is of utmost signification in cemented of the appliances
Other than errors in the cementation procedure, cement solubility is probably the main factor contributing to caries around the appliances. Every precaution must be taken to produce an accurately fitting appliance that minimizes the layer of exposed cement and then to handle the material in such manner that its solubility is as low as possible.
Studies indicated that all cements except resin are soluble in the oral cavity. Solubility of zinc phosphate cement and polycarboxylate cement are high and increase by time.
Glass ionomer cements are evidently less soluble than conventional cements in optimal condition, although clinical studies show that cementation of the appliances with glass ionomer cement have more marginal defect than appliances cemented with zinc phosphate cement. This situation may be due to the sensitivity of the glass ionomer cement to moisture in early period.
Moisture sensitivity of glass ionomer cement in the early period is due to two reasons (28):
1-When the water exists; the calcium and aluminum ions may be removed from the matrix.
2-Sodium ions and anions form (salt soluble in water).

If this happens, the result set cement is more soluble and weak physical properties. Because of this sensitivity it is recommended that the margin of the appliance should be cover with water resistant gels, to prevent the early contamination in the early stage of setting. Also to overcome these problem new brands of glass ionomer cements is marketed. In these cements, the liquid is dried up and added to powder, and distilled water is used as the cement liquid.

Solubility also affected by powder-liquid ratio, clinical study of the solubility of three powder-liquid ratios of polycarboxylate cement demonstrated a threefold increase in the solubility for the lower powder-liquid ratios. In other hand the data suggest that the higher powder/liquid ratio (1.5:1) is preferable when minimal solubility is a primary requirement.

The solubility of dental cements may be determined clinically or in the laboratory. The formulation of dental cement is inevitably a matter for compromise. Color, handling characteristics, setting time, shelf life and convenience of mixing are only a few of the properties which must be acceptable. However, once it is in place, mechanical strength and resistance to the combined effects of abrasion, erosion and dissolution are the prime requirements of a satisfactory material (113).

Different techniques have been employed to measure cement solubility. Various researches calculated the cement loss by weigh analysis of cement specimens or by chemical analysis of the ion concentration in the erosion liquid (31).

The classical laboratory test is that described in ADA test number 8 in which a disc of cement is immersed in water for 23 hours after which the water is evaporated to dryness and the weight of elute thereby measured. The limitations of this test for solubility and disintegration in specification for dental cement have been published by Wilson (134, 135).

The limitations are:

1- The duration of the test is too short.

2- The test medium is not comparable to oral fluids.

3- There is no aspect of abrasion in the test.

The solubility of a solid defined as a physico-chemical property, can only be applied to situation where a chemical compound is in thermodynamic equilibrium with its solution. These criteria are not met in this test. Furthermore, the ADA-test has only a limited clinical significance because it dose not give an indication of fully hardened cement either in water or in oral fluids. The test relates, therefore, to an early vulnerability to aqueous attack and hardening rate. Long term extrapolations can not be made and cement type with different setting reactions can not be compared. Therefore the test needs to be supplemented by other tests done on fully hardened cement for longer periods of time and in media that simulate oral conditions. As far as physico-chemical research on cement is concerned, extensive techniques and studies have been done. In 1972 Wilson and Kent introduced new translucent cement for dentistry: the glass ionomer cement, a comparison with existing cements showed that it had the advantage of increased strength and better biocompatibility, while the surface of these cements exhibited a greater resistance to mild acid attack (136). The setting reaction gives a hard water-insoluble gel. Because of their criticism and demands on the ADA-specification, Wilson et al, submitted this new cement not only to the standard solubility test, but also tested fully hardened cement under acid conditions over long periods (137). Subsequently the same tests on zinc phosphate, silicate and polycarboxylate cements were applied and all surfaces were studied by scanning electron microscopy. The combined results were compiled by Kent, Lewis and Wilson (136). The main conclusions were:

1- Glass ionomer cement combines certain favorable properties of both dental silicate and polycarboxylate cements.

2- Compared to silicate cement, the glass ionomer cement has a superior surface.

3- Surface integrity is maintained against both aqueous and weak acid attack.

Subsequently extensive studies were started, ranging from compressive strength through the effects of the powder / liquid ratio, the polyacid concentration, molecular weight, tartaric acid concentration and a study of erosion in neutral and acidic media. This resulted in a series of papers and is probably the most thorough investigations ever done on any kind of dental cement.

Finally researches were concentrated on the erosion factor because an important limitation of dental cement is their tendency to erode in oral fluids. Total erosion was described as being the combination of dissolution together with disintegration (19).

**4.2.1. In vitro literature review**

Swartz et al, in 1979 compared the results obtained by three different in vitro disintegration tests (weight loss test, loss in area of film, and transverse strength test) with those obtained in vivo. They found that the results that best correlated with in vivo results were those obtained by measuring the reduction in area of cement film hold between glass plates using 0.01 M acetic acid as the medium. Also they conclude that the surface area of the specimen exposed to the medium appear to be a critical factor in the disintegration rate of certain cements (120).

Gudbrand Öilo in 1984 compared the early disintegration of zinc phosphate cement, Polycarboxylate cement and six glass ionomer cements (i.e. Three filling material and three luting material) by mean of a suitable erosion test. The cements were mixed within 1 min and immediately placed in small resin cups holding approximately 0.6 g cement, two minutes after commencement of mixing, the specimens were placed in a chamber at 37 ºC and for 100% relative humidity. After 2, 4, or 6 minutes storage time, the specimens were removed and weighed to an accuracy of 1 mg. they were thereafter placed in erosion test apparatus and immediately exposed to constant jet of distilled water for 15 seconds. In this study the author conclude that no or negligible weigh changes were observed for zinc phosphate and polycarboxylate cements independent of the storage time. All glass ionomer material showed a reduced weight when tested after 2 minutes storage. The weight reduction for all these materials was less pronounced when tested after 4 minutes storage, and for the majority of these materials negligible when tested after 6 min storage (90).

Setchell D.J, in 1985 used a jet-test method to measures the dissolution/erosion of four glass-ionomer dental cements. Two of these (Chemfil and Aqua-Cem) are based on polyacrylic acid. The other two (Ketac-Cem and Chelon) are based on the polymaleic acid. With this method a volume (usually around 6 liters) of dilute lactic acid which is circulated through the apparatus by a pump. A number of cement samples are arranged in small holders and the liquid, emerging from a series of small jets, impinging on the cement samples, one beneath each jet. In this way, a mechanically erosive element is combined with the chemical erosion which occurs during the test procedure (113). Because a dilute acid, rather than water, is used as test liquid, the erosion proceeds in hours rather than days. In this test it has been shown that the Polyacrylic based cements appear to be less soluble and more erosion-resistant than those based on the polymaleic acid.

Walls et al, in 1985 filled a hole (5mm diameter and 5 mm deep) bored in the center of the square of Perspex (20 mm x 20 mm x 5 mm) with five types of dental cements, zinc phosphate, silicate, zinc polycarboxylate and two glass polyalkenoate cements and immersed in sodium lactate/lactic acid buffer at pH 4.0 and distilled water at pH 5.5. After 6 hours of continuous erosion cycling, they measure the depth loss in micrometer (129).

Chun-His Chung et al, in 1991 measured the shear bond strength of a resin-reinforced glass ionomer under various conditions of surfaces preparation and moisture. They found after 24 hours of bracket placement the etched teeth had the highest bond strength and dry condition providing a stronger bond than wet condition, they also found that the site of bond failure was apparently related to the condition of the tooth surface. In the etched group, the bond failed between bracket and adhesive, in the unetched group, the site of failure was between adhesive and enamel, and no bonding material remained on the enamel surfaces.

Knobloch L.A et al, in 2000 compared seven day water sorption, water solubility and lactic acid solubility of three composite cements (Panavia 21, Enforce and Resiment) and three resin-modified glass-ionomer cements (Vitremer luting, Advance and Fuji Duet). In this study four disc-shaped specimens measuring 15 mm in diameter and 0.5 mm in thickness were prepared for each cement type, utilizing polypropylene molds that were compressed between two glass plates under a constant load (5Kg). After bench curing, specimens were removed from the mold and placed in a 37 ºC oven for 24 hours to insure complete set. The diameter and thickness of each specimen was measured three times utilizing a digital micrometer. Specimens were then placed in a desiccators at 37 ºC for 24 hours and then transferred to a second desiccators at 23 Cº for one hour and weighed using an electronic analytic balance, the specimens were then immersed in distilled water at 37 Cº and in 0, 01 M lactic acid (pH 4.0) lactic acid for seven days. They conclude that Vitremer luting cement exhibited a seven day water sorption greater than any of the other cement tested, and Fuji Duet exhibited a seven day water solubility which was significantly higher than any of the other cements tested. Vitremer luting cement exhibited less water solubility when compared to the other resin-modified glass ionomer cements tested in this study, and Vitremer luting cement exhibited a lactic acid solubility that was significantly higher than any of the other cements tested (59).

Declan T. Millet et al, in 2003 compared the mean retentive strength of micro etched orthodontic bands cemented to extracted human third molars with a modified composite (Transbond Plus band adhesive), a resin-modified glass ionomer cement (Fuji Ortho LC), and a conventional glass ionomer cement (Ketac-Cem; Espe, Seefeld, Oberbay, Germany)

The mode of band failure and amount of cement remaining on the tooth at deband were also assessed. The mean retentive strength of molar bands with micro etched fitting surfaces cemented with Transbond Plus was significantly less than that of bands cemented with either the resin-modified or the conventional glass ionomer cement (21).

Weibull analysis indicated that for a given probability of failure, less force would be required to dislodge a band cemented with Transbond Plus than for those cemented with either of the other cements (21).

- The amount of cement remaining on the tooth after deband differed significantly between bands cemented with either resin-modified or conventional glass ionomer cement.
- Mean survival time of bands cemented with resin-modified glass ionomer was significantly longer than for bands cemented with conventional glass ionomer cement but did not differ significantly from that of bands cemented with modified composite.

### 4.2.2. In vivo literature review

Norman in 1969 started in vivo research by filled a relatively large windows on the lingual side of lower frame prosthesis, worn during 30 days by 8 patients. Every few days the appliances were weighed and the loss of cement calculated in $mg.cm^{-2}$ (88).

In this research three types of cements were evaluated, silicate cement, zinc phosphate cement and zinc oxide eugenol cement.

1. Silicate cement proved nearly insoluble in this period.

2. The loss of zinc phosphate cement varied from 5-30 $mg.cm^{-2}$.

3. The loss of zinc oxide eugenol varied from 20-100 $mg.cm^{-2}$ (88).

Richter and Ueno in 1975 filled holes (approximately 3 mm in diameter and 2 mm deep) in the pontic of bridge with silicophosphate, a zinc phosphate, zinc Polycarboxylate and zinc oxide eugenol-EBA cement. Impression of the cement surfaces were made at the start and after one year, silver plated and photographed. The ranking was done by comparison. In this research silicophosphate cement exhibit the most durable cement followed by zinc phosphate cement; the two other cements ranked even (107).

Osborne in 1978 filled small holes (0.82mm in diameter, 1.5mm deep) in crowns of 15 patients with the same cements and measured cement loss directly with a micrometer after six months.

In this research, the average depth of loss was:

- 7.6 µm for silicophosphate cement.

- 43 µm for Polycarboxylate cement.

- 127 µm for zinc phosphate cement.

- Zinc oxide eugenol cement disappeared nearly completely (94).

Mitchem and Groans in 1978 placed the same cements plus for the first time glass ionomer cements in the sample holders with holes (2mm diameter, 2mm deep) fitted in denture and worn by 10 patents .After six months an impression of the sample holder surface was made and measured directly with a micrometer. The amount of cement lost ranged from 200 micrometer for glass ionomer cement, 350 micrometer for silicophosphate cement, 600 micrometer for zinc phosphate cement to 930 micrometer for Polycarboxylate cement (74).

Mitchem and Groans In 1981 repeated the experiment with more glass ionomer, silicophosphate and zinc phosphate cement. The result was comparable to Mitchem and Groans study (75).

Sidler and Strub in 1983 tested two glass ionomer and one zinc phosphate cement by filling small holes (0.8mm in diameter, 3mm deep) in mesio-distal inlay on wisdom teeth with these cements. After 14 months teeth were extracted and the depth of the holes calculated by measuring three points on the edge of each hole and three points on the bottom.

The result was 500 micrometer cement lost for zinc phosphate cement, for one brand of glass ionomer cement 100 micrometer and 40 micrometer for the other (114).

Mesu and Reedijk in 1983 compared one zinc phosphate, one polycarboxylate, one fortified zinc oxide eugenol and two glass ionomer cements in vitro as well as in vivo. In this study round plane parallel glass plates (7mm in diameter) were cemented upon stainless steel bottom plates. 20 micrometer of cement layer was exposed to the oral cavity. In this study zinc oxide eugenol showed the highest and glass ionomer cement the lowest dissolution rate (71).

Pluim L.J. et al, in 1984 measured the disintegration rate of glass ionomer cement and zinc phosphate cement. In this study cement samples were placed in the holes (1.3 mm in diameter and 3 mm depth) on the enamel surface of freshly extracted bovine incisors located on the side of full prosthesis and worn in the mouth for up to 6 months. In this study the solubility rate of glass ionomer cement was order of 2 micrometer per week and for zinc phosphate cement was after (3-6 weeks) 80 micrometers (104).

Ralph W. Phillips et al, in 1987 filled a wells (0.8 mm in diameter and 0.9 to 1.3 mm depth) placed on the full crown restoration of 20 patient, four on the mesial surface and four on the distal surface, worn during 12 months. Measurements were done at six- and 12 months. The cements tested were glass ionomer cement, zinc phosphate cement, silicophosphate cement, and polycarboxylate cement (99).

They found that during a 12-month period, glass ionomer and silicophosphate cement showed the lowest rates of disintegration, followed by polycarboxylate cement prepared with a high powder- liquid ratio. Zinc phosphate cement showed significantly more disintegration than the other three cements (99).

Osborne J.W. and M.S.Wolff, in 1991 filled holes prepared on the mesial and distal surfaces of a single unit-cast restoration with three different powder/liquid ratio of durelon Polycarboxylate cement (1.5:1, 1.25:1, and1:1). After 6 months they found that the highest solubility was at 1:1 powder/liquid ratio and they suggested that the higher powder/liquid ratio 1.5:1 is preferable when minimal solubility is a primary requirement (95).

Finally resistance to dissolution or disintegration is one of the most important properties that determine the durability of the cement in the mouth. Acid erosion, In particular, is of clinical significance because acid condition can occur orally either by ingestion of acidic foods or by the degradation of polysaccharides to acids in stagnation areas of the mouth.

The purpose of this study is to evaluate the acidic erosion of commonly used orthodontic band cements using the recent test method described by Nomoto and McCabe.

# 5. MATERIAL AND METHOD

## 5.1. MATERIAL

### 5.1.1. Tested cements

Measuring of the acidic solubility of 6 different orthodontic band cements; zinc phosphate, Multi-Cure Glass Ionomer Orthodontic Band Cement , Band-LoK Fluoride Releasing Orthodontic Band Cement , MR-look Orthodontic Band Cement, Ultra Band-LoK Cement and Transpond-plus Light cure Band Adhesive in lactic acid buffer solution under two different pH storage mediums using the method described by Nomoto and McCabe (86).

**Table 5.1 Tested cements and their manufactures**

| Name of cement | Type of cement | Manufactures |
|---|---|---|
| Zinc phosphate cement | Phosphate cement | Heraeus Kulzer, Wehrheim, Germany REF CE 0044 |
| Multi cure glass ionomer orthodontic band cement | Hybrid cement | 3M Unitek Monrovia. USA REF 712-051 |
| Transbond plus light cure band adhesive | Hybrid cement | (3M Unitek Monrovia. USA) REF 712-080 |
| MR LOCK LC visible light cure band cement | Hybrid cement | American Ortho. Sheboygan USA) REF 001-975 |
| Ultra band-LoK | Hybrid cement | (Reliance Ortho. USA) REF- UBLP 1-800323-4348 |
| Band-Lok | Hybrid cement | (Reliance Ortho. USA) REF CE 0473 |

### 5.1.2. Eroding solution

0.1 M aqueous sodium lactate/lactic acid buffer was selected as eroding medium. The initial pH of the medium was 2.7 and 4.0. These two solutions were prepared by using the following agents at least 20 h before use: lactic acid (Merck, Darmstadt, Germany) and sodium lactate (Merck, Darmstadt, Germany). Prior to use, the pH of these solutions was checked and adjusted to 2.7 and 4.0, if necessary with sodium lactate or lactic acid solution.

### 5.1.3. Eroding solution preparation machine

the pH of the test solution were measured with a pH electrode (Schott Glaswerke, Mainz 1, Germany) and pH meter (model 710 pH/ISE meter, ORION,Boston,USA).

### 5.1.4. Measuring machine

A vertical mounted, digital dial gauge (Digimicro/ MF-1001, MS-31G, MFC-101, Nikon; Japan) (fig 5.1 a, b) was used for measurement of depth loss. The measuring force applied by the dial gauge was 133g and the tip diameter of dial gauge probe was 1.5 mm. Since the diameter of the dial gauge probe is 1.5 mm and the diameter of the hole within the acrylic block is 5.0 mm, the tip of dial gauge probe was positioned in close to the center of the cement specimen during measurement. The dial gauge was graduated in unit of 1 µm and the measurement was estimated to the nearest 0.1 µm.

### 5.1.5 Other test material

- Sensitive balance (AND HM-200, A D, Tokyo, Japan).
- Light cure machine (Eliza-Light 500, Apoza Enterprise Co, Ltd, Taipei hsien, Taiwan).
- 100 ml plastic container (Lar, Milan, Italya).
- Waterproof silicon carbide paper 166 (P360A, England).
- Oven (EN 400, Nüve, Öveçler, Ankara).


(a)

(b)

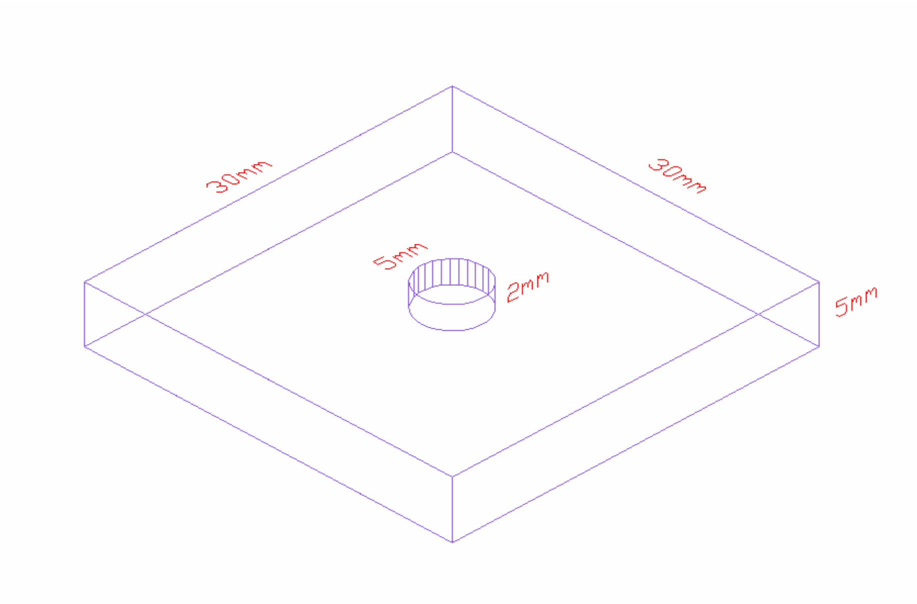
**Figure 5.1 Digital micrometer**
**Frontal view (a), Lateral view (b).**

## 5.2. METHOD

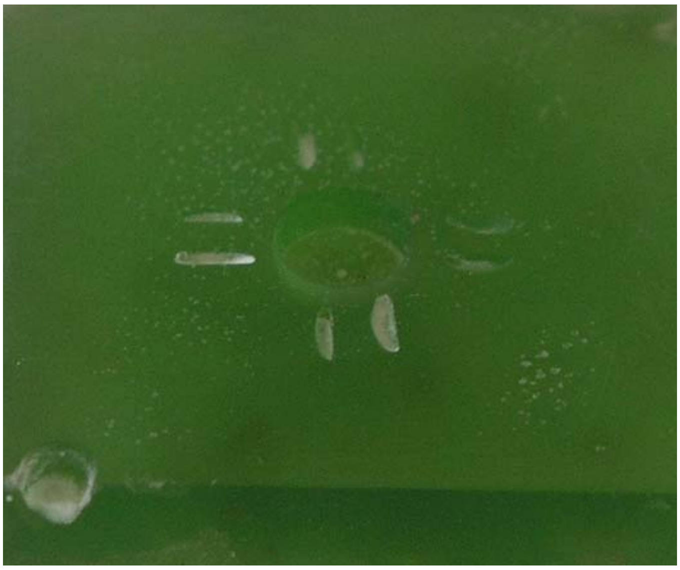
All the work was done in orthodontic department and in the biochemistry laboratory of Dental Faculty of Marmara University.

### 5.2.1 Preparation of specimens holders

60 pieces of acrylic block (30 x 30x 5 mm) were prepared from Technovit 5071 resin methacrylate (Kulzer, Werheim, Germany)




(a)



(b)

**Figure 5.2 Acrylic block specimen (a) and (b).**

Each block was made by firmly finger comprising of standard metal cast between two glass pieces (fig5.3).

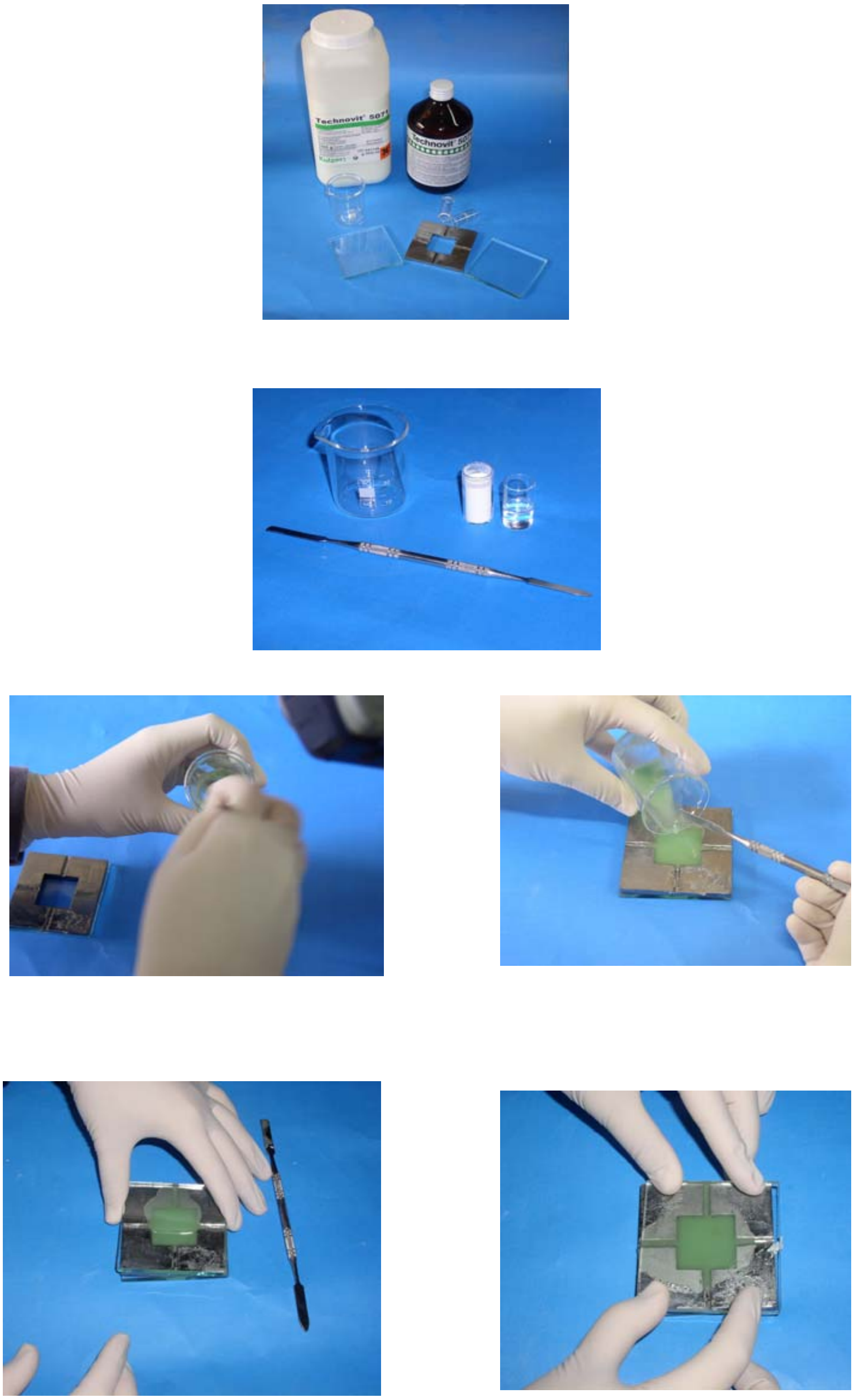


**Figure 5.3 Preparation of acrylic block specimens holder**

At the center of each acrylic block a hole (5 mm in diameter and 2 mm in depth) was made with the help of drilling machine (LHN CHANG, Taichung schiann, Taiwan) and 1.5 mm from the periphery of the hole 8 reference lines two at each side were made Fig (5.4).

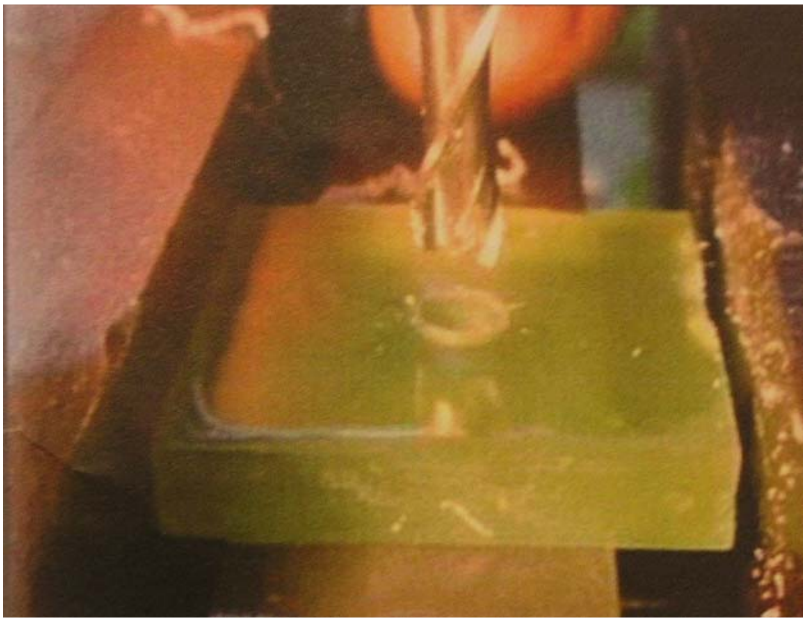


**Figure 5.4 Hole Preparation at the center of the acrylic block**

**5.2.2. CEMENT PLACEMENT**

Ten acrylic blocks were made for each type of cement, five of them were immersed in 0.1 M sodium lactate/lactic acid buffer at pH 2.74 and the other five were immersed in the same solution at pH 4.0.

**5.2.2.1. Zinc phosphate cement**

The powder and liquid ratio were carefully dispensed by use of a sensitive balance (AND HM-200, A D, Tokyo, Japan). The manufacture instructions were followed with respect do mixing procedures; 1.20g of powder was placed on a glass plate and divided into several portions. Using a small amount first, the powder is added to 0.888 liquid in portions and mixed quickly for 1 minute 30 seconds at 23 ºC room temperature.

After mixing properly the cement was placed in the hole of the specimen holder to a slight excess taking care to avoid trapping air. The specimen was covered with a thin laboratory test glass, pressed firmly for 5.5-7.5 minutes for complete setting as recommended by the manufactures. The specimen was transferred to an oven at 37 ºC and a relative humidity of at least 90%.


**Figure 5.5 Zinc phosphate cement**

### 5.2.2.2. Multi cure glass ionomer cement

Multi cure glass ionomer cement was mixed by dividing one small level of powder scoop into two halves on a glass slab using a large cement spatula, (fig 5.7). Once the first halve had been fully mixed with on droop of liquid, the second halve was added and the mixing continued until all of the powder was incorporated into the liquids.

After mixing properly the cement was placed in the hole of the specimen holder to a slight excess taking care to avoid trapping air. The specimen was covered with a thin laboratory test glass, pressed firmly and cured for

40 seconds to insure a complete setting of the cement as recommended by manufactures. The specimen was transferred to an oven at 37 ºC and a relative humidity of at least 90%.


**Figure 5.6 Multi cure glass-ionomer cement**

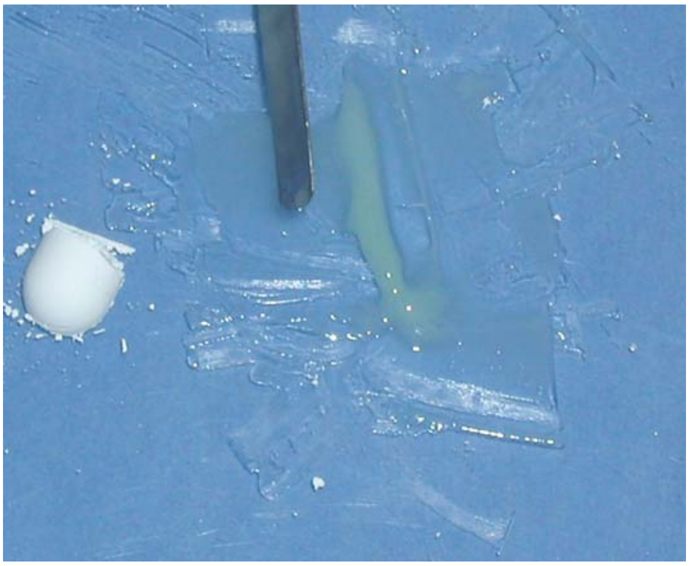


**Figure 5.7 Mixing of Glass-ionomer cement**

### 5.2.2.3. Band LoK

Is two paste system, no messy powder liquid systems. Unlike other glass ionomer cement because it dose not have aftertaste or odor.

Is a unique combination of resin and glass ionomer technology. Band-lok cement is a dual cure cement which can be used with or without a dental curing light.

After the two pastes are mixed together, the cement was inserted into the hole of the specimen holder directly to a slight excess taking care to avoid trapping air. The specimen was covered with a thin laboratory test glass, pressed firmly and cured for 40 seconds to insure a complete setting of the cement as recommended by manufactures.

**Figure 5.8 Band LoK cement**

#### 5.2.2.4. MR LOCK LC visible light cure band cement

Since MR LOCK LC visible light cure band cement is a single paste cement, it was inserted into the hole of the specimen holder by squeezed slowly the carpule to fill the hole directly to a slight excess taking care to avoid trapping air. The specimen was covered with a thin laboratory test glass, pressed firmly and cured for 40 seconds to insure a complete setting of the cement as recommended by manufactures. The specimen was transferred to an oven at 37 ºC and a relative humidity of at least 90%.

**Figure 5.9 MR LOCK LC**

**Figure 5.10 Carpule**

#### 5.2.2.5. Ultra band-LoK

Ultra Band-Lok, new light-cured glass ionomer cement, requires no mixing and hence, unlike most dual-cure composites, provides significantly extended working time when needed. This allows more accurate band placement as well as easier removal of excess cement.

Ultra Band-LoK is a compomer cement that release fluoride which is available in either a tooth-color or a blue paste, the blue paste contrasts with the enamel surface to make cleanup even easier.

**Figure 5.11 Ultra band LoK**

Ultra Band-LoK can also be used to bond brackets, lingual retainers and large acrylic appliances. When bonding these appliances, you must first etch the enamel surface. It is a unique combination of resin and glass ionomer technology.

### 5.2.2.6. Transbond Plus light cure band adhesive

Is a single paste, no mix adhesive with a rapid 30-second set time to reduce the risk of moisture contamination, Furthermore, Transpond Plus banding adhesive contains and releases fluoride, and has the ability to replenish its fluoride ions when exposed to other fluoride containing systems like fluoride-containing water or toothpaste

Transbond Plus band adhesive is a single-component modified composite (compomer) formed by combining a composite resin with glass ionomer particles. Supplied in sealed capsules from which it is applied to the band-fitting surface, it hardens only through photopolymerization.

**Figure 5.12 Transbond plus**

As a single paste, the major advantage of Transbond Plus light cure band adhesive is the elimination of mixing, resulting in reduced clean-up, more consistent adhesive performance, increased office efficiency, and less chair time.

### 5.2.3. Measuring procedure

After 24h of cement placement, all the specimens were removed and lapped using 1200-grit silicon carbide paper with continuous water irrigation until the surface of the cement will be within 5μm of the surface of the specimen holder.  After lapping, the height at four points on the specimen holder and one at the center of the cement were recorded as a baseline depth using a digital height gauge (Fig 5.13).

The four points of the specimen holder were spaced evenly at 90º intervals at 0.5-1.5 mm from the margin of the cavity. The average of the four heights of the specimen holder was calculated and the height at the center of the specimen was subtracted from this value to obtain the original depth at the center of the specimen, **D0.** The specimen was kept wet during measurements. Each measurement was repeated three times to ensure reproducibility.

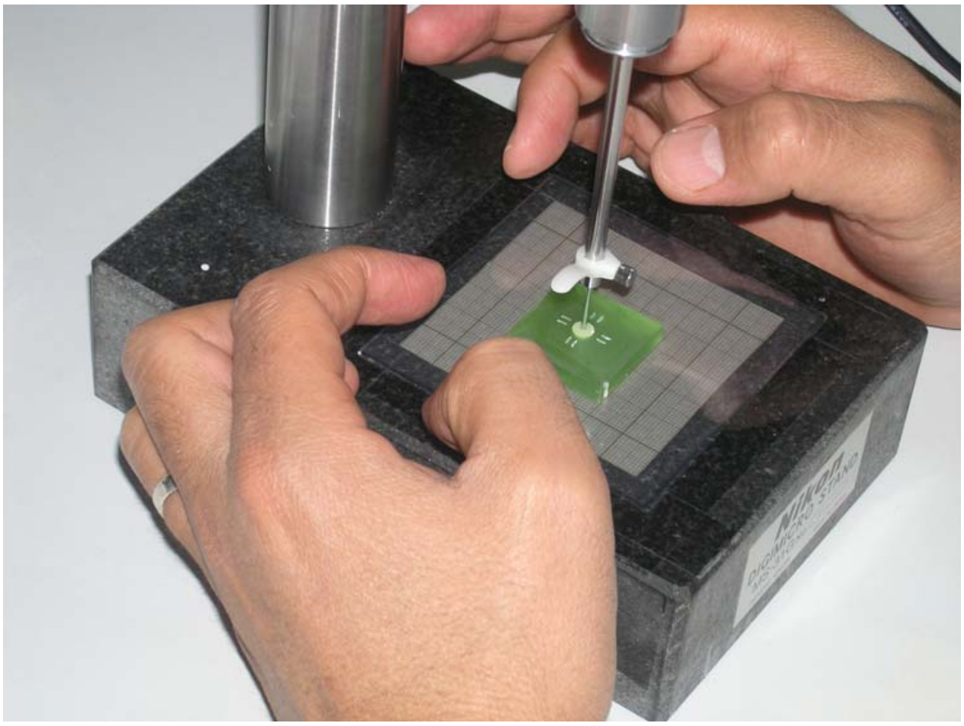



**Figure 5.13 Depth loss measuring**

Each specimen with specimen holder were immersed horizontally face upward into individual containers with 30 ml of eroding solution such that the whole surface of the specimen bathed in the eroding solution to a depth of 8-12mm. The container was sealed and stored at 37 ºC for the specified test period of 7 days. At the specified time, each specimen with specimen holder, were removed and rinsed with distilled water. The height at four points on the specimen holder and at the center of the material was recorded using digital height gauge as before (fig 5.15). The depth at the center of the specimen after each specified immersion period, **Dt**, was obtained as described above. The eroded depth, **D**, at the center of the cement for each specimen after the specified immersion period, was calculated using the following equation:

**D=Dt-D0** (fig 5.14).

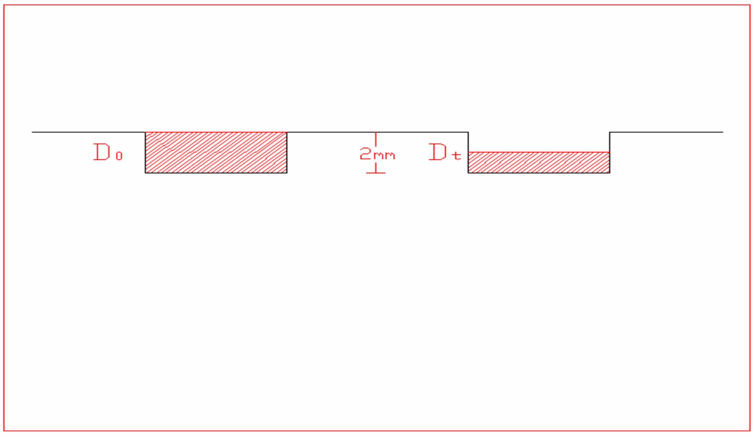


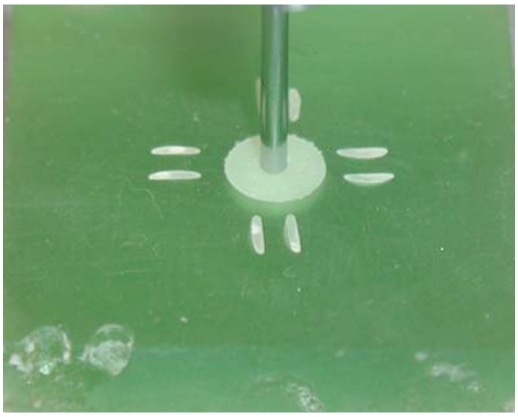

**Figure 5.14**

Where **D0** is the original depth at the center of the specimen before immersion, and **Dt**, the depth at the center of the specimen after specified immersion period. Each specimen will be returned to the same container and immersed for a further period of time. The depth loss will be measured after 1, 2, 3, 4, 5, 6, 7 days immersion and the eroding solution was not renewed during the test period.

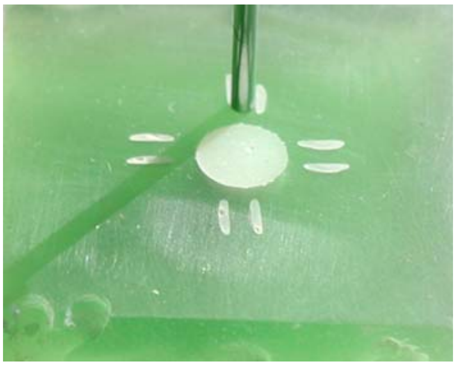
### 5.2.4. Statistical analysis

Statistical calculations were performed with GraphPad Prisma V.3 program for Windows. Besides standard descriptive statistical calculations (mean and standard deviation), Two way ANOVA was used in the comparison of groups, times and pH groups, post Hoc Tukey multiple comparison test was utilized in the comparison of subgroups, repeated ANOVA was used in the comparison of time groups, post Hoc Newman Keuls multiple comparison test was utilized in the comparison of subgroups,

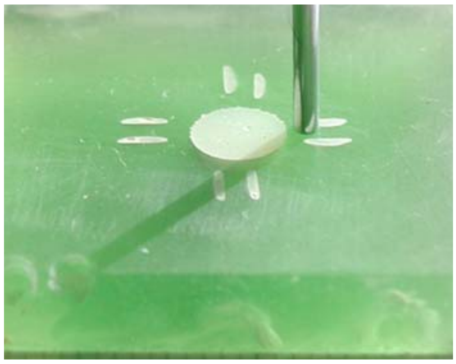
Statistical significance level was established at $p<0,05$.



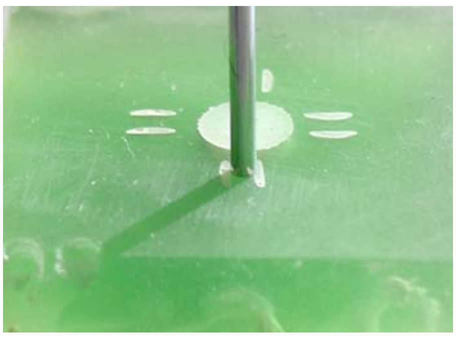
(a)



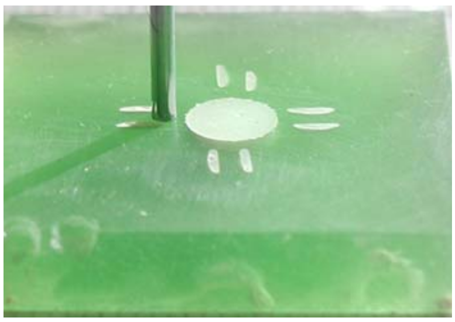
(b)



(c)



(d)



(e)

**Fig 5.15 Measuring depth loss at the center of the the hole (a), upper reference point (b), right reference point (c), lower reference point (d), and left reference point (e).**

# 6. RESULT

The vertical cement loss of 10 specimens of zinc phosphate cement at the beginning (Do) and the depth of the erosion at various times (Dt), as well as the values of 4 acrylic reference points are given in table 6.1 and 6.2.

The (Do), (Dt) and the values of 4 acrylic reference points for other 5 tested cements are show in the table 6.3 to table 6.12.

The depth of the vertical cement loss of all cements at two different pH of sodium lactate/ lactic acid buffer with respect to time are shown in table 6.13 to 6.18.

The mean depth of the erosion and standard deviation for all types of tested cements at tow different pH media are shown in table.6.19

The negative values indicate the amount of expansion of the cement due to water absorption while the positive values indicate the amount of cement loss.

Two -way ANOVA showed that depth loss was significantly different for tested cements ($p<0.0001$)

Tukey's Multiple Comparison test showed that zinc phosphate cement was the only significant different cement among all tested cements.

Newman-Keuls Multiple comparison test showed that in which day the cement loss was significant.

Zinc phosphate cements at pH 2.74 in day 7 shows the higher disintegration rate 534, 67 µm while multi cure glass ionomer cement at pH 2.74 in day 3 shows the lower disintegration rate -30 µm

For zinc phosphate cement, when depth was plotted against time an approximately linear relationship was apparent (fig 6.1).

Other tested hybrid cements show variable amount of water sorption.

**Table 6.1. Seven days recorded heights and reference points of five samples of Zinc phosphate cement at pH 2.74 (mm).**

| pH 2,74 Begining | Middle of Siman | | | Mean | Upper of Acril | | | Right of Acril | | | Down of Acril | | | Left of Acril | | | Mean | Different |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zinc Phosphate 1 | 5,052 | 5,053 | 5,053 | **5,053** | 5,116 | 5,119 | 5,114 | 5,123 | 5,119 | 5,121 | 5,120 | 5,123 | 5,117 | 5,141 | 5,141 | 5,135 | **5,124** | **0,071** |
| Zinc Phosphate 2 | 5,288 | 5,289 | 5,288 | **5,288** | 5,388 | 5,382 | 5,377 | 5,387 | 5,386 | 5,388 | 5,332 | 5,337 | 5,335 | 5,377 | 5,373 | 5,378 | **5,370** | **0,082** |
| Zinc Phosphate 3 | 5,126 | 5,127 | 5,126 | **5,126** | 5,196 | 5,193 | 5,191 | 5,174 | 5,171 | 5,172 | 5,190 | 5,191 | 5,192 | 5,199 | 5,191 | 5,192 | **5,188** | **0,061** |
| Zinc Phosphate 4 | 5,285 | 5,287 | 5,284 | **5,285** | 5,407 | 5,403 | 5,404 | 5,303 | 5,303 | 5,300 | 5,303 | 5,299 | 5,300 | 5,381 | 5,380 | 5,380 | **5,347** | **0,062** |
| Zinc Phosphate 5 | 5,324 | 5,329 | 5,326 | **5,326** | 5,325 | 5,323 | 5,320 | 5,369 | 5,374 | 5,375 | 5,368 | 5,377 | 5,375 | 5,350 | 5,353 | 5,342 | **5,354** | **0,028** |
| pH 2,74 1.Day | | | | | | | | | | | | | | | | | | |
| Zinc Phosphate 1 | 4,940 | 4,940 | 4,941 | **4,940** | 5,125 | 5,122 | 5,121 | 5,127 | 5,126 | 5,121 | 5,131 | 5,133 | 5,130 | 5,142 | 5,145 | 5,146 | **5,131** | **0,190** |
| Zinc Phosphate 2 | 5,152 | 5,152 | 5,146 | **5,150** | 5,381 | 5,380 | 5,380 | 5,383 | 5,385 | 5,379 | 5,334 | 5,332 | 5,331 | 5,374 | 5,365 | 5,376 | **5,367** | **0,217** |
| Zinc Phosphate 3 | 5,016 | 5,011 | 5,016 | **5,014** | 5,197 | 5,202 | 5,199 | 5,183 | 5,181 | 5,178 | 5,196 | 5,192 | 5,195 | 5,208 | 5,198 | 5,203 | **5,194** | **0,180** |
| Zinc Phosphate 4 | 5,177 | 5,171 | 5,176 | **5,175** | 5,420 | 5,408 | 5,419 | 5,298 | 5,308 | 5,309 | 5,305 | 5,314 | 5,315 | 5,392 | 5,396 | 5,399 | **5,357** | **0,182** |
| Zinc Phosphate 5 | 5,208 | 5,198 | 5,204 | **5,203** | 5,325 | 5,322 | 5,315 | 5,369 | 5,371 | 5,376 | 5,369 | 5,372 | 5,373 | 5,350 | 5,350 | 5,350 | **5,354** | **0,150** |
| pH 2,74 2.Day | | | | | | | | | | | | | | | | | | |
| Zinc Phosphate 1 | 4,822 | 4,827 | 4,828 | **4,826** | 5,122 | 5,120 | 5,122 | 5,122 | 5,119 | 5,119 | 5,128 | 5,126 | 5,123 | 5,141 | 5,143 | 5,139 | **5,127** | **0,301** |
| Zinc Phosphate 2 | 5,022 | 5,019 | 5,017 | **5,019** | 5,362 | 5,369 | 5,357 | 5,369 | 5,374 | 5,366 | 5,330 | 5,330 | 5,328 | 5,380 | 5,370 | 5,380 | **5,360** | **0,340** |
| Zinc Phosphate 3 | 4,898 | 4,909 | 4,900 | **4,902** | 5,204 | 5,208 | 5,203 | 5,181 | 5,189 | 5,183 | 5,199 | 5,208 | 5,203 | 5,209 | 5,215 | 5,211 | **5,201** | **0,299** |
| Zinc Phosphate 4 | 5,063 | 5,064 | 5,070 | **5,066** | 5,415 | 5,417 | 5,423 | 5,306 | 5,303 | 5,304 | 5,313 | 5,310 | 5,307 | 5,391 | 5,391 | 5,395 | **5,356** | **0,291** |
| Zinc Phosphate 5 | 5,102 | 5,096 | 5,097 | **5,098** | 5,330 | 5,334 | 5,334 | 5,380 | 5,376 | 5,377 | 5,385 | 5,381 | 5,373 | 5,354 | 5,351 | 5,344 | **5,360** | **0,262** |
| pH 2,74 3.Day | | | | | | | | | | | | | | | | | | |
| Zinc Phosphate 1 | 4,750 | 4,748 | 4,751 | **4,750** | 5,135 | 5,129 | 5,133 | 5,123 | 5,123 | 5,177 | 5,123 | 5,129 | 5,127 | 5,141 | 5,144 | 5,146 | **5,136** | **0,386** |
| Zinc Phosphate 2 | 4,992 | 4,930 | 4,935 | **4,952** | 5,378 | 5,376 | 5,370 | 5,363 | 5,365 | 5,366 | 5,329 | 5,337 | 5,338 | 5,368 | 5,386 | 5,389 | **5,364** | **0,411** |
| Zinc Phosphate 3 | 4,817 | 4,818 | 4,814 | **4,816** | 5,209 | 5,212 | 5,211 | 5,184 | 5,189 | 5,186 | 5,206 | 5,206 | 5,204 | 5,210 | 5,214 | 5,214 | **5,204** | **0,387** |
| Zinc Phosphate 4 | 4,995 | 4,996 | 5,005 | **4,999** | 5,445 | 5,439 | 5,437 | 5,322 | 5,322 | 5,310 | 5,331 | 5,327 | 5,310 | 5,416 | 5,416 | 5,395 | **5,373** | **0,374** |
| Zinc Phosphate 5 | 5,009 | 5,008 | 5,007 | **5,008** | 5,332 | 5,331 | 5,337 | 5,390 | 5,379 | 5,376 | 5,385 | 5,379 | 5,380 | 5,355 | 5,355 | 5,351 | **5,363** | **0,355** |
| pH 2,74 4.Day | | | | | | | | | | | | | | | | | | |
| Zinc Phosphate 1 | 4,712 | 4,714 | 4,720 | **4,715** | 5,136 | 5,132 | 5,131 | 5,126 | 5,126 | 5,126 | 5,132 | 5,131 | 5,130 | 5,146 | 5,150 | 5,153 | **5,135** | **0,420** |
| Zinc Phosphate 2 | 4,885 | 4,884 | 4,883 | **4,884** | 5,375 | 5,368 | 5,370 | 5,371 | 5,374 | 5,376 | 5,338 | 5,337 | 5,337 | 5,375 | 5,373 | 5,376 | **5,364** | **0,480** |
| Zinc Phosphate 3 | 4,762 | 4,755 | 4,747 | **4,755** | 5,209 | 5,205 | 5,200 | 5,179 | 5,182 | 5,187 | 5,200 | 5,206 | 5,206 | 5,211 | 5,213 | 5,216 | **5,201** | **0,447** |
| Zinc Phosphate 4 | 4,920 | 4,915 | 4,916 | **4,917** | 5,424 | 5,428 | 5,425 | 5,324 | 5,328 | 5,330 | 5,319 | 5,321 | 5,325 | 5,401 | 5,408 | 5,405 | **5,370** | **0,453** |
| Zinc Phosphate 5 | 4,941 | 4,943 | 4,940 | **4,941** | 5,333 | 5,337 | 5,342 | 5,392 | 5,382 | 5,376 | 5,384 | 5,383 | 5,379 | 5,357 | 5,358 | 5,355 | **5,365** | **0,424** |
| pH 2,74 5.Day | | | | | | | | | | | | | | | | | | |
| Zinc Phosphate 1 | 4,647 | 4,645 | 4,647 | **4,646** | 5,133 | 5,127 | 5,129 | 5,131 | 5,133 | 5,133 | 5,125 | 5,126 | 5,130 | 5,144 | 5,147 | 5,144 | **5,134** | **0,487** |
| Zinc Phosphate 2 | 4,805 | 4,801 | 4,808 | **4,805** | 5,378 | 5,380 | 5,380 | 5,383 | 5,396 | 5,377 | 5,339 | 5,335 | 5,341 | 5,378 | 5,375 | 5,374 | **5,370** | **0,565** |
| Zinc Phosphate 3 | 4,719 | 4,709 | 4,710 | **4,713** | 5,213 | 5,211 | 5,213 | 5,187 | 5,188 | 5,191 | 5,208 | 5,210 | 5,213 | 5,213 | 5,213 | 5,212 | **5,206** | **0,493** |
| Zinc Phosphate 4 | 4,862 | 4,865 | 4,866 | **4,864** | 5,419 | 5,417 | 5,419 | 5,319 | 5,324 | 5,320 | 5,320 | 5,319 | 5,318 | 5,402 | 5,406 | 5,410 | **5,366** | **0,502** |
| Zinc Phosphate 5 | 4,896 | 4,902 | 4,893 | **4,897** | 5,333 | 5,337 | 5,336 | 5,383 | 5,383 | 5,383 | 5,384 | 5,384 | 5,382 | 5,360 | 5,362 | 5,360 | **5,366** | **0,469** |
| pH 2,74 6.Day | | | | | | | | | | | | | | | | | | |
| Zinc Phosphate 1 | 4,622 | 4,619 | 4,615 | **4,632** | 5,134 | 5,134 | 5,135 | 5,132 | 5,134 | 5,134 | 5,134 | 5,130 | 5,132 | 5,150 | 5,147 | 5,148 | **5,137** | **0,505** |
| Zinc Phosphate 2 | 4,743 | 4,743 | 4,745 | **4,744** | 5,379 | 5,378 | 5,372 | 5,385 | 5,381 | 5,385 | 5,341 | 5,341 | 5,340 | 5,371 | 5,371 | 5,371 | **5,368** | **0,624** |
| Zinc Phosphate 3 | 4,651 | 4,656 | 4,655 | **4,654** | 5,198 | 5,201 | 5,207 | 5,179 | 5,179 | 5,180 | 5,206 | 5,197 | 5,202 | 5,203 | 5,203 | 5,206 | **5,197** | **0,543** |
| Zinc Phosphate 4 | 4,830 | 4,832 | 4,828 | **4,830** | 5,427 | 5,433 | 5,428 | 5,315 | 5,327 | 5,306 | 5,323 | 5,330 | 5,319 | 5,412 | 5,411 | 5,401 | **5,369** | **0,539** |
| Zinc Phosphate 5 | 4,856 | 4,857 | 4,853 | **4,855** | 5,335 | 5,339 | 5,342 | 5,384 | 5,385 | 5,384 | 5,389 | 5,385 | 5,384 | 5,365 | 5,364 | 5,363 | **5,368** | **0,513** |
| pH 2,74 7.Day | | | | | | | | | | | | | | | | | | |
| Zinc Phosphate 1 | 4,592 | 4,589 | 4,587 | **4,589** | 5,133 | 5,136 | 5,138 | 5,130 | 5,133 | 5,137 | 5,139 | 5,133 | 5,139 | 5,153 | 5,153 | 5,151 | **5,140** | **0,550** |
| Zinc Phosphate 2 | 4,709 | 4,707 | 4,705 | **4,707** | 5,389 | 5,393 | 5,402 | 5,388 | 5,386 | 5,385 | 5,354 | 5,352 | 5,353 | 5,387 | 5,392 | 5,396 | **5,381** | **0,674** |
| Zinc Phosphate 3 | 4,616 | 4,627 | 4,626 | **4,623** | 5,211 | 5,212 | 5,215 | 5,191 | 5,188 | 5,188 | 5,207 | 5,207 | 5,205 | 5,224 | 5,219 | 5,219 | **5,207** | **0,584** |
| Zinc Phosphate 4 | 4,783 | 4,783 | 4,782 | **4,783** | 5,427 | 5,423 | 5,423 | 5,325 | 5,327 | 5,329 | 5,323 | 5,323 | 5,323 | 5,405 | 5,405 | 5,403 | **5,370** | **0,587** |
| Zinc Phosphate 5 | 4,787 | 4,789 | 4,788 | **4,788** | 5,338 | 5,340 | 5,338 | 5,387 | 5,384 | 5,383 | 5,386 | 5,387 | 5,385 | 5,369 | 5,369 | 5,367 | **5,369** | **0,581** |

### Table 6.2. Seven days recorded heights and reference points of five samples of Zinc phosphate cement at pH 4.0 (mm).

| pH 4 Beginning | Middle of cement | | | Mean | Upper acrylic reference point | | | Right acrylic reference point | | | Down acrylic reference point | | | Left acrylic reference point | | | Mean | Different |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Zinc Phosphate 1** | 5,339 | 5,339 | 5,342 | **5,340** | 5,312 | 5,314 | 5,315 | 5,293 | 5,288 | 5,288 | 5,278 | 5,279 | 5,275 | 5,307 | 5,311 | 5,313 | **5,298** | **-0,042** |
| **Zinc Phosphate 2** | 5,385 | 5,388 | 5,388 | **5,387** | 5,313 | 5,310 | 5,307 | 5,349 | 5,346 | 5,343 | 5,338 | 5,340 | 5,342 | 5,302 | 5,306 | 5,306 | **5,325** | **-0,062** |
| **Zinc Phosphate 3** | 5,344 | 5,343 | 5,341 | **5,343** | 5,399 | 5,295 | 5,296 | 5,272 | 5,269 | 5,274 | 5,291 | 5,295 | 5,293 | 5,322 | 5,328 | 5,321 | **5,305** | **-0,038** |
| **Zinc Phosphate 4** | 5,306 | 5,305 | 5,303 | **5,305** | 5,276 | 5,281 | 5,277 | 5,268 | 5,264 | 5,268 | 5,277 | 5,277 | 5,278 | 5,290 | 5,290 | 5,288 | **5,278** | **-0,027** |
| **Zinc Phosphate 5** | 5,275 | 5,275 | 5,274 | **5,275** | 5,239 | 5,232 | 5,232 | 5,229 | 5,229 | 5,231 | 5,236 | 5,236 | 5,237 | 5,243 | 5,240 | 5,245 | **5,236** | **-0,039** |
| **pH 4 1.Day** | | | | | | | | | | | | | | | | | | |
| **Zinc Phosphate 1** | 5,299 | 5,301 | 5,290 | **5,297** | 5,320 | 5,325 | 5,322 | 5,306 | 5,308 | 5,299 | 5,298 | 5,293 | 5,285 | 5,324 | 5,308 | 5,308 | **5,308** | **0,011** |
| **Zinc Phosphate 2** | 5,343 | 5,345 | 5,344 | **5,344** | 5,317 | 5,317 | 5,306 | 5,350 | 5,354 | 5,350 | 5,350 | 5,353 | 5,347 | 5,316 | 5,318 | 5,312 | **5,333** | **-0,012** |
| **Zinc Phosphate 3** | 5,501 | 5,300 | 5,299 | **5,367** | 5,305 | 5,297 | 5,303 | 5,280 | 5,280 | 5,277 | 5,297 | 5,302 | 5,301 | 5,329 | 5,330 | 5,331 | **5,303** | **-0,064** |
| **Zinc Phosphate 4** | 5,260 | 5,257 | 5,254 | **5,257** | 5,272 | 5,272 | 5,275 | 5,263 | 5,266 | 5,261 | 5,277 | 5,275 | 5,277 | 5,287 | 5,284 | 5,283 | **5,274** | **0,017** |
| **Zinc Phosphate 5** | 5,222 | 5,219 | 5,223 | **5,221** | 5,237 | 5,236 | 5,234 | 5,226 | 5,226 | 5,223 | 5,229 | 5,229 | 5,231 | 5,240 | 5,240 | 5,243 | **5,233** | **0,011** |
| **pH 4 2.Day** | | | | | | | | | | | | | | | | | | |
| **Zinc Phosphate 1** | 5,240 | 5,242 | 5,242 | **5,241** | 5,331 | 5,326 | 5,321 | 5,306 | 5,309 | 5,305 | 5,383 | 5,284 | 5,290 | 5,318 | 5,317 | 5,218 | **5,309** | **0,068** |
| **Zinc Phosphate 2** | 5,394 | 5,397 | 5,299 | **5,363** | 5,319 | 5,319 | 5,318 | 5,368 | 5,358 | 5,358 | 5,352 | 5,343 | 5,356 | 5,316 | 5,305 | 5,310 | **5,335** | **-0,028** |
| **Zinc Phosphate 3** | 5,245 | 5,246 | 5,245 | **5,245** | 5,301 | 5,300 | 5,301 | 5,279 | 5,278 | 5,274 | 5,303 | 5,298 | 5,302 | 5,333 | 5,228 | 5,335 | **5,294** | **0,049** |
| **Zinc Phosphate 4** | 5,210 | 5,213 | 5,215 | **5,213** | 5,287 | 5,291 | 5,290 | 5,273 | 5,275 | 5,270 | 5,289 | 5,292 | 5,284 | 5,304 | 5,300 | 5,299 | **5,288** | **0,075** |
| **Zinc Phosphate 5** | 5,164 | 5,167 | 5,266 | **5,199** | 5,240 | 5,247 | 5,242 | 5,235 | 5,230 | 5,233 | 5,242 | 5,236 | 5,236 | 5,250 | 5,243 | 5,249 | **5,240** | **0,041** |
| **pH 4 3.Day** | | | | | | | | | | | | | | | | | | |
| **Zinc Phosphate 1** | 5,208 | 5,207 | 5,209 | **5,208** | 5,331 | 5,329 | 5,332 | 5,311 | 5,307 | 5,307 | 5,297 | 5,293 | 5,294 | 5,322 | 5,322 | 5,323 | **5,314** | **0,106** |
| **Zinc Phosphate 2** | 5,259 | 5,256 | 5,255 | **5,257** | 5,317 | 5,317 | 5,321 | 5,352 | 5,350 | 5,353 | 5,352 | 5,350 | 5,352 | 5,316 | 5,309 | 5,316 | **5,334** | **0,077** |
| **Zinc Phosphate 3** | 5,220 | 5,220 | 5,220 | **5,220** | 5,310 | 5,312 | 5,307 | 5,288 | 5,287 | 5,290 | 5,308 | 5,307 | 5,311 | 5,340 | 5,337 | 5,342 | **5,312** | **0,092** |
| **Zinc Phosphate 4** | 5,173 | 5,168 | 5,169 | **5,170** | 5,291 | 5,285 | 5,288 | 5,270 | 5,270 | 5,269 | 5,288 | 5,287 | 5,286 | 5,305 | 5,303 | 5,305 | **5,287** | **0,117** |
| **Zinc Phosphate 5** | 5,145 | 5,149 | 5,150 | **5,148** | 5,249 | 5,246 | 5,240 | 5,232 | 5,238 | 5,238 | 5,241 | 5,248 | 5,246 | 5,253 | 5,257 | 5,256 | **5,245** | **0,097** |
| **pH 4 4.Day** | | | | | | | | | | | | | | | | | | |
| **Zinc Phosphate 1** | 5,180 | 5,178 | 5,174 | **5,177** | 5,333 | 5,336 | 5,336 | 5,316 | 5,315 | 5,311 | 5,300 | 5,302 | 5,299 | 5,325 | 5,328 | 5,324 | **5,319** | **0,141** |
| **Zinc Phosphate 2** | 5,233 | 5,232 | 5,230 | **5,232** | 5,334 | 5,334 | 5,329 | 5,360 | 5,365 | 5,362 | 5,360 | 5,362 | 5,362 | 5,321 | 5,324 | 5,324 | **5,345** | **0,113** |
| **Zinc Phosphate 3** | 5,189 | 5,190 | 5,188 | **5,189** | 5,312 | 5,311 | 5,312 | 5,288 | 5,288 | 5,289 | 5,307 | 5,307 | 5,306 | 5,335 | 5,335 | 5,335 | **5,310** | **0,121** |
| **Zinc Phosphate 4** | 5,136 | 5,134 | 5,135 | **5,135** | 5,285 | 5,283 | 5,290 | 5,271 | 5,269 | 5,270 | 5,284 | 5,285 | 5,285 | 5,296 | 5,296 | 5,299 | **5,284** | **0,149** |
| **Zinc Phosphate 5** | 5,115 | 5,110 | 5,106 | **5,110** | 5,242 | 5,247 | 5,253 | 5,237 | 5,234 | 5,229 | 5,241 | 5,238 | 5,236 | 5,250 | 5,247 | 5,245 | **5,242** | **0,131** |
| **pH 4 5.Day** | | | | | | | | | | | | | | | | | | |
| **Zinc Phosphate 1** | 5,151 | 5,147 | 5,148 | **5,149** | 5,329 | 5,334 | 5,334 | 5,300 | 5,309 | 5,306 | 5,297 | 5,300 | 5,296 | 5,326 | 5,321 | 5,318 | **5,314** | **0,166** |
| **Zinc Phosphate 2** | 5,216 | 5,213 | 5,210 | **5,213** | 5,324 | 5,323 | 5,330 | 5,354 | 5,355 | 5,356 | 5,351 | 5,353 | 5,353 | 5,317 | 5,314 | 5,318 | **5,337** | **0,124** |
| **Zinc Phosphate 3** | 5,167 | 5,169 | 5,168 | **5,168** | 5,308 | 5,310 | 5,308 | 5,284 | 5,286 | 5,286 | 5,305 | 5,306 | 5,307 | 5,334 | 5,334 | 5,334 | **5,309** | **0,141** |
| **Zinc Phosphate 4** | 5,111 | 5,110 | 5,107 | **5,109** | 5,287 | 5,290 | 5,285 | 5,272 | 5,274 | 5,279 | 5,289 | 5,283 | 5,290 | 5,300 | 5,296 | 5,300 | **5,287** | **0,178** |
| **Zinc Phosphate 5** | 5,088 | 5,088 | 5,087 | **5,088** | 5,242 | 5,243 | 5,245 | 5,233 | 5,231 | 5,231 | 5,239 | 5,238 | 5,237 | 5,249 | 5,248 | 5,247 | **5,240** | **0,153** |
| **pH 4 6.Day** | | | | | | | | | | | | | | | | | | |
| **Zinc Phosphate 1** | 5,130 | 5,117 | 5,114 | **5,120** | 5,325 | 5,329 | 5,328 | 5,309 | 5,307 | 5,308 | 5,293 | 5,293 | 5,296 | 5,317 | 5,314 | 5,320 | **5,312** | **0,191** |
| **Zinc Phosphate 2** | 5,171 | 5,169 | 5,170 | **5,170** | 5,322 | 5,322 | 5,320 | 5,355 | 5,356 | 5,353 | 5,352 | 5,351 | 5,351 | 5,315 | 5,315 | 5,312 | **5,335** | **0,165** |
| **Zinc Phosphate 3** | 5,144 | 5,141 | 5,139 | **5,141** | 5,312 | 5,315 | 5,313 | 5,290 | 5,293 | 5,291 | 5,311 | 5,312 | 5,310 | 5,339 | 5,339 | 5,340 | **5,314** | **0,172** |
| **Zinc Phosphate 4** | 5,085 | 5,083 | 5,084 | **5,084** | 5,285 | 5,285 | 5,287 | 5,272 | 5,272 | 5,272 | 5,288 | 5,287 | 5,286 | 5,301 | 5,299 | 5,298 | **5,286** | **0,202** |
| **Zinc Phosphate 5** | 5,072 | 5,068 | 5,067 | **5,069** | 5,248 | 5,249 | 5,248 | 5,235 | 5,236 | 5,236 | 5,241 | 5,242 | 5,243 | 5,251 | 5,251 | 5,252 | **5,244** | **0,175** |
| **pH 4 7.Day** | | | | | | | | | | | | | | | | | | |
| **Zinc Phosphate 1** | 5,101 | 5,106 | 5,112 | **5,106** | 5,328 | 5,335 | 5,330 | 5,304 | 5,313 | 5,307 | 5,284 | 5,295 | 5,291 | 5,314 | 5,322 | 5,319 | **5,312** | **0,206** |
| **Zinc Phosphate 2** | 5,158 | 5,153 | 5,154 | **5,155** | 5,325 | 5,326 | 5,326 | 5,356 | 5,358 | 5,357 | 5,355 | 5,356 | 5,355 | 5,316 | 5,317 | 5,317 | **5,339** | **0,184** |
| **Zinc Phosphate 3** | 5,134 | 5,134 | 5,137 | **5,135** | 5,314 | 5,315 | 5,314 | 5,293 | 5,294 | 5,292 | 5,311 | 5,312 | 5,310 | 5,340 | 5,341 | 5,340 | **5,315** | **0,180** |
| **Zinc Phosphate 4** | 5,064 | 5,061 | 5,059 | **5,061** | 5,288 | 5,288 | 5,295 | 5,278 | 5,274 | 5,275 | 5,289 | 5,288 | 5,287 | 5,303 | 5,301 | 5,300 | **5,289** | **0,228** |
| **Zinc Phosphate 5** | 5,052 | 5,052 | 5,047 | **5,050** | 5,248 | 5,247 | 5,247 | 5,234 | 5,235 | 5,235 | 5,242 | 5,242 | 5,242 | 5,252 | 5,250 | 5,252 | **5,244** | **0,193** |

## Table 6.3. Seven days recorded heights and reference points of five samples of Multi cure glass ionomer cement at pH 2.74 (mm).

| pH 2,74 Beginning | Middle of cement | | | Mean | Upper acrylic reference point | | | Right acrylic reference point | | | Down acrylic reference point | | | Left acrylic reference point | | | Mean | Different |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Multi C.G.I 1** | 5,257 | 5,251 | 5,252 | **5,253** | 5,248 | 5,245 | 5,243 | 5,241 | 5,242 | 5,243 | 5,234 | 5,234 | 5,234 | 5,215 | 5,226 | 5,218 | **5,235** | **-0,018** |
| **Multi C.G.I 2** | 5,209 | 5,206 | 5,201 | **5,205** | 5,207 | 5,201 | 5,209 | 5,162 | 5,184 | 5,183 | 5,166 | 5,198 | 5,201 | 5,163 | 5,191 | 5,191 | **5,188** | **-0,017** |
| **Multi C.G.I 3** | 5,161 | 5,165 | 5,166 | **5,164** | 5,165 | 5,171 | 5,159 | 5,176 | 5,179 | 5,176 | 5,177 | 5,174 | 5,172 | 5,166 | 5,164 | 5,171 | **5,171** | **0,007** |
| **Multi C.G.I 4** | 5,171 | 5,170 | 5,171 | **5,171** | 5,204 | 5,198 | 5,195 | 5,198 | 5,191 | 5,203 | 5,212 | 5,216 | 5,211 | 5,208 | 5,210 | 5,206 | **5,204** | **0,034** |
| **Multi C.G.I 5** | 5,174 | 5,177 | 5,173 | **5,175** | 5,230 | 5,231 | 5,220 | 5,233 | 5,234 | 5,225 | 5,218 | 5,219 | 5,210 | 5,207 | 5,207 | 5,206 | **5,220** | **0,045** |
| **pH 2,74 1.Day** | | | | | | | | | | | | | | | | | | |
| **Multi C.G.I 1** | 5,254 | 5,253 | 5,248 | **5,252** | 5,225 | 5,227 | 5,229 | 5,216 | 5,210 | 5,213 | 5,215 | 5,217 | 5,216 | 5,215 | 5,214 | 5,211 | **5,217** | **-0,034** |
| **Multi C.G.I 2** | 5,210 | 5,205 | 5,205 | **5,207** | 5,192 | 5,192 | 5,193 | 5,166 | 5,166 | 5,167 | 5,177 | 5,181 | 5,171 | 5,171 | 5,172 | 5,169 | **5,176** | **-0,030** |
| **Multi C.G.I 3** | 5,201 | 5,201 | 5,202 | **5,201** | 5,167 | 5,168 | 5,178 | 5,178 | 5,178 | 5,176 | 5,180 | 5,174 | 5,172 | 5,170 | 5,167 | 5,161 | **5,172** | **-0,029** |
| **Multi C.G.I 4** | 5,185 | 5,186 | 5,183 | **5,185** | 5,196 | 5,202 | 5,192 | 5,193 | 5,200 | 5,194 | 5,208 | 5,211 | 5,207 | 5,200 | 5,204 | 5,203 | **5,201** | **0,016** |
| **Multi C.G.I 5** | 5,237 | 5,232 | 5,232 | **5,234** | 5,242 | 5,242 | 5,246 | 5,256 | 5,250 | 5,248 | 5,234 | 5,230 | 5,224 | 5,225 | 5,220 | 5,219 | **5,236** | **0,003** |
| **pH 2,74 2.Day** | | | | | | | | | | | | | | | | | | |
| **Multi C.G.I 1** | 5,256 | 5,261 | 5,260 | **5,259** | 5,238 | 5,235 | 5,232 | 5,220 | 5,228 | 5,226 | 5,214 | 5,223 | 5,228 | 5,214 | 5,220 | 5,220 | **5,225** | **-0,034** |
| **Multi C.G.I 2** | 5,215 | 5,221 | 5,220 | **5,219** | 5,211 | 5,211 | 5,204 | 5,181 | 5,175 | 5,182 | 5,181 | 5,182 | 5,183 | 5,178 | 5,181 | 5,177 | **5,187** | **-0,032** |
| **Multi C.G.I 3** | 5,220 | 5,217 | 5,217 | **5,218** | 5,181 | 5,181 | 5,175 | 5,187 | 5,189 | 5,190 | 5,188 | 5,187 | 5,188 | 5,170 | 5,179 | 5,184 | **5,183** | **-0,035** |
| **Multi C.G.I 4** | 5,191 | 5,190 | 5,187 | **5,189** | 5,204 | 5,206 | 5,206 | 5,209 | 5,208 | 5,206 | 5,219 | 5,221 | 5,218 | 5,214 | 5,215 | 5,213 | **5,212** | **0,022** |
| **Multi C.G.I 5** | 5,252 | 5,251 | 5,254 | **5,252** | 5,267 | 5,263 | 5,262 | 5,266 | 5,268 | 5,268 | 5,251 | 5,246 | 5,253 | 5,235 | 5,241 | 5,247 | **5,256** | **0,003** |
| **pH 2,74 3.Day** | | | | | | | | | | | | | | | | | | |
| **Multi C.G.I 1** | 5,253 | 5,259 | 5,259 | **5,257** | 5,235 | 5,229 | 5,230 | 5,218 | 5,213 | 5,220 | 5,213 | 5,213 | 5,212 | 5,210 | 5,212 | 5,216 | **5,218** | **-0,039** |
| **Multi C.G.I 2** | 5,213 | 5,216 | 5,217 | **5,215** | 5,198 | 5,197 | 5,194 | 5,170 | 5,171 | 5,177 | 5,176 | 5,181 | 5,184 | 5,169 | 5,171 | 5,176 | **5,180** | **-0,035** |
| **Multi C.G.I 3** | 5,222 | 5,222 | 5,223 | **5,222** | 5,180 | 5,180 | 5,178 | 5,191 | 5,191 | 5,193 | 5,183 | 5,187 | 5,184 | 5,174 | 5,175 | 5,177 | **5,183** | **-0,040** |
| **Multi C.G.I 4** | 5,186 | 5,186 | 5,187 | **5,186** | 5,203 | 5,204 | 5,199 | 5,204 | 5,200 | 5,199 | 5,217 | 5,208 | 5,212 | 5,212 | 5,210 | 5,211 | **5,207** | **0,020** |
| **Multi C.G.I 5** | 5,246 | 5,246 | 5,238 | **5,243** | 5,242 | 5,240 | 5,246 | 5,255 | 5,248 | 5,248 | 5,235 | 5,231 | 5,227 | 5,219 | 5,221 | 5,225 | **5,236** | **-0,007** |
| **pH 2,74 4.Day** | | | | | | | | | | | | | | | | | | |
| **Multi C.G.I 1** | 5,260 | 5,260 | 5,259 | **5,260** | 5,235 | 5,234 | 5,234 | 5,220 | 5,221 | 5,221 | 5,229 | 5,229 | 5,226 | 5,218 | 5,218 | 5,219 | **5,225** | **-0,034** |
| **Multi C.G.I 2** | 5,211 | 5,209 | 5,208 | **5,209** | 5,203 | 5,202 | 5,203 | 5,174 | 5,172 | 5,174 | 5,186 | 5,181 | 5,188 | 5,178 | 5,178 | 5,177 | **5,185** | **-0,025** |
| **Multi C.G.I 3** | 5,216 | 5,217 | 5,216 | **5,216** | 5,181 | 5,181 | 5,178 | 5,190 | 5,192 | 5,192 | 5,187 | 5,188 | 5,188 | 5,177 | 5,177 | 5,178 | **5,184** | **-0,032** |
| **Multi C.G.I 4** | 5,189 | 5,190 | 5,190 | **5,190** | 5,208 | 5,206 | 5,207 | 5,205 | 5,206 | 5,206 | 5,219 | 5,220 | 5,219 | 5,212 | 5,214 | 5,213 | **5,211** | **0,022** |
| **Multi C.G.I 5** | 5,251 | 5,251 | 5,252 | **5,251** | 5,253 | 5,252 | 5,252 | 5,262 | 5,263 | 5,263 | 5,242 | 5,243 | 5,245 | 5,233 | 5,233 | 5,235 | **5,248** | **-0,003** |
| **pH 2,74 5.Day** | | | | | | | | | | | | | | | | | | |
| **Multi C.G.I 1** | 5,261 | 5,261 | 5,260 | **5,261** | 5,236 | 5,235 | 5,236 | 5,221 | 5,223 | 5,220 | 5,231 | 5,224 | 5,223 | 5,224 | 5,221 | 5,225 | **5,227** | **-0,034** |
| **Multi C.G.I 2** | 5,219 | 5,215 | 5,213 | **5,216** | 5,197 | 5,202 | 5,202 | 5,175 | 5,188 | 5,171 | 5,184 | 5,187 | 5,181 | 5,180 | 5,179 | 5,174 | **5,185** | **-0,031** |
| **Multi C.G.I 3** | 5,226 | 5,224 | 5,225 | **5,225** | 5,181 | 5,181 | 5,181 | 5,192 | 5,193 | 5,194 | 5,188 | 5,189 | 5,190 | 5,178 | 5,179 | 5,180 | **5,186** | **-0,040** |
| **Multi C.G.I 4** | 5,192 | 5,192 | 5,192 | **5,192** | 5,208 | 5,208 | 5,208 | 5,207 | 5,207 | 5,207 | 5,220 | 5,220 | 5,220 | 5,214 | 5,214 | 5,214 | **5,212** | **0,020** |
| **Multi C.G.I 5** | 5,250 | 5,249 | 5,249 | **5,249** | 5,255 | 5,255 | 5,254 | 5,260 | 5,263 | 5,261 | 5,244 | 5,244 | 5,245 | 5,233 | 5,234 | 5,234 | **5,249** | **-0,001** |
| **pH 2,74 6.Day** | | | | | | | | | | | | | | | | | | |
| **Multi C.G.I 1** | 5,252 | 5,252 | 5,251 | **5,252** | 5,236 | 5,235 | 5,235 | 5,224 | 5,226 | 5,223 | 5,227 | 5,220 | 5,225 | 5,217 | 5,218 | 5,218 | **5,225** | **-0,026** |
| **Multi C.G.I 2** | 5,208 | 5,208 | 5,207 | **5,208** | 5,205 | 5,205 | 5,204 | 5,176 | 5,175 | 5,176 | 5,179 | 5,184 | 5,184 | 5,175 | 5,176 | 5,178 | **5,185** | **-0,023** |
| **Multi C.G.I 3** | 5,212 | 5,213 | 5,212 | **5,212** | 5,182 | 5,182 | 5,182 | 5,194 | 5,194 | 5,195 | 5,190 | 5,191 | 5,191 | 5,180 | 5,180 | 5,181 | **5,187** | **-0,026** |
| **Multi C.G.I 4** | 5,184 | 5,183 | 5,185 | **5,184** | 5,212 | 5,212 | 5,211 | 5,211 | 5,212 | 5,212 | 5,224 | 5,225 | 5,226 | 5,218 | 5,218 | 5,218 | **5,217** | **0,033** |
| **Multi C.G.I 5** | 5,240 | 5,244 | 5,244 | **5,243** | 5,257 | 5,256 | 5,256 | 5,265 | 5,266 | 5,266 | 5,243 | 5,243 | 5,243 | 5,236 | 5,237 | 5,238 | **5,251** | **0,008** |
| **pH 2,74 7.Day** | | | | | | | | | | | | | | | | | | |
| **Multi C.G.I 1** | 5,259 | 5,258 | 5,256 | **5,258** | 5,239 | 5,239 | 5,238 | 5,226 | 5,229 | 5,225 | 5,221 | 5,222 | 5,222 | 5,225 | 5,227 | 5,221 | **5,228** | **-0,03** |
| **Multi C.G.I 2** | 5,209 | 5,207 | 5,205 | **5,207** | 5,201 | 5,200 | 5,200 | 5,178 | 5,177 | 5,178 | 5,187 | 5,185 | 5,185 | 5,184 | 5,182 | 5,180 | **5,186** | **-0,021** |
| **Multi C.G.I 3** | 5,219 | 5,219 | 5,218 | **5,219** | 5,188 | 5,187 | 5,186 | 5,198 | 5,199 | 5,199 | 5,193 | 5,193 | 5,193 | 5,185 | 5,184 | 5,185 | **5,191** | **-0,028** |
| **Multi C.G.I 4** | 5,183 | 5,185 | 5,183 | **5,184** | 5,213 | 5,213 | 5,212 | 5,212 | 5,212 | 5,211 | 5,223 | 5,223 | 5,223 | 5,218 | 5,219 | 5,219 | **5,217** | **0,033** |
| **Multi C.G.I 5** | 5,241 | 5,240 | 5,242 | **5,241** | 5,263 | 5,259 | 5,257 | 5,266 | 5,266 | 5,270 | 5,248 | 5,245 | 5,248 | 5,236 | 5,243 | 5,242 | **5,254** | **0,013** |

## Table 6.4. Seven days recorded heights and reference points of five samples of Multi cure glass ionomer cement at pH 4.0 (mm).

| pH 4 Beginning | Middle of cement | | | Mean | Upper acrylic reference point | | | Right acrylic reference point | | | Down acrylic reference point | | | Left acrylic reference point | | | Mean | Different |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Multi C.G.I 1 | 5,108 | 5,109 | 5,117 | **5,111** | 5,147 | 5,146 | 5,150 | 5,165 | 5,150 | 5,166 | 5,178 | 5,163 | 5,151 | 5,137 | 5,145 | 5,146 | **5,154** | **0,042** |
| Multi C.G.I 2 | 5,320 | 5,324 | 5,283 | **5,309** | 5,310 | 5,341 | 5,349 | 5,338 | 5,301 | 5,286 | 5,345 | 5,330 | 5,329 | 5,342 | 5,319 | 5,308 | **5,325** | **0,016** |
| Multi C.G.I 3 | 5,213 | 5,217 | 5,211 | **5,214** | 5,204 | 5,208 | 5,203 | 5,224 | 5,208 | 5,209 | 5,207 | 5,207 | 5,215 | 5,210 | 5,195 | 5,204 | **5,208** | **-0,006** |
| Multi C.G.I 4 | 5,284 | 5,283 | 5,287 | **5,285** | 5,310 | 5,310 | 5,303 | 5,302 | 5,303 | 5,320 | 5,297 | 5,298 | 5,303 | 5,299 | 5,295 | 5,290 | **5,303** | **0,018** |
| Multi C.G.I 5 | 5,238 | 5,233 | 5,243 | **5,238** | 5,245 | 5,239 | 5,244 | 5,235 | 5,224 | 5,223 | 5,225 | 5,220 | 5,232 | 5,215 | 5,221 | 5,224 | **5,229** | **-0,009** |
| **pH 4 1.Day** | | | | | | | | | | | | | | | | | | |
| Multi C.G.I 1 | 5,137 | 5,138 | 5,139 | **5,138** | 5,162 | 5,166 | 5,159 | 5,161 | 5,165 | 5,166 | 5,171 | 5,175 | 5,170 | 5,149 | 5,150 | 5,148 | **5,162** | **0,024** |
| Multi C.G.I 2 | 5,303 | 5,302 | 5,299 | **5,301** | 5,309 | 5,311 | 5,310 | 5,302 | 5,303 | 5,302 | 5,326 | 5,323 | 5,326 | 5,327 | 5,326 | 5,324 | **5,316** | **0,014** |
| Multi C.G.I 3 | 5,216 | 5,214 | 5,216 | **5,215** | 5,214 | 5,211 | 5,213 | 5,224 | 5,221 | 5,222 | 5,213 | 5,212 | 5,212 | 5,212 | 5,212 | 5,212 | **5,215** | **0,000** |
| Multi C.G.I 4 | 5,284 | 5,286 | 5,289 | **5,286** | 5,314 | 5,310 | 5,305 | 5,309 | 5,311 | 5,315 | 5,287 | 5,295 | 5,292 | 5,286 | 5,290 | 5,290 | **5,300** | **0,014** |
| Multi C.G.I 5 | 5,245 | 5,247 | 5,249 | **5,247** | 5,253 | 5,249 | 5,243 | 5,242 | 5,241 | 5,247 | 5,229 | 5,230 | 5,231 | 5,224 | 5,228 | 5,225 | **5,237** | **-0,010** |
| **pH 4 2.Day** | | | | | | | | | | | | | | | | | | |
| Multi C.G.I 1 | 5,142 | 5,142 | 5,137 | **5,140** | 5,158 | 5,162 | 5,160 | 5,163 | 5,166 | 5,163 | 5,166 | 5,163 | 5,171 | 5,146 | 5,144 | 5,144 | **5,159** | **0,018** |
| Multi C.G.I 2 | 5,306 | 5,307 | 5,308 | **5,307** | 5,314 | 5,312 | 5,308 | 5,305 | 5,307 | 5,308 | 5,331 | 5,335 | 5,335 | 5,330 | 5,331 | 5,333 | **5,321** | **0,014** |
| Multi C.G.I 3 | 5,223 | 5,225 | 5,226 | **5,225** | 5,225 | 5,223 | 5,220 | 5,229 | 5,229 | 5,232 | 5,217 | 5,218 | 5,217 | 5,219 | 5,220 | 5,217 | **5,222** | **-0,003** |
| Multi C.G.I 4 | 5,294 | 5,294 | 5,297 | **5,295** | 5,322 | 5,320 | 5,311 | 5,317 | 5,324 | 5,327 | 5,295 | 5,298 | 6,302 | 5,293 | 5,296 | 5,300 | **5,392** | **0,097** |
| Multi C.G.I 5 | 5,243 | 5,252 | 5,253 | **5,249** | 5,259 | 5,257 | 5,255 | 5,251 | 5,247 | 5,248 | 5,234 | 5,226 | 5,231 | 5,231 | 5,238 | 5,325 | **5,250** | **0,001** |
| **pH 4 3.Day** | | | | | | | | | | | | | | | | | | |
| Multi C.G.I 1 | 5,144 | 5,145 | 5,148 | **5,146** | 5,166 | 5,162 | 5,159 | 5,163 | 5,169 | 5,170 | 5,165 | 5,170 | 5,174 | 5,140 | 5,148 | 5,149 | **5,161** | **0,016** |
| Multi C.G.I 2 | 5,309 | 5,303 | 5,298 | **5,303** | 5,311 | 5,314 | 5,317 | 5,309 | 5,301 | 5,302 | 5,337 | 5,333 | 5,334 | 5,333 | 5,327 | 5,326 | **5,320** | **0,017** |
| Multi C.G.I 3 | 5,222 | 5,221 | 5,217 | **5,220** | 5,210 | 5,212 | 5,217 | 5,221 | 5,222 | 5,212 | 5,215 | 5,211 | 5,204 | 5,211 | 5,211 | 5,207 | **5,213** | **-0,007** |
| Multi C.G.I 4 | 5,292 | 5,293 | 5,288 | **5,291** | 5,310 | 5,314 | 5,311 | 5,311 | 5,316 | 5,304 | 5,290 | 5,293 | 5,289 | 5,292 | 5,289 | 5,283 | **5,300** | **0,009** |
| Multi C.G.I 5 | 5,243 | 5,248 | 5,250 | **5,247** | 5,254 | 5,250 | 5,245 | 5,244 | 5,238 | 5,247 | 5,237 | 5,235 | 5,233 | 5,226 | 5,231 | 5,230 | **5,239** | **-0,008** |
| **pH 4 4.Day** | | | | | | | | | | | | | | | | | | |
| Multi C.G.I 1 | 5,148 | 5,149 | 5,147 | **5,148** | 5,161 | 5,162 | 5,161 | 5,166 | 5,167 | 5,165 | 5,168 | 5,169 | 5,168 | 5,149 | 5,148 | 5,149 | **5,161** | **0,013** |
| Multi C.G.I 2 | 5,307 | 5,308 | 5,307 | **5,307** | 5,314 | 5,313 | 5,312 | 5,304 | 5,304 | 5,306 | 5,328 | 5,332 | 5,329 | 5,330 | 5,332 | 5,330 | **5,320** | **0,012** |
| Multi C.G.I 3 | 5,221 | 5,222 | 5,221 | **5,221** | 5,216 | 5,216 | 5,215 | 5,223 | 5,223 | 5,225 | 5,215 | 5,215 | 5,215 | 5,210 | 5,214 | 5,213 | **5,217** | **-0,005** |
| Multi C.G.I 4 | 5,292 | 5,292 | 5,294 | **5,293** | 5,318 | 5,316 | 5,310 | 5,316 | 5,316 | 5,319 | 5,293 | 5,294 | 5,296 | 5,291 | 5,292 | 5,294 | **5,305** | **0,012** |
| Multi C.G.I 5 | 5,250 | 5,249 | 5,247 | **5,249** | 5,253 | 5,253 | 5,251 | 5,244 | 5,246 | 5,246 | 5,237 | 5,238 | 5,241 | 5,230 | 5,230 | 5,233 | **5,242** | **-0,007** |
| **pH 4 5.Day** | | | | | | | | | | | | | | | | | | |
| Multi C.G.I 1 | 5,148 | 5,145 | 5,145 | **5,146** | 5,163 | 5,163 | 5,164 | 5,167 | 5,167 | 5,167 | 5,171 | 5,170 | 5,170 | 5,149 | 5,149 | 5,150 | **5,163** | **0,016** |
| Multi C.G.I 2 | 5,312 | 5,314 | 5,313 | **5,313** | 5,317 | 5,315 | 5,313 | 5,308 | 5,307 | 5,306 | 5,333 | 5,332 | 5,332 | 5,334 | 5,334 | 5,332 | **5,322** | **0,009** |
| Multi C.G.I 3 | 5,221 | 5,222 | 5,222 | **5,222** | 5,216 | 5,216 | 5,216 | 5,223 | 5,224 | 5,225 | 5,214 | 5,215 | 5,215 | 5,212 | 5,212 | 5,213 | **5,217** | **-0,005** |
| Multi C.G.I 4 | 5,307 | 5,307 | 5,309 | **5,308** | 5,336 | 5,337 | 5,334 | 5,334 | 5,334 | 5,334 | 5,305 | 5,307 | 5,307 | 5,305 | 5,307 | 5,305 | **5,320** | **0,013** |
| Multi C.G.I 5 | 5,249 | 5,246 | 5,247 | **5,247** | 5,253 | 5,252 | 5,251 | 5,243 | 5,245 | 5,245 | 5,224 | 5,225 | 5,228 | 5,229 | 5,229 | 5,231 | **5,238** | **-0,009** |
| **pH 4 6.Day** | | | | | | | | | | | | | | | | | | |
| Multi C.G.I 1 | 5,140 | 5,141 | 5,140 | **5,140** | 5,163 | 5,164 | 5,164 | 5,168 | 5,169 | 5,170 | 5,171 | 5,170 | 5,171 | 5,151 | 5,151 | 5,149 | **5,163** | **0,023** |
| Multi C.G.I 2 | 5,311 | 5,312 | 5,313 | **5,312** | 5,319 | 5,319 | 5,319 | 5,311 | 5,311 | 5,310 | 5,338 | 5,339 | 5,337 | 5,339 | 5,338 | 5,338 | **5,327** | **0,014** |
| Multi C.G.I 3 | 5,222 | 5,222 | 5,222 | **5,222** | 5,220 | 5,221 | 5,221 | 5,230 | 5,229 | 5,229 | 5,219 | 5,219 | 5,218 | 5,217 | 5,217 | 5,215 | **5,221** | **-0,001** |
| Multi C.G.I 4 | 5,307 | 5,305 | 5,306 | **5,306** | 5,337 | 5,337 | 5,338 | 5,341 | 5,339 | 5,340 | 5,310 | 5,311 | 5,310 | 5,312 | 5,310 | 5,312 | **5,325** | **0,019** |
| Multi C.G.I 5 | 5,242 | 5,243 | 5,243 | **5,243** | 5,257 | 5,256 | 5,256 | 5,252 | 5,252 | 5,253 | 5,229 | 5,234 | 5,237 | 5,235 | 5,235 | 5,230 | **5,244** | **0,001** |
| **pH 4 7.Day** | | | | | | | | | | | | | | | | | | |
| Multi C.G.I 1 | 5,152 | 5,152 | 5,150 | **5,151** | 5,166 | 5,166 | 5,166 | 5,171 | 5,171 | 5,170 | 5,175 | 5,175 | 5,173 | 5,152 | 5,152 | 5,150 | **5,166** | **0,014** |
| Multi C.G.I 2 | 5,310 | 5,307 | 5,306 | **5,308** | 5,317 | 5,318 | 5,318 | 5,315 | 5,316 | 5,315 | 5,337 | 5,338 | 5,338 | 5,336 | 5,335 | 5,337 | **5,327** | **0,019** |
| Multi C.G.I 3 | 5,217 | 5,218 | 5,217 | **5,217** | 5,220 | 5,222 | 5,223 | 5,229 | 5,229 | 5,229 | 5,220 | 5,220 | 5,220 | 5,219 | 5,217 | 5,217 | **5,222** | **0,005** |
| Multi C.G.I 4 | 5,300 | 5,301 | 5,300 | **5,300** | 5,341 | 5,337 | 5,341 | 5,339 | 5,338 | 5,339 | 5,313 | 5,312 | 5,314 | 5,309 | 5,310 | 5,310 | **5,325** | **0,025** |
| Multi C.G.I 5 | 5,246 | 5,246 | 5,246 | **5,246** | 5,257 | 5,257 | 5,256 | 5,247 | 5,248 | 5,247 | 5,228 | 5,222 | 5,227 | 5,228 | 5,231 | 5,232 | **5,240** | **-0,006** |

**Table 6.5. Seven days recorded heights and reference points of five samples of Ultra band LoK cement at pH 2.74 (mm).**

| pH 2,74 Beginning | Middle of cement | | | Mean | Upper acrylic reference point | | | Right acrylic reference point | | | Down acrylic reference point | | | Left acrylic reference point | | | Mean | Different |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ultra B.L 1 | 5,501 | 5,504 | 5,506 | **5,504** | 5,492 | 5,492 | 5,491 | 5,469 | 5,468 | 5,470 | 5,461 | 5,457 | 5,462 | 5,482 | 5,482 | 5,483 | **5,476** | **-0,028** |
| Ultra B.L 2 | 5,228 | 5,227 | 5,228 | **5,228** | 5,203 | 5,205 | 5,202 | 5,198 | 5,200 | 5,199 | 5,205 | 5,202 | 5,205 | 5,218 | 5,217 | 5,218 | **5,206** | **-0,022** |
| Ultra B.L 3 | 5,264 | 5,267 | 5,266 | **5,266** | 5,263 | 5,264 | 5,267 | 5,255 | 5,252 | 5,254 | 5,261 | 5,259 | 5,260 | 5,286 | 5,283 | 5,281 | **5,265** | **0,000** |
| Ultra B.L 4 | 5,234 | 5,231 | 5,230 | **5,232** | 5,208 | 5,208 | 5,208 | 5,220 | 5,221 | 5,221 | 5,187 | 5,191 | 5,189 | 5,204 | 5,205 | 5,202 | **5,205** | **-0,026** |
| Ultra B.L 5 | 5,295 | 5,292 | 5,292 | **5,293** | 5,295 | 5,299 | 5,297 | 5,292 | 5,291 | 5,291 | 5,285 | 5,282 | 5,282 | 5,291 | 5,291 | 5,292 | **5,291** | **-0,002** |
| pH 2,74 1.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,518 | 5,518 | 5,519 | **5,518** | 5,500 | 5,500 | 5,499 | 5,479 | 5,479 | 5,480 | 5,464 | 5,467 | 5,467 | 5,488 | 5,487 | 5,489 | **5,483** | **-0,035** |
| Ultra B.L 2 | 5,243 | 5,242 | 5,243 | **5,243** | 5,214 | 5,208 | 5,209 | 5,214 | 5,211 | 5,210 | 5,211 | 5,216 | 5,214 | 5,228 | 5,227 | 5,228 | **5,216** | **-0,027** |
| Ultra B.L 3 | 5,280 | 5,281 | 5,283 | **5,281** | 5,269 | 5,268 | 5,267 | 5,263 | 5,262 | 5,260 | 5,264 | 5,265 | 5,265 | 5,293 | 5,290 | 5,291 | **5,271** | **-0,010** |
| Ultra B.L 4 | 5,271 | 5,272 | 5,271 | **5,271** | 5,213 | 5,212 | 5,210 | 5,225 | 5,226 | 5,227 | 5,198 | 5,198 | 5,199 | 5,212 | 5,211 | 5,216 | **5,212** | **-0,059** |
| Ultra B.L 5 | 5,300 | 5,300 | 5,301 | **5,300** | 5,300 | 5,299 | 5,300 | 5,294 | 5,295 | 5,297 | 5,287 | 5,285 | 5,288 | 5,293 | 5,295 | 5,295 | **5,294** | **-0,006** |
| pH 2,74 2.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,525 | 5,526 | 5,524 | **5,525** | 5,505 | 5,505 | 5,505 | 5,485 | 5,484 | 5,484 | 5,467 | 5,470 | 5,471 | 5,493 | 5,492 | 5,492 | **5,488** | **-0,037** |
| Ultra B.L 2 | 5,244 | 5,246 | 5,246 | **5,245** | 5,216 | 5,214 | 5,216 | 5,213 | 5,214 | 5,214 | 5,214 | 5,214 | 5,215 | 5,233 | 5,234 | 5,233 | **5,219** | **-0,026** |
| Ultra B.L 3 | 5,276 | 5,275 | 5,278 | **5,276** | 5,256 | 5,257 | 5,256 | 5,255 | 5,255 | 5,256 | 5,262 | 5,262 | 5,263 | 5,282 | 5,281 | 5,282 | **5,264** | **-0,012** |
| Ultra B.L 4 | 5,281 | 5,283 | 5,280 | **5,281** | 5,220 | 5,220 | 5,217 | 5,233 | 5,233 | 5,234 | 5,204 | 5,208 | 5,208 | 5,215 | 5,216 | 5,216 | **5,219** | **-0,063** |
| Ultra B.L 5 | 5,309 | 5,309 | 5,309 | **5,309** | 5,310 | 5,308 | 5,308 | 5,303 | 5,303 | 5,303 | 5,293 | 5,290 | 5,290 | 5,302 | 5,305 | 5,304 | **5,302** | **-0,007** |
| pH 2,74 3.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,533 | 5,536 | 5,535 | **5,535** | 5,513 | 5,513 | 5,513 | 5,491 | 5,490 | 5,491 | 5,466 | 5,472 | 5,470 | 5,493 | 5,493 | 5,493 | **5,492** | **-0,043** |
| Ultra B.L 2 | 5,252 | 5,251 | 5,251 | **5,251** | 5,213 | 5,216 | 5,216 | 5,221 | 5,222 | 5,222 | 5,222 | 5,220 | 5,219 | 5,238 | 5,237 | 5,237 | **5,224** | **-0,028** |
| Ultra B.L 3 | 5,284 | 5,285 | 5,284 | **5,284** | 5,262 | 5,262 | 5,261 | 5,258 | 5,258 | 5,259 | 5,264 | 5,264 | 5,265 | 5,288 | 5,286 | 5,290 | **5,268** | **-0,016** |
| Ultra B.L 4 | 5,280 | 5,279 | 5,278 | **5,279** | 5,218 | 5,218 | 5,216 | 5,233 | 5,233 | 5,234 | 5,198 | 5,195 | 5,196 | 5,220 | 5,220 | 5,221 | **5,217** | **-0,062** |
| Ultra B.L 5 | 5,314 | 5,316 | 5,316 | **5,315** | 5,309 | 5,311 | 5,309 | 5,306 | 5,309 | 5,308 | 5,295 | 5,297 | 5,297 | 5,305 | 5,305 | 5,304 | **5,305** | **-0,011** |
| pH 2,74 4.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,534 | 5,536 | 5,533 | **5,534** | 5,510 | 5,512 | 5,512 | 5,490 | 5,488 | 5,489 | 5,468 | 5,472 | 5,472 | 5,496 | 5,495 | 5,493 | **5,491** | **-0,043** |
| Ultra B.L 2 | 5,253 | 5,252 | 5,252 | **5,252** | 5,223 | 5,226 | 5,227 | 5,221 | 5,222 | 5,221 | 5,220 | 5,221 | 5,220 | 5,241 | 5,241 | 5,241 | **5,227** | **-0,025** |
| Ultra B.L 3 | 5,284 | 5,285 | 5,283 | **5,284** | 5,264 | 5,264 | 5,262 | 5,260 | 5,260 | 5,260 | 5,267 | 5,267 | 5,267 | 5,289 | 5,288 | 5,287 | **5,270** | **-0,014** |
| Ultra B.L 4 | 5,284 | 5,285 | 5,284 | **5,284** | 5,225 | 5,226 | 5,224 | 5,238 | 5,238 | 5,235 | 5,208 | 5,205 | 5,209 | 5,220 | 5,222 | 5,220 | **5,223** | **-0,062** |
| Ultra B.L 5 | 5,315 | 5,316 | 5,317 | **5,316** | 5,315 | 5,313 | 5,312 | 5,307 | 5,307 | 5,307 | 5,292 | 5,290 | 5,290 | 5,306 | 5,306 | 5,306 | **5,304** | **-0,012** |
| pH 2,74 5.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,538 | 5,537 | 5,538 | **5,538** | 5,513 | 5,514 | 5,513 | 5,490 | 5,490 | 5,490 | 5,472 | 5,475 | 5,475 | 5,496 | 5,494 | 5,493 | **5,493** | **-0,045** |
| Ultra B.L 2 | 5,253 | 5,253 | 5,256 | **5,254** | 5,223 | 5,223 | 5,223 | 5,223 | 5,221 | 5,222 | 5,221 | 5,220 | 5,221 | 5,240 | 5,240 | 5,240 | **5,226** | **-0,028** |
| Ultra B.L 3 | 5,286 | 5,287 | 5,287 | **5,287** | 5,265 | 5,263 | 5,264 | 5,259 | 5,260 | 5,260 | 5,266 | 5,267 | 5,267 | 5,289 | 5,288 | 5,288 | **5,270** | **-0,017** |
| Ultra B.L 4 | 5,287 | 5,284 | 5,285 | **5,285** | 5,223 | 5,221 | 5,224 | 5,234 | 5,235 | 5,237 | 5,212 | 5,210 | 5,208 | 5,221 | 5,222 | 5,223 | **5,223** | **-0,063** |
| Ultra B.L 5 | 5,318 | 5,319 | 5,319 | **5,319** | 5,313 | 5,314 | 5,314 | 5,310 | 5,308 | 5,308 | 5,296 | 5,294 | 5,298 | 5,307 | 5,307 | 5,308 | **5,306** | **-0,012** |
| pH 2,74 6.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,539 | 5,539 | 5,539 | **5,539** | 5,514 | 5,515 | 5,516 | 5,492 | 5,493 | 5,494 | 5,473 | 5,471 | 5,473 | 5,497 | 5,494 | 5,494 | **5,494** | **-0,045** |
| Ultra B.L 2 | 5,258 | 5,257 | 5,256 | **5,257** | 5,230 | 5,225 | 5,233 | 5,227 | 5,227 | 5,226 | 5,223 | 5,223 | 5,223 | 5,246 | 5,245 | 5,245 | **5,231** | **-0,026** |
| Ultra B.L 3 | 5,290 | 5,288 | 5,288 | **5,289** | 5,266 | 5,268 | 5,266 | 5,263 | 5,262 | 5,263 | 5,269 | 5,269 | 5,270 | 5,291 | 5,290 | 5,290 | **5,272** | **-0,016** |
| Ultra B.L 4 | 5,288 | 5,287 | 5,288 | **5,288** | 5,227 | 5,228 | 5,228 | 5,239 | 5,237 | 5,238 | 5,210 | 5,213 | 5,211 | 5,225 | 5,224 | 5,226 | **5,226** | **-0,062** |
| Ultra B.L 5 | 5,321 | 5,322 | 5,323 | **5,322** | 5,316 | 5,316 | 5,315 | 5,310 | 5,311 | 5,312 | 5,296 | 5,292 | 5,293 | 5,308 | 5,309 | 5,309 | **5,307** | **-0,015** |
| pH 2,74 7.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,540 | 5,541 | 5,540 | **5,540** | 5,516 | 5,516 | 5,518 | 5,492 | 5,494 | 5,493 | 5,468 | 5,464 | 5,464 | 5,492 | 5,495 | 5,495 | **5,492** | **-0,048** |
| Ultra B.L 2 | 5,255 | 5,255 | 5,255 | **5,255** | 5,221 | 5,224 | 5,223 | 5,224 | 5,224 | 5,224 | 5,222 | 5,224 | 5,225 | 5,243 | 5,243 | 5,243 | **5,228** | **-0,027** |
| Ultra B.L 3 | 5,291 | 5,292 | 5,292 | **5,292** | 5,269 | 5,269 | 5,268 | 5,264 | 5,264 | 5,264 | 5,271 | 5,271 | 5,271 | 5,291 | 5,290 | 5,290 | **5,274** | **-0,018** |
| Ultra B.L 4 | 5,289 | 5,289 | 5,288 | **5,289** | 5,230 | 5,233 | 5,232 | 5,238 | 5,239 | 5,240 | 5,208 | 5,209 | 5,208 | 5,225 | 5,224 | 5,225 | **5,226** | **-0,063** |
| Ultra B.L 5 | 5,322 | 5,323 | 5,324 | **5,323** | 5,316 | 5,317 | 5,315 | 5,312 | 5,312 | 5,313 | 5,295 | 5,297 | 5,297 | 5,307 | 5,306 | 5,309 | **5,308** | **-0,015** |

### Table 6.6. Seven days recorded heights and reference points of five samples of Ultra Band LoK cement at pH 4.0 (mm).

| pH 4 Beginning | Middle of cement | | | Mean | Upper acrylic reference point | | | Right acrylic reference point | | | Down acrylic reference point | | | Left acrylic reference point | | | Mean | Different |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ultra B.L 1 | 5,184 | 5,181 | 5,181 | **5,182** | 5,168 | 5,164 | 5,163 | 5,146 | 5,148 | 5,149 | 5,174 | 5,172 | 5,172 | 5,188 | 5,184 | 5,184 | **5,168** | **-0,014** |
| Ultra B.L 2 | 5,177 | 5,178 | 5,181 | **5,179** | 5,181 | 5,180 | 5,176 | 5,174 | 5,178 | 5,180 | 5,163 | 5,168 | 5,171 | 5,182 | 5,183 | 5,177 | **5,176** | **-0,003** |
| Ultra B.L 3 | 5,159 | 5,156 | 5,165 | **5,160** | 5,171 | 5,168 | 5,171 | 5,171 | 5,168 | 5,173 | 5,165 | 5,164 | 5,163 | 5,168 | 5,169 | 5,165 | **5,168** | **0,008** |
| Ultra B.L 4 | 5,326 | 5,329 | 5,331 | **5,329** | 5,290 | 5,385 | 5,287 | 5,310 | 5,306 | 5,312 | 5,339 | 5,343 | 5,347 | 5,306 | 5,309 | 5,311 | **5,320** | **-0,008** |
| Ultra B.L 5 | 5,218 | 5,220 | 5,222 | **5,220** | 5,233 | 5,227 | 5,224 | 5,220 | 5,211 | 5,214 | 5,193 | 5,197 | 5,207 | 5,194 | 5,196 | 5,195 | **5,209** | **-0,011** |
| pH 4 1.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,201 | 5,201 | 5,201 | **5,201** | 5,168 | 5,169 | 5,168 | 5,155 | 5,156 | 5,157 | 5,179 | 5,179 | 5,179 | 5,191 | 5,185 | 5,187 | **5,173** | **-0,028** |
| Ultra B.L 2 | 5,182 | 5,183 | 5,183 | **5,183** | 5,177 | 5,176 | 5,176 | 5,177 | 5,176 | 5,177 | 5,172 | 5,172 | 5,172 | 5,182 | 5,182 | 5,183 | **5,177** | **-0,006** |
| Ultra B.L 3 | 5,177 | 5,177 | 5,177 | **5,177** | 5,179 | 5,180 | 5,181 | 5,175 | 5,177 | 5,178 | 5,165 | 5,167 | 5,165 | 5,170 | 5,170 | 5,171 | **5,173** | **-0,004** |
| Ultra B.L 4 | 5,340 | 5,340 | 5,338 | **5,339** | 5,300 | 5,300 | 5,300 | 5,320 | 5,323 | 5,319 | 5,350 | 5,350 | 5,351 | 5,320 | 5,319 | 5,321 | **5,323** | **-0,017** |
| Ultra B.L 5 | 5,231 | 5,230 | 5,231 | **5,231** | 5,236 | 5,237 | 5,236 | 5,212 | 5,214 | 5,215 | 5,204 | 5,208 | 5,208 | 5,197 | 5,195 | 5,197 | **5,213** | **-0,017** |
| pH 4 2.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,201 | 5,199 | 5,200 | **5,200** | 5,169 | 5,168 | 5,170 | 5,158 | 5,158 | 5,157 | 5,180 | 5,179 | 5,179 | 5,189 | 5,187 | 5,187 | **5,173** | **-0,027** |
| Ultra B.L 2 | 5,185 | 5,186 | 5,186 | **5,186** | 5,180 | 5,177 | 5,178 | 5,176 | 5,177 | 5,176 | 5,171 | 5,172 | 5,172 | 5,183 | 5,185 | 5,185 | **5,178** | **-0,008** |
| Ultra B.L 3 | 5,180 | 5,181 | 5,181 | **5,181** | 5,182 | 5,182 | 5,182 | 5,179 | 5,177 | 5,178 | 5,170 | 5,170 | 5,170 | 5,173 | 5,173 | 5,173 | **5,176** | **-0,005** |
| Ultra B.L 4 | 5,335 | 5,334 | 5,333 | **5,334** | 5,290 | 5,291 | 5,290 | 5,312 | 5,311 | 5,308 | 5,343 | 5,343 | 5,343 | 5,308 | 5,310 | 5,310 | **5,313** | **-0,021** |
| Ultra B.L 5 | 5,233 | 5,233 | 5,234 | **5,233** | 5,239 | 5,239 | 5,238 | 5,214 | 5,216 | 5,216 | 5,208 | 5,208 | 5,209 | 5,198 | 5,197 | 5,199 | **5,215** | **-0,018** |
| pH 4 3.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,206 | 5,208 | 5,207 | **5,207** | 5,175 | 5,174 | 5,174 | 5,163 | 5,164 | 5,164 | 5,186 | 5,187 | 5,189 | 5,199 | 5,197 | 5,195 | **5,181** | **-0,026** |
| Ultra B.L 2 | 5,191 | 5,191 | 5,190 | **5,191** | 5,180 | 5,182 | 5,181 | 5,181 | 5,183 | 5,181 | 5,186 | 5,180 | 5,179 | 5,190 | 5,186 | 5,185 | **5,183** | **-0,008** |
| Ultra B.L 3 | 5,187 | 5,186 | 5,186 | **5,186** | 5,188 | 5,187 | 5,189 | 5,182 | 5,184 | 5,183 | 5,174 | 5,175 | 5,174 | 5,179 | 5,179 | 5,179 | **5,181** | **-0,005** |
| Ultra B.L 4 | 5,334 | 5,333 | 5,332 | **5,333** | 5,292 | 5,293 | 5,295 | 5,321 | 5,323 | 5,324 | 5,347 | 5,349 | 5,349 | 5,315 | 5,315 | 5,315 | **5,320** | **-0,013** |
| Ultra B.L 5 | 5,238 | 5,240 | 5,238 | **5,239** | 5,246 | 5,245 | 5,246 | 5,222 | 5,222 | 5,223 | 5,212 | 5,215 | 5,214 | 5,200 | 5,201 | 5,201 | **5,221** | **-0,018** |
| pH 4 4.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,208 | 5,205 | 5,206 | **5,206** | 5,173 | 5,174 | 5,172 | 5,161 | 5,163 | 5,162 | 5,183 | 5,183 | 5,184 | 5,193 | 5,191 | 5,191 | **5,178** | **-0,029** |
| Ultra B.L 2 | 5,189 | 5,189 | 5,190 | **5,189** | 5,180 | 5,178 | 5,180 | 5,177 | 5,176 | 5,179 | 5,175 | 5,174 | 5,176 | 5,185 | 5,187 | 5,186 | **5,179** | **-0,010** |
| Ultra B.L 3 | 5,185 | 5,185 | 5,185 | **5,185** | 5,186 | 5,187 | 5,187 | 5,183 | 5,181 | 5,183 | 5,174 | 5,175 | 5,175 | 5,177 | 5,177 | 5,177 | **5,180** | **-0,005** |
| Ultra B.L 4 | 5,342 | 5,340 | 5,340 | **5,341** | 5,297 | 5,297 | 5,298 | 5,315 | 5,313 | 5,316 | 5,347 | 5,350 | 5,349 | 5,315 | 5,317 | 5,315 | **5,319** | **-0,022** |
| Ultra B.L 5 | 5,238 | 5,241 | 5,239 | **5,239** | 5,243 | 5,240 | 5,243 | 5,218 | 5,218 | 5,218 | 5,210 | 5,212 | 5,211 | 5,200 | 5,205 | 5,204 | **5,219** | **-0,021** |
| pH 4 5.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,213 | 5,213 | 5,213 | **5,213** | 5,179 | 5,180 | 5,179 | 5,167 | 5,167 | 5,167 | 5,190 | 5,189 | 5,190 | 5,197 | 5,195 | 5,197 | **5,183** | **-0,030** |
| Ultra B.L 2 | 5,196 | 5,197 | 5,196 | **5,196** | 5,184 | 5,183 | 5,184 | 5,182 | 5,183 | 5,184 | 5,181 | 5,180 | 5,180 | 5,190 | 5,189 | 5,188 | **5,184** | **-0,012** |
| Ultra B.L 3 | 5,192 | 5,192 | 5,190 | **5,191** | 5,192 | 5,192 | 5,192 | 5,190 | 5,188 | 5,188 | 5,179 | 5,179 | 5,180 | 5,183 | 5,183 | 5,182 | **5,186** | **-0,006** |
| Ultra B.L 4 | 5,346 | 5,344 | 5,344 | **5,345** | 5,301 | 5,301 | 5,301 | 5,323 | 5,322 | 5,323 | 5,353 | 5,351 | 5,350 | 5,319 | 5,319 | 5,318 | **5,323** | **-0,021** |
| Ultra B.L 5 | 5,241 | 5,241 | 5,241 | **5,241** | 5,245 | 5,246 | 5,246 | 5,222 | 5,222 | 5,222 | 5,213 | 5,214 | 5,212 | 5,204 | 5,202 | 5,202 | **5,221** | **-0,020** |
| pH 4 6.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,213 | 5,212 | 5,212 | **5,212** | 5,178 | 5,177 | 5,177 | 5,166 | 5,167 | 5,167 | 5,190 | 5,188 | 5,188 | 5,197 | 5,195 | 5,195 | **5,182** | **-0,030** |
| Ultra B.L 2 | 5,199 | 5,199 | 5,198 | **5,199** | 5,184 | 5,183 | 5,183 | 5,183 | 5,185 | 5,183 | 5,182 | 5,182 | 5,183 | 5,189 | 5,189 | 5,189 | **5,185** | **-0,014** |
| Ultra B.L 3 | 5,190 | 5,191 | 5,191 | **5,191** | 5,193 | 5,193 | 5,192 | 5,188 | 5,188 | 5,188 | 5,181 | 5,181 | 5,181 | 5,183 | 5,183 | 5,184 | **5,186** | **-0,004** |
| Ultra B.L 4 | 5,347 | 5,347 | 5,347 | **5,347** | 5,301 | 5,303 | 5,303 | 5,323 | 5,323 | 5,326 | 5,353 | 5,353 | 5,352 | 5,320 | 5,318 | 5,320 | **5,325** | **-0,022** |
| Ultra B.L 5 | 5,242 | 5,242 | 5,242 | **5,242** | 5,244 | 5,244 | 5,243 | 5,222 | 5,222 | 5,224 | 5,216 | 5,215 | 5,215 | 5,203 | 5,204 | 5,203 | **5,221** | **-0,021** |
| pH 4 7.Day | | | | | | | | | | | | | | | | | | |
| Ultra B.L 1 | 5,219 | 5,218 | 5,217 | **5,218** | 5,183 | 5,184 | 5,183 | 5,171 | 5,169 | 5,172 | 5,194 | 5,193 | 5,192 | 5,202 | 5,204 | 5,201 | **5,187** | **-0,031** |
| Ultra B.L 2 | 5,201 | 5,202 | 5,202 | **5,202** | 5,187 | 5,187 | 5,187 | 5,184 | 5,185 | 5,183 | 5,185 | 5,185 | 5,182 | 5,192 | 5,192 | 5,192 | **5,187** | **-0,015** |
| Ultra B.L 3 | 5,196 | 5,196 | 5,196 | **5,196** | 5,197 | 5,198 | 5,199 | 5,195 | 5,193 | 5,194 | 5,185 | 5,184 | 5,185 | 5,188 | 5,188 | 5,187 | **5,191** | **-0,005** |
| Ultra B.L 4 | 5,352 | 5,352 | 5,351 | **5,352** | 5,304 | 5,303 | 5,304 | 5,324 | 5,320 | 5,321 | 5,354 | 5,355 | 5,354 | 5,323 | 5,322 | 5,321 | **5,325** | **-0,026** |
| Ultra B.L 5 | 5,244 | 5,244 | 5,244 | **5,244** | 5,246 | 5,250 | 5,248 | 5,224 | 5,225 | 5,225 | 5,218 | 5,216 | 5,216 | 5,205 | 5,204 | 5,206 | **5,224** | **-0,020** |

**Table 6.7. Seven days recorded heights and reference points of five samples of MR LOCK cement at pH 2.74 (mm).**

| pH 2,74 Begining | Middle of Siman | | | Mean | Upper of Acril | | | Right of Acril | | | Down of Acril | | | Left of Acril | | | Mean | Different |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MR Lock 1 | 5,254 | 5,249 | 5,252 | **5,252** | 5,229 | 5,228 | 5,233 | 5,235 | 5,232 | 5,233 | 5,236 | 5,238 | 5,237 | 5,235 | 5,230 | 5,230 | **5,233** | **-0,019** |
| MR Lock 2 | 5,319 | 5,315 | 5,318 | **5,317** | 5,298 | 5,294 | 5,296 | 5,284 | 5,283 | 5,287 | 5,274 | 5,281 | 5,284 | 5,271 | 5,275 | 5,278 | **5,284** | **-0,034** |
| MR Lock 3 | 5,396 | 5,393 | 5,396 | **5,395** | 5,363 | 5,362 | 5,362 | 5,391 | 5,389 | 5,392 | 5,397 | 5,393 | 5,392 | 5,374 | 5,377 | 5,378 | **5,381** | **-0,014** |
| MR Lock 4 | 5,126 | 5,129 | 5,122 | **5,126** | 5,121 | 5,115 | 5,117 | 5,129 | 5,122 | 5,121 | 5,126 | 5,121 | 5,123 | 5,124 | 5,117 | 5,119 | **5,121** | **-0,004** |
| MR Lock 5 | 5,278 | 5,270 | 5,273 | **5,274** | 5,265 | 5,266 | 5,268 | 5,266 | 5,260 | 5,265 | 5,295 | 5,296 | 5,298 | 5,287 | 5,286 | 5,288 | **5,278** | **0,005** |
| pH 2,74 1.Day | | | | | | | | | | | | | | | | | | |
| MR Lock 1 | 5,242 | 5,243 | 5,241 | **5,242** | 5,217 | 5,217 | 5,217 | 5,221 | 5,229 | 5,222 | 5,223 | 5,223 | 5,223 | 5,216 | 5,216 | 5,217 | **5,220** | **-0,022** |
| MR Lock 2 | 5,327 | 5,327 | 5,328 | **5,327** | 5,303 | 5,304 | 5,303 | 5,293 | 5,294 | 5,295 | 5,293 | 5,293 | 5,293 | 5,286 | 5,287 | 5,286 | **5,294** | **-0,033** |
| MR Lock 3 | 5,426 | 5,424 | 5,424 | **5,425** | 5,366 | 5,365 | 5,366 | 5,395 | 5,395 | 5,395 | 5,399 | 5,398 | 5,399 | 5,381 | 5,378 | 5,379 | **5,385** | **-0,040** |
| MR Lock 4 | 5,135 | 5,136 | 5,136 | **5,136** | 5,118 | 5,120 | 5,117 | 5,129 | 5,128 | 5,130 | 5,131 | 5,132 | 5,132 | 5,123 | 5,125 | 5,126 | **5,126** | **-0,010** |
| MR Lock 5 | 5,286 | 5,288 | 5,288 | **5,287** | 5,276 | 5,276 | 5,275 | 5,274 | 5,274 | 5,273 | 5,309 | 5,310 | 5,309 | 5,295 | 5,296 | 5,296 | **5,289** | **0,001** |
| pH 2,74 2.Day | | | | | | | | | | | | | | | | | | |
| MR Lock 1 | 5,246 | 5,247 | 5,246 | **5,246** | 5,218 | 5,217 | 5,218 | 5,222 | 5,222 | 5,223 | 5,222 | 5,224 | 5,224 | 5,218 | 5,219 | 5,217 | **5,220** | **-0,026** |
| MR Lock 2 | 5,331 | 5,332 | 5,332 | **5,332** | 5,308 | 5,308 | 5,308 | 5,297 | 5,295 | 5,295 | 5,292 | 5,291 | 5,293 | 5,289 | 5,291 | 5,290 | **5,296** | **-0,035** |
| MR Lock 3 | 5,430 | 5,428 | 5,432 | **5,430** | 5,367 | 5,367 | 5,364 | 5,395 | 5,396 | 5,397 | 5,397 | 5,397 | 5,395 | 5,381 | 5,380 | 5,379 | **5,385** | **-0,045** |
| MR Lock 4 | 5,143 | 5,143 | 5,141 | **5,142** | 5,121 | 5,120 | 5,121 | 5,128 | 5,129 | 5,129 | 5,130 | 5,130 | 5,129 | 5,125 | 5,126 | 5,126 | **5,126** | **-0,016** |
| MR Lock 5 | 5,290 | 5,292 | 5,292 | **5,291** | 5,272 | 5,273 | 5,273 | 5,271 | 5,273 | 5,273 | 5,306 | 5,306 | 5,308 | 5,296 | 5,296 | 5,296 | **5,287** | **-0,004** |
| pH 2,74 3.Day | | | | | | | | | | | | | | | | | | |
| MR Lock 1 | 5,243 | 5,245 | 5,245 | **5,244** | 5,219 | 5,219 | 5,218 | 5,226 | 5,225 | 5,227 | 5,223 | 5,224 | 5,223 | 5,217 | 5,218 | 5,218 | **5,221** | **-0,023** |
| MR Lock 2 | 5,337 | 5,336 | 5,336 | **5,336** | 5,307 | 5,308 | 5,305 | 5,299 | 5,298 | 5,299 | 5,295 | 5,295 | 5,294 | 5,289 | 5,290 | 5,289 | **5,297** | **-0,039** |
| MR Lock 3 | 5,429 | 5,427 | 5,428 | **5,428** | 5,369 | 5,368 | 5,367 | 5,399 | 5,398 | 5,399 | 5,400 | 5,399 | 5,401 | 5,381 | 5,378 | 5,380 | **5,387** | **-0,041** |
| MR Lock 4 | 5,146 | 5,147 | 5,147 | **5,147** | 5,125 | 5,125 | 5,125 | 5,137 | 5,137 | 5,138 | 5,133 | 5,134 | 5,135 | 5,131 | 5,130 | 5,132 | **5,132** | **-0,015** |
| MR Lock 5 | 5,300 | 5,296 | 5,296 | **5,297** | 5,276 | 5,276 | 5,276 | 5,277 | 5,278 | 5,278 | 5,311 | 5,312 | 5,312 | 5,298 | 5,299 | 5,298 | **5,291** | **-0,006** |
| pH 2,74 4.Day | | | | | | | | | | | | | | | | | | |
| MR Lock 1 | 5,250 | 5,250 | 5,250 | **5,250** | 5,222 | 5,222 | 5,222 | 5,227 | 5,227 | 5,227 | 5,224 | 5,224 | 5,226 | 5,222 | 5,221 | 5,222 | **5,224** | **-0,026** |
| MR Lock 2 | 5,335 | 5,337 | 5,335 | **5,336** | 5,308 | 5,309 | 5,309 | 5,300 | 5,299 | 5,298 | 5,290 | 5,291 | 5,294 | 5,292 | 5,292 | 5,291 | **5,298** | **-0,038** |
| MR Lock 3 | 5,437 | 5,435 | 5,435 | **5,436** | 5,370 | 5,371 | 5,369 | 5,400 | 5,401 | 5,401 | 5,397 | 5,396 | 5,398 | 5,384 | 5,384 | 5,384 | **5,388** | **-0,048** |
| MR Lock 4 | 5,147 | 5,147 | 5,148 | **5,147** | 5,126 | 5,124 | 5,125 | 5,133 | 5,134 | 5,134 | 5,132 | 5,131 | 5,133 | 5,130 | 5,131 | 5,131 | **5,130** | **-0,017** |
| MR Lock 5 | 5,301 | 5,299 | 5,302 | **5,301** | 5,277 | 5,278 | 5,275 | 5,275 | 5,276 | 5,275 | 5,310 | 5,310 | 5,311 | 5,298 | 5,299 | 5,298 | **5,290** | **-0,011** |
| pH 2,74 5.Day | | | | | | | | | | | | | | | | | | |
| MR Lock 1 | 5,250 | 5,250 | 5,252 | **5,251** | 5,222 | 5,223 | 5,222 | 5,229 | 5,228 | 5,229 | 5,223 | 5,225 | 5,223 | 5,222 | 5,221 | 5,221 | **5,224** | **-0,027** |
| MR Lock 2 | 5,338 | 5,338 | 5,338 | **5,338** | 5,309 | 5,309 | 5,309 | 5,298 | 5,297 | 5,297 | 5,289 | 5,290 | 5,291 | 5,291 | 5,290 | 5,290 | **5,297** | **-0,041** |
| MR Lock 3 | 5,433 | 5,437 | 5,434 | **5,435** | 5,373 | 5,373 | 5,373 | 5,401 | 5,401 | 5,400 | 5,396 | 5,398 | 5,398 | 5,380 | 5,382 | 5,380 | **5,388** | **-0,047** |
| MR Lock 4 | 5,147 | 5,148 | 5,148 | **5,148** | 5,128 | 5,127 | 5,126 | 5,133 | 5,134 | 5,133 | 5,133 | 5,130 | 5,132 | 5,130 | 5,131 | 5,131 | **5,131** | **-0,017** |
| MR Lock 5 | 5,299 | 5,300 | 5,302 | **5,300** | 5,276 | 5,274 | 5,275 | 5,273 | 5,274 | 5,274 | 5,309 | 5,310 | 5,310 | 5,297 | 5,297 | 5,297 | **5,289** | **-0,012** |
| pH 2,74 6.Day | | | | | | | | | | | | | | | | | | |
| MR Lock 1 | 5,248 | 5,248 | 5,248 | **5,248** | 5,220 | 5,220 | 5,219 | 5,226 | 5,227 | 5,227 | 5,221 | 5,222 | 5,223 | 5,219 | 5,219 | 5,220 | **5,222** | **-0,026** |
| MR Lock 2 | 5,334 | 5,335 | 5,335 | **5,335** | 5,307 | 5,306 | 5,306 | 5,295 | 5,297 | 5,297 | 5,288 | 5,287 | 5,287 | 5,289 | 5,289 | 5,289 | **5,295** | **-0,040** |
| MR Lock 3 | 5,435 | 5,435 | 5,435 | **5,435** | 5,370 | 5,372 | 5,369 | 5,400 | 5,399 | 5,400 | 5,396 | 5,395 | 5,398 | 5,380 | 5,381 | 5,381 | **5,387** | **-0,048** |
| MR Lock 4 | 5,145 | 5,146 | 5,146 | **5,146** | 5,125 | 5,125 | 5,123 | 5,131 | 5,132 | 5,132 | 5,129 | 5,131 | 5,131 | 5,129 | 5,129 | 5,129 | **5,129** | **-0,017** |
| MR Lock 5 | 5,301 | 5,300 | 5,301 | **5,301** | 5,277 | 5,277 | 5,275 | 5,273 | 5,275 | 5,275 | 5,309 | 5,309 | 5,310 | 5,296 | 5,298 | 5,298 | **5,289** | **-0,011** |
| pH 2,74 7.Day | | | | | | | | | | | | | | | | | | |
| MR Lock 1 | 5,251 | 5,251 | 5,251 | **5,251** | 5,219 | 5,222 | 5,222 | 5,226 | 5,226 | 5,228 | 5,223 | 5,223 | 5,223 | 5,220 | 5,220 | 5,220 | **5,223** | **-0,028** |
| MR Lock 2 | 5,336 | 5,336 | 5,336 | **5,336** | 5,308 | 5,309 | 5,308 | 5,295 | 5,297 | 5,299 | 5,289 | 5,289 | 5,289 | 5,291 | 5,291 | 5,293 | **5,297** | **-0,040** |
| MR Lock 3 | 5,434 | 5,435 | 5,435 | **5,435** | 5,372 | 5,370 | 5,373 | 5,399 | 5,399 | 5,401 | 5,394 | 5,395 | 5,397 | 5,382 | 5,382 | 5,383 | **5,387** | **-0,047** |
| MR Lock 4 | 5,147 | 5,147 | 5,147 | **5,147** | 5,126 | 5,124 | 5,125 | 5,133 | 5,132 | 5,133 | 5,130 | 5,131 | 5,132 | 5,129 | 5,130 | 5,130 | **5,130** | **-0,017** |
| MR Lock 5 | 5,301 | 5,302 | 5,302 | **5,302** | 5,278 | 5,278 | 5,278 | 5,275 | 5,276 | 5,277 | 5,311 | 5,311 | 5,312 | 5,298 | 5,300 | 5,300 | **5,291** | **-0,011** |

**Table 6.8. Seven days recorded heights and reference points of five samples of MR LOCK cement at pH 4.0 (mm).**

| pH 4 Beginning | Middle of cement | | | Mean | Upper acrylic reference point | | | Right acrylic reference point | | | Down acrylic reference point | | | Left acrylic reference point | | | Mean | Different |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MR Lock 1** | 5,196 | 5,198 | 5,198 | **5,197** | 5,201 | 5,197 | 5,198 | 5,207 | 5,212 | 5,207 | 5,207 | 5,208 | 5,206 | 5,200 | 5,205 | 5,202 | **5,204** | **0,007** |
| **MR Lock 2** | 5,207 | 5,208 | 5,208 | **5,208** | 5,177 | 5,171 | 5,171 | 5,187 | 5,184 | 5,194 | 5,206 | 5,203 | 5,200 | 5,203 | 5,203 | 5,203 | **5,192** | **-0,016** |
| **MR Lock 3** | 5,207 | 5,205 | 5,203 | **5,205** | 5,191 | 5,199 | 5,196 | 5,196 | 5,199 | 5,184 | 5,174 | 5,179 | 5,166 | 5,189 | 5,201 | 5,188 | **5,189** | **-0,016** |
| **MR Lock 4** | 5,308 | 5,308 | 5,311 | **5,309** | 5,319 | 5,316 | 5,320 | 5,281 | 5,279 | 5,283 | 5,278 | 5,288 | 5,284 | 5,314 | 5,310 | 5,313 | **5,299** | **-0,010** |
| **MR Lock 5** | 5,191 | 5,193 | 5,193 | **5,192** | 5,190 | 5,188 | 5,189 | 5,190 | 5,195 | 5,193 | 5,194 | 5,196 | 5,196 | 5,183 | 5,180 | 5,183 | **5,190** | **-0,003** |
| **pH 4 1.Day** | | | | | | | | | | | | | | | | | | |
| **MR Lock 1** | 5,204 | 5,206 | 5,202 | **5,204** | 5,200 | 5,205 | 5,200 | 5,212 | 5,200 | 5,213 | 5,208 | 5,212 | 5,208 | 5,203 | 5,208 | 5,202 | **5,206** | **0,002** |
| **MR Lock 2** | 5,215 | 5,215 | 5,214 | **5,215** | 5,177 | 5,178 | 5,178 | 5,190 | 5,191 | 5,191 | 5,210 | 5,211 | 5,210 | 5,208 | 5,210 | 5,210 | **5,197** | **-0,018** |
| **MR Lock 3** | 5,210 | 5,210 | 5,210 | **5,210** | 5,196 | 5,195 | 5,195 | 5,190 | 5,190 | 5,191 | 5,168 | 5,169 | 5,170 | 5,191 | 5,192 | 5,191 | **5,187** | **-0,023** |
| **MR Lock 4** | 5,317 | 5,316 | 5,315 | **5,316** | 5,320 | 5,320 | 5,321 | 5,292 | 5,294 | 5,293 | 5,295 | 5,294 | 5,300 | 5,311 | 5,310 | 5,310 | **5,305** | **-0,011** |
| **MR Lock 5** | 5,193 | 5,193 | 5,194 | **5,193** | 5,186 | 5,188 | 5,186 | 5,190 | 5,191 | 5,190 | 5,192 | 5,193 | 5,192 | 5,177 | 5,178 | 5,177 | **5,187** | **-0,007** |
| **pH 4 2.Day** | | | | | | | | | | | | | | | | | | |
| **MR Lock 1** | 5,213 | 5,214 | 5,214 | **5,214** | 5,201 | 5,202 | 5,202 | 5,214 | 5,214 | 5,213 | 5,206 | 5,207 | 5,205 | 5,206 | 5,205 | 5,207 | **5,207** | **-0,007** |
| **MR Lock 2** | 5,219 | 5,220 | 5,220 | **5,220** | 5,181 | 5,181 | 5,178 | 5,193 | 5,194 | 5,196 | 5,211 | 5,212 | 5,212 | 5,213 | 5,213 | 5,213 | **5,200** | **-0,020** |
| **MR Lock 3** | 5,215 | 5,214 | 5,214 | **5,214** | 5,198 | 5,199 | 5,199 | 5,193 | 5,194 | 5,195 | 5,164 | 5,164 | 5,168 | 5,193 | 5,194 | 5,193 | **5,188** | **-0,027** |
| **MR Lock 4** | 5,314 | 5,314 | 5,314 | **5,314** | 5,320 | 5,319 | 5,319 | 5,287 | 5,289 | 5,291 | 5,292 | 5,289 | 5,294 | 5,311 | 5,310 | 5,311 | **5,303** | **-0,011** |
| **MR Lock 5** | 5,194 | 5,194 | 5,195 | **5,194** | 5,184 | 5,185 | 5,185 | 5,189 | 5,190 | 5,189 | 5,192 | 5,193 | 5,193 | 5,180 | 5,181 | 5,180 | **5,187** | **-0,008** |
| **pH 4 3.Day** | | | | | | | | | | | | | | | | | | |
| **MR Lock 1** | 5,213 | 5,215 | 5,214 | **5,214** | 5,203 | 5,201 | 5,202 | 5,216 | 5,215 | 5,217 | 5,207 | 5,208 | 5,208 | 5,204 | 5,206 | 5,205 | **5,208** | **-0,006** |
| **MR Lock 2** | 5,222 | 5,223 | 5,223 | **5,223** | 5,184 | 5,183 | 5,181 | 5,200 | 5,199 | 5,199 | 5,215 | 5,216 | 5,216 | 5,215 | 5,214 | 5,216 | **5,203** | **-0,019** |
| **MR Lock 3** | 5,215 | 5,217 | 5,217 | **5,216** | 5,203 | 5,201 | 5,201 | 5,195 | 5,197 | 5,197 | 5,169 | 5,171 | 5,172 | 5,197 | 5,198 | 5,197 | **5,192** | **-0,025** |
| **MR Lock 4** | 5,321 | 5,321 | 5,321 | **5,321** | 5,323 | 5,322 | 5,322 | 5,294 | 5,296 | 5,296 | 5,296 | 5,298 | 5,295 | 5,313 | 5,313 | 5,315 | **5,307** | **-0,014** |
| **MR Lock 5** | 5,199 | 5,198 | 5,198 | **5,198** | 5,188 | 5,188 | 5,187 | 5,193 | 5,193 | 5,194 | 5,195 | 5,195 | 5,197 | 5,178 | 5,179 | 5,179 | **5,189** | **-0,010** |
| **pH 4 4.Day** | | | | | | | | | | | | | | | | | | |
| **MR Lock 1** | 5,219 | 5,220 | 5,219 | **5,219** | 5,205 | 5,205 | 5,206 | 5,216 | 5,216 | 5,216 | 5,206 | 5,206 | 5,203 | 5,209 | 5,208 | 5,208 | **5,209** | **-0,011** |
| **MR Lock 2** | 5,227 | 5,228 | 5,228 | **5,228** | 5,187 | 5,189 | 5,188 | 5,204 | 5,201 | 5,204 | 5,219 | 5,219 | 5,219 | 5,223 | 5,223 | 5,222 | **5,208** | **-0,019** |
| **MR Lock 3** | 5,219 | 5,219 | 5,220 | **5,219** | 5,205 | 5,205 | 5,205 | 5,199 | 5,199 | 5,199 | 5,170 | 5,173 | 5,170 | 5,198 | 5,199 | 5,197 | **5,193** | **-0,026** |
| **MR Lock 4** | 5,321 | 5,321 | 5,322 | **5,321** | 5,324 | 5,324 | 5,322 | 5,296 | 5,296 | 5,296 | 5,291 | 5,292 | 5,290 | 5,315 | 5,315 | 5,315 | **5,306** | **-0,015** |
| **MR Lock 5** | 5,202 | 5,202 | 5,201 | **5,202** | 5,190 | 5,189 | 5,190 | 5,195 | 5,195 | 5,195 | 5,200 | 5,199 | 5,199 | 5,183 | 5,184 | 5,183 | **5,192** | **-0,010** |
| **pH 4 5.Day** | | | | | | | | | | | | | | | | | | |
| **MR Lock 1** | 5,217 | 5,220 | 5,220 | **5,219** | 5,205 | 5,205 | 5,205 | 5,215 | 5,215 | 5,216 | 5,201 | 5,201 | 5,205 | 5,207 | 5,208 | 5,208 | **5,208** | **-0,011** |
| **MR Lock 2** | 5,225 | 5,225 | 5,225 | **5,225** | 5,186 | 5,185 | 5,185 | 5,198 | 5,199 | 5,200 | 5,216 | 5,216 | 5,215 | 5,218 | 5,219 | 5,218 | **5,205** | **-0,020** |
| **MR Lock 3** | 5,217 | 5,216 | 5,217 | **5,217** | 5,204 | 5,204 | 5,204 | 5,198 | 5,199 | 5,199 | 5,188 | 5,170 | 5,171 | 5,196 | 5,197 | 5,197 | **5,194** | **-0,023** |
| **MR Lock 4** | 5,319 | 5,320 | 5,320 | **5,320** | 5,323 | 5,323 | 5,321 | 5,291 | 5,294 | 5,292 | 5,295 | 5,292 | 5,288 | 5,313 | 5,314 | 5,315 | **5,305** | **-0,015** |
| **MR Lock 5** | 5,197 | 5,198 | 5,197 | **5,197** | 5,185 | 5,185 | 5,186 | 5,190 | 5,190 | 5,190 | 5,197 | 5,197 | 5,194 | 5,179 | 5,179 | 5,179 | **5,188** | **-0,010** |
| **pH 4 6.Day** | | | | | | | | | | | | | | | | | | |
| **MR Lock 1** | 5,218 | 5,221 | 5,219 | **5,219** | 5,205 | 5,206 | 5,207 | 5,216 | 5,217 | 5,217 | 5,203 | 5,206 | 5,205 | 5,208 | 5,208 | 5,208 | **5,209** | **-0,011** |
| **MR Lock 2** | 5,225 | 5,225 | 5,225 | **5,225** | 5,186 | 5,186 | 5,187 | 5,199 | 5,199 | 5,199 | 5,216 | 5,216 | 5,216 | 5,217 | 5,218 | 5,219 | **5,205** | **-0,020** |
| **MR Lock 3** | 5,217 | 5,217 | 5,216 | **5,217** | 5,205 | 5,206 | 5,205 | 5,198 | 5,198 | 5,198 | 5,170 | 5,173 | 5,171 | 5,196 | 5,197 | 5,197 | **5,193** | **-0,024** |
| **MR Lock 4** | 5,321 | 5,320 | 5,321 | **5,321** | 5,323 | 5,322 | 5,323 | 5,293 | 5,293 | 5,293 | 5,295 | 5,294 | 5,293 | 5,313 | 5,313 | 5,313 | **5,306** | **-0,015** |
| **MR Lock 5** | 5,197 | 5,197 | 5,197 | **5,197** | 5,187 | 5,186 | 5,186 | 5,190 | 5,191 | 5,191 | 5,197 | 5,198 | 5,196 | 5,178 | 5,179 | 5,180 | **5,188** | **-0,009** |
| **pH 4 7.Day** | | | | | | | | | | | | | | | | | | |
| **MR Lock 1** | 5,220 | 5,220 | 5,220 | **5,220** | 5,207 | 5,205 | 5,206 | 5,217 | 5,217 | 5,218 | 5,204 | 5,205 | 5,206 | 5,209 | 5,208 | 5,209 | **5,209** | **-0,011** |
| **MR Lock 2** | 5,225 | 5,226 | 5,227 | **5,226** | 5,187 | 5,185 | 5,185 | 5,201 | 5,200 | 5,201 | 5,217 | 5,217 | 5,217 | 5,218 | 5,219 | 5,220 | **5,206** | **-0,020** |
| **MR Lock 3** | 5,217 | 5,217 | 5,217 | **5,217** | 5,205 | 5,206 | 5,205 | 5,198 | 5,198 | 5,199 | 5,173 | 5,175 | 5,174 | 5,197 | 5,196 | 5,198 | **5,194** | **-0,023** |
| **MR Lock 4** | 5,321 | 5,322 | 5,323 | **5,322** | 5,323 | 5,323 | 5,323 | 5,294 | 5,294 | 5,295 | 5,296 | 5,293 | 5,295 | 5,312 | 5,315 | 5,314 | **5,306** | **-0,016** |
| **MR Lock 5** | 5,198 | 5,198 | 5,198 | **5,198** | 5,187 | 5,186 | 5,187 | 5,191 | 5,191 | 5,191 | 5,195 | 5,196 | 5,197 | 5,179 | 5,178 | 5,179 | **5,188** | **-0,010** |

## Table 6.9. Seven days recorded heights and reference points of five samples of Transbond plus cement at pH 2.74 (mm).

| **pH 2,74 Beginning** | **Middle of cement** | | | **Mean** | **Upper acrylic reference point** | | | **Right acrylic reference point** | | | **Down acrylic reference point** | | | **Left acrylic reference point** | | | **Mean** | **Different** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tr.bond Pl 1** | 5,297 | 5,296 | 5,301 | **5,298** | 5,285 | 5,282 | 5,277 | 5,299 | 5,305 | 5,307 | 5,292 | 5,293 | 5,289 | 5,263 | 5,273 | 5,269 | **5,286** | **-0,012** |
| **Tr.bond Pl 2** | 5,243 | 5,244 | 5,242 | **5,243** | 5,237 | 5,230 | 5,235 | 5,216 | 5,214 | 5,215 | 5,200 | 5,198 | 5,202 | 5,224 | 5,224 | 5,224 | **5,218** | **-0,025** |
| **Tr.bond Pl 3** | 5,230 | 5,235 | 5,238 | **5,234** | 5,196 | 5,204 | 5,210 | 5,211 | 5,205 | 5,201 | 5,219 | 5,211 | 5,204 | 5,231 | 5,222 | 5,218 | **5,211** | **-0,023** |
| **Tr.bond Pl 4** | 5,387 | 5,382 | 5,378 | **5,382** | 5,389 | 5,390 | 5,397 | 5,365 | 5,367 | 5,365 | 5,370 | 5,370 | 5,365 | 5,388 | 5,391 | 5,390 | **5,379** | **-0,003** |
| **Tr.bond Pl 5** | 5,249 | 5,248 | 5,258 | **5,252** | 5,204 | 5,199 | 5,196 | 5,229 | 5,227 | 5,230 | 5,284 | 5,280 | 5,287 | 5,250 | 5,251 | 5,255 | **5,241** | **-0,011** |
| **pH 2,74 1.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,295 | 5,295 | 5,294 | **5,295** | 5,276 | 5,276 | 5,275 | 5,300 | 5,299 | 5,301 | 5,293 | 5,290 | 5,289 | 5,261 | 5,261 | 5,261 | **5,282** | **-0,013** |
| **Tr.bond Pl 2** | 5,253 | 5,252 | 5,253 | **5,253** | 5,223 | 5,225 | 5,222 | 5,216 | 5,216 | 5,216 | 5,206 | 5,207 | 5,220 | 5,229 | 5,230 | 5,230 | **5,220** | **-0,033** |
| **Tr.bond Pl 3** | 5,242 | 5,243 | 5,242 | **5,242** | 5,210 | 5,212 | 5,213 | 5,219 | 5,225 | 5,223 | 5,224 | 5,221 | 5,222 | 5,231 | 5,232 | 5,231 | **5,222** | **-0,020** |
| **Tr.bond Pl 4** | 5,401 | 5,399 | 5,399 | **5,400** | 5,410 | 5,410 | 5,411 | 5,387 | 5,382 | 5,386 | 5,385 | 5,385 | 5,384 | 5,407 | 5,408 | 5,408 | **5,397** | **-0,003** |
| **Tr.bond Pl 5** | 5,251 | 5,250 | 5,251 | **5,251** | 5,193 | 5,193 | 5,193 | 5,222 | 5,223 | 5,223 | 5,276 | 5,276 | 5,277 | 5,239 | 5,241 | 5,242 | **5,233** | **-0,018** |
| **pH 2,74 2.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,301 | 5,301 | 5,300 | **5,301** | 5,281 | 5,282 | 5,281 | 5,304 | 5,305 | 5,302 | 5,288 | 5,286 | 5,283 | 5,266 | 5,267 | 5,266 | **5,284** | **-0,016** |
| **Tr.bond Pl 2** | 5,255 | 5,255 | 5,255 | **5,255** | 5,225 | 5,222 | 5,223 | 5,217 | 5,217 | 5,214 | 5,209 | 5,204 | 5,209 | 5,232 | 5,232 | 5,233 | **5,220** | **-0,035** |
| **Tr.bond Pl 3** | 5,238 | 5,239 | 5,238 | **5,238** | 5,211 | 5,208 | 5,210 | 5,203 | 5,214 | 5,214 | 5,216 | 5,215 | 5,215 | 5,229 | 5,229 | 5,230 | **5,216** | **-0,022** |
| **Tr.bond Pl 4** | 5,394 | 5,395 | 5,397 | **5,395** | 5,409 | 5,408 | 5,406 | 5,382 | 5,382 | 5,384 | 5,382 | 5,384 | 5,385 | 5,401 | 5,403 | 5,403 | **5,394** | **-0,001** |
| **Tr.bond Pl 5** | 5,253 | 5,254 | 5,254 | **5,254** | 5,194 | 5,193 | 5,191 | 5,221 | 5,225 | 5,224 | 5,276 | 5,276 | 5,280 | 5,238 | 5,240 | 5,238 | **5,233** | **-0,021** |
| **pH 2,74 3.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,303 | 5,304 | 5,303 | **5,303** | 5,284 | 5,284 | 5,281 | 5,310 | 5,309 | 5,309 | 5,284 | 5,278 | 5,280 | 5,263 | 5,263 | 5,264 | **5,284** | **-0,019** |
| **Tr.bond Pl 2** | 5,260 | 5,260 | 5,260 | **5,260** | 5,223 | 5,224 | 5,224 | 5,224 | 5,225 | 5,228 | 5,212 | 5,213 | 5,212 | 5,236 | 5,236 | 5,236 | **5,224** | **-0,036** |
| **Tr.bond Pl 3** | 5,244 | 5,244 | 5,244 | **5,244** | 5,214 | 5,216 | 5,214 | 5,218 | 5,219 | 5,220 | 5,221 | 5,218 | 5,220 | 5,235 | 5,234 | 5,233 | **5,222** | **-0,022** |
| **Tr.bond Pl 4** | 5,400 | 5,400 | 5,400 | **5,400** | 5,412 | 5,411 | 5,412 | 5,385 | 5,387 | 5,387 | 5,388 | 5,389 | 5,387 | 5,405 | 5,406 | 5,406 | **5,398** | **-0,002** |
| **Tr.bond Pl 5** | 5,251 | 5,253 | 5,254 | **5,253** | 5,190 | 5,191 | 5,194 | 5,227 | 5,223 | 5,228 | 5,278 | 5,277 | 5,276 | 5,238 | 5,234 | 5,238 | **5,233** | **-0,020** |
| **pH 2,74 4.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,304 | 5,304 | 5,304 | **5,304** | 5,287 | 5,285 | 5,286 | 5,308 | 5,307 | 5,308 | 5,271 | 5,271 | 5,274 | 5,267 | 5,266 | 5,268 | **5,283** | **-0,021** |
| **Tr.bond Pl 2** | 5,256 | 5,258 | 5,256 | **5,257** | 5,229 | 5,227 | 5,226 | 5,224 | 5,226 | 5,224 | 5,206 | 5,207 | 5,204 | 5,234 | 5,234 | 5,235 | **5,223** | **-0,034** |
| **Tr.bond Pl 3** | 5,242 | 5,242 | 5,242 | **5,242** | 5,214 | 5,216 | 5,215 | 5,217 | 5,217 | 5,218 | 5,219 | 5,217 | 5,216 | 5,231 | 5,232 | 5,232 | **5,220** | **-0,022** |
| **Tr.bond Pl 4** | 5,398 | 5,398 | 5,398 | **5,398** | 5,410 | 5,411 | 5,411 | 5,385 | 5,386 | 5,385 | 5,385 | 5,385 | 5,387 | 5,406 | 5,407 | 5,406 | **5,397** | **-0,001** |
| **Tr.bond Pl 5** | 5,259 | 5,256 | 5,256 | **5,257** | 5,202 | 5,204 | 5,203 | 5,228 | 5,226 | 5,227 | 5,284 | 5,280 | 5,280 | 5,242 | 5,240 | 5,240 | **5,238** | **-0,019** |
| **pH 2,74 5.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,310 | 5,308 | 5,307 | **5,308** | 5,288 | 5,286 | 5,290 | 5,310 | 5,306 | 5,307 | 5,278 | 5,275 | 5,273 | 5,269 | 5,268 | 5,268 | **5,285** | **-0,023** |
| **Tr.bond Pl 2** | 5,261 | 5,260 | 5,260 | **5,260** | 5,227 | 5,228 | 5,233 | 5,224 | 5,224 | 5,224 | 5,213 | 5,210 | 5,211 | 5,237 | 5,237 | 5,237 | **5,225** | **-0,035** |
| **Tr.bond Pl 3** | 5,245 | 5,245 | 5,245 | **5,245** | 5,216 | 5,216 | 5,218 | 5,218 | 5,219 | 5,219 | 5,221 | 5,221 | 5,220 | 5,235 | 5,234 | 5,233 | **5,223** | **-0,023** |
| **Tr.bond Pl 4** | 5,401 | 5,401 | 5,402 | **5,401** | 5,414 | 5,414 | 5,413 | 5,383 | 5,387 | 5,387 | 5,389 | 5,388 | 5,389 | 5,408 | 5,410 | 5,408 | **5,399** | **-0,002** |
| **Tr.bond Pl 5** | 5,258 | 5,259 | 5,259 | **5,259** | 5,195 | 5,200 | 5,200 | 5,229 | 5,227 | 5,228 | 5,282 | 5,281 | 5,284 | 5,242 | 5,243 | 5,245 | **5,238** | **-0,021** |
| | | | | | | | | | | | | | | | | | | |
| **pH 2,74 6.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,310 | 5,308 | 5,307 | **5,308** | 5,286 | 5,289 | 5,287 | 5,311 | 5,310 | 5,311 | 5,272 | 5,276 | 5,276 | 5,266 | 5,263 | 5,263 | **5,284** | **-0,024** |
| **Tr.bond Pl 2** | 5,263 | 5,262 | 5,261 | **5,262** | 5,229 | 5,228 | 5,232 | 5,227 | 5,227 | 5,226 | 5,217 | 5,214 | 5,213 | 5,239 | 5,237 | 5,237 | **5,227** | **-0,035** |
| **Tr.bond Pl 3** | 5,247 | 5,247 | 5,246 | **5,247** | 5,218 | 5,217 | 5,217 | 5,219 | 5,219 | 5,218 | 5,219 | 5,221 | 5,218 | 5,236 | 5,236 | 5,235 | **5,223** | **-0,024** |
| **Tr.bond Pl 4** | 5,405 | 5,405 | 5,405 | **5,405** | 5,415 | 5,415 | 5,416 | 5,388 | 5,386 | 5,386 | 5,392 | 5,391 | 5,391 | 5,411 | 5,410 | 5,410 | **5,401** | **-0,004** |
| **Tr.bond Pl 5** | 5,260 | 5,261 | 5,259 | **5,260** | 5,192 | 5,193 | 5,196 | 5,230 | 5,226 | 5,227 | 5,250 | 5,281 | 5,281 | 5,241 | 5,238 | 5,241 | **5,233** | **-0,027** |
| **pH 2,74 7.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,314 | 5,310 | 5,309 | **5,311** | 5,288 | 5,288 | 5,288 | 5,309 | 5,309 | 5,309 | 5,272 | 5,275 | 5,275 | 5,261 | 5,267 | 5,267 | **5,284** | **-0,027** |
| **Tr.bond Pl 2** | 5,263 | 5,265 | 5,263 | **5,264** | 5,229 | 5,232 | 5,231 | 5,234 | 5,232 | 5,228 | 5,217 | 5,212 | 5,214 | 5,240 | 5,239 | 5,237 | **5,229** | **-0,035** |
| **Tr.bond Pl 3** | 5,250 | 5,249 | 5,249 | **5,249** | 5,219 | 5,217 | 5,218 | 5,220 | 5,217 | 5,217 | 5,221 | 5,221 | 5,219 | 5,237 | 5,236 | 5,236 | **5,223** | **-0,026** |
| **Tr.bond Pl 4** | 5,405 | 5,405 | 5,405 | **5,405** | 5,416 | 5,416 | 5,416 | 5,390 | 5,391 | 5,390 | 5,394 | 5,392 | 5,392 | 5,413 | 5,411 | 5,410 | **5,403** | **-0,002** |
| **Tr.bond Pl 5** | 5,261 | 5,260 | 5,260 | **5,260** | 5,195 | 5,194 | 5,193 | 5,229 | 5,231 | 5,230 | 5,281 | 5,284 | 5,283 | 5,242 | 5,242 | 5,241 | **5,237** | **-0,023** |

**Table 6.10. Seven days recorded heights and reference points of five samples of Transbond plus cement at pH 4.0 (mm).**

| pH 4 Beginning | Middle of cement | | | Mean | Upper acrylic reference point | | | Right acrylic reference point | | | Down acrylic reference point | | | Left acrylic reference point | | | Mean | Different |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tr.bond Pl 1** | 5,317 | 5,316 | 5,315 | **5,316** | 5,306 | 5,300 | 5,307 | 5,302 | 5,297 | 5,302 | 5,284 | 5,283 | 5,289 | 5,295 | 5,299 | 5,299 | **5,297** | **-0,019** |
| **Tr.bond Pl 2** | 5,224 | 5,226 | 5,225 | **5,225** | 5,218 | 5,217 | 5,219 | 5,217 | 5,215 | 5,215 | 5,198 | 5,193 | 5,194 | 5,223 | 5,220 | 5,221 | **5,213** | **-0,012** |
| **Tr.bond Pl 3** | 5,454 | 5,450 | 5,453 | **5,452** | 5,402 | 5,405 | 5,405 | 5,457 | 5,455 | 5,453 | 5,436 | 5,432 | 5,428 | 5,406 | 5,399 | 5,403 | **5,423** | **-0,029** |
| **Tr.bond Pl 4** | 5,282 | 5,284 | 5,285 | **5,284** | 5,282 | 5,284 | 5,277 | 5,247 | 5,247 | 5,252 | 5,251 | 5,258 | 5,257 | 5,264 | 5,265 | 5,262 | **5,262** | **-0,021** |
| **Tr.bond Pl 5** | 5,231 | 5,235 | 5,230 | **5,232** | 5,200 | 5,199 | 5,198 | 5,223 | 5,220 | 5,220 | 5,219 | 5,218 | 5,218 | 5,215 | 5,215 | 5,216 | **5,213** | **-0,019** |
| **pH 4 1.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,310 | 5,310 | 5,311 | **5,310** | 5,304 | 5,303 | 5,304 | 5,296 | 5,297 | 5,298 | 5,286 | 5,287 | 5,288 | 5,294 | 5,295 | 5,296 | **5,296** | **-0,015** |
| **Tr.bond Pl 2** | 5,226 | 5,226 | 5,226 | **5,226** | 5,215 | 5,216 | 5,216 | 5,218 | 5,217 | 5,216 | 5,193 | 5,187 | 5,188 | 5,215 | 5,217 | 5,219 | **5,210** | **-0,016** |
| **Tr.bond Pl 3** | 5,447 | 5,448 | 5,448 | **5,448** | 5,402 | 5,396 | 5,400 | 5,451 | 5,453 | 5,453 | 5,432 | 5,434 | 5,434 | 5,402 | 5,399 | 5,404 | **5,422** | **-0,026** |
| **Tr.bond Pl 4** | 5,288 | 5,288 | 5,288 | **5,288** | 5,277 | 5,276 | 5,275 | 5,247 | 5,249 | 5,255 | 5,264 | 5,266 | 5,264 | 5,255 | 5,258 | 5,256 | **5,262** | **-0,026** |
| **Tr.bond Pl 5** | 5,240 | 5,240 | 5,240 | **5,240** | 5,203 | 5,198 | 5,203 | 5,222 | 5,222 | 5,224 | 5,226 | 5,226 | 5,227 | 5,216 | 5,216 | 5,216 | **5,217** | **-0,023** |
| **pH 4 2.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,315 | 5,315 | 5,315 | **5,315** | 5,307 | 5,307 | 5,308 | 5,302 | 5,302 | 5,302 | 5,287 | 5,286 | 5,288 | 5,299 | 5,297 | 5,298 | **5,299** | **-0,016** |
| **Tr.bond Pl 2** | 5,230 | 5,230 | 5,230 | **5,230** | 5,220 | 5,220 | 5,220 | 5,222 | 5,220 | 5,221 | 5,195 | 5,192 | 5,188 | 5,225 | 5,220 | 5,220 | **5,214** | **-0,016** |
| **Tr.bond Pl 3** | 5,453 | 5,454 | 5,453 | **5,453** | 5,404 | 5,400 | 5,402 | 5,456 | 5,457 | 5,456 | 5,434 | 5,434 | 5,436 | 5,409 | 5,407 | 5,408 | **5,425** | **-0,028** |
| **Tr.bond Pl 4** | 5,290 | 5,290 | 5,290 | **5,290** | 5,281 | 5,280 | 5,278 | 5,254 | 5,254 | 5,254 | 5,262 | 5,261 | 5,261 | 5,261 | 5,259 | 5,258 | **5,264** | **-0,026** |
| **Tr.bond Pl 5** | 5,245 | 5,245 | 5,246 | **5,245** | 5,207 | 5,207 | 5,203 | 5,229 | 5,229 | 5,229 | 5,229 | 5,226 | 5,221 | 5,221 | 5,221 | 5,222 | **5,220** | **-0,025** |
| **pH 4 3.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,320 | 5,320 | 5,320 | **5,320** | 5,313 | 5,313 | 5,312 | 5,306 | 5,307 | 5,306 | 5,292 | 5,290 | 5,291 | 5,302 | 5,300 | 5,300 | **5,303** | **-0,017** |
| **Tr.bond Pl 2** | 5,255 | 5,254 | 5,255 | **5,255** | 5,240 | 5,239 | 5,239 | 5,243 | 5,242 | 5,242 | 5,215 | 5,212 | 5,215 | 5,239 | 5,239 | 5,241 | **5,234** | **-0,021** |
| **Tr.bond Pl 3** | 5,450 | 5,453 | 5,456 | **5,453** | 5,404 | 5,404 | 5,403 | 5,457 | 5,458 | 5,460 | 5,435 | 5,435 | 5,435 | 5,400 | 5,406 | 5,403 | **5,425** | **-0,028** |
| **Tr.bond Pl 4** | 5,296 | 5,296 | 5,296 | **5,296** | 5,283 | 5,283 | 5,280 | 5,261 | 5,259 | 5,261 | 5,269 | 5,265 | 5,268 | 5,255 | 5,255 | 5,256 | **5,266** | **-0,030** |
| **Tr.bond Pl 5** | 5,258 | 5,257 | 5,255 | **5,257** | 5,212 | 5,210 | 5,208 | 5,236 | 5,236 | 5,236 | 5,234 | 5,230 | 5,233 | 5,224 | 5,224 | 5,223 | **5,226** | **-0,031** |
| **pH 4 4.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,318 | 5,319 | 5,319 | **5,319** | 5,310 | 5,310 | 5,311 | 5,306 | 5,306 | 5,306 | 5,286 | 5,293 | 5,289 | 5,300 | 5,298 | 5,299 | **5,301** | **-0,018** |
| **Tr.bond Pl 2** | 5,232 | 5,233 | 5,233 | **5,233** | 5,226 | 5,226 | 5,226 | 5,222 | 5,223 | 5,224 | 5,190 | 5,190 | 5,191 | 5,225 | 5,225 | 5,225 | **5,216** | **-0,017** |
| **Tr.bond Pl 3** | 5,454 | 5,455 | 5,455 | **5,455** | 5,405 | 5,405 | 5,406 | 5,459 | 5,458 | 5,458 | 5,434 | 5,434 | 5,433 | 5,413 | 5,412 | 5,406 | **5,427** | **-0,028** |
| **Tr.bond Pl 4** | 5,294 | 5,295 | 5,295 | **5,295** | 5,285 | 5,287 | 5,287 | 5,258 | 5,256 | 5,256 | 5,261 | 5,261 | 5,261 | 5,264 | 5,262 | 5,260 | **5,267** | **-0,028** |
| **Tr.bond Pl 5** | 5,252 | 5,252 | 5,252 | **5,252** | 5,211 | 5,210 | 5,211 | 5,233 | 5,234 | 5,234 | 5,225 | 5,227 | 5,223 | 5,223 | 5,222 | 5,223 | **5,223** | **-0,029** |
| **pH 4 5.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,325 | 5,323 | 5,321 | **5,323** | 5,315 | 5,314 | 5,316 | 5,310 | 5,308 | 5,309 | 5,295 | 5,293 | 5,293 | 5,307 | 5,305 | 5,303 | **5,306** | **-0,017** |
| **Tr.bond Pl 2** | 5,238 | 5,239 | 5,238 | **5,238** | 5,230 | 5,232 | 5,231 | 5,229 | 5,229 | 5,227 | 5,198 | 5,197 | 5,197 | 5,227 | 5,225 | 5,226 | **5,221** | **-0,018** |
| **Tr.bond Pl 3** | 5,458 | 5,462 | 5,460 | **5,460** | 5,414 | 5,412 | 5,414 | 5,463 | 5,462 | 5,462 | 5,441 | 5,439 | 5,437 | 5,416 | 5,409 | 5,412 | **5,432** | **-0,028** |
| **Tr.bond Pl 4** | 5,296 | 5,296 | 5,296 | **5,296** | 5,286 | 5,285 | 5,280 | 5,255 | 5,250 | 5,255 | 5,263 | 5,263 | 5,264 | 5,263 | 5,263 | 5,264 | **5,266** | **-0,030** |
| **Tr.bond Pl 5** | 5,258 | 5,257 | 5,256 | **5,257** | 5,213 | 5,216 | 5,216 | 5,238 | 5,238 | 5,238 | 5,231 | 5,228 | 5,231 | 5,226 | 5,226 | 5,227 | **5,227** | **-0,030** |
| **pH 4 6.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,320 | 5,320 | 5,321 | **5,320** | 5,310 | 5,311 | 5,312 | 5,307 | 5,307 | 5,306 | 5,293 | 5,289 | 5,287 | 5,301 | 5,300 | 5,300 | **5,302** | **-0,018** |
| **Tr.bond Pl 2** | 5,238 | 5,239 | 5,238 | **5,238** | 5,230 | 5,231 | 5,230 | 5,227 | 5,227 | 5,226 | 5,196 | 5,196 | 5,193 | 5,226 | 5,226 | 5,227 | **5,220** | **-0,019** |
| **Tr.bond Pl 3** | 5,458 | 5,459 | 5,461 | **5,459** | 5,409 | 5,406 | 5,409 | 5,462 | 5,461 | 5,461 | 5,440 | 5,439 | 5,436 | 5,409 | 5,413 | 5,413 | **5,430** | **-0,030** |
| **Tr.bond Pl 4** | 5,297 | 5,297 | 5,297 | **5,297** | 5,284 | 5,288 | 5,286 | 5,256 | 5,256 | 5,253 | 5,260 | 5,263 | 5,261 | 5,258 | 5,266 | 5,260 | **5,266** | **-0,031** |
| **Tr.bond Pl 5** | 5,255 | 5,256 | 5,256 | **5,256** | 5,214 | 5,213 | 5,215 | 5,236 | 5,235 | 5,238 | 5,230 | 5,229 | 5,229 | 5,224 | 5,226 | 5,225 | **5,226** | **-0,029** |
| **pH 4 7.Day** | | | | | | | | | | | | | | | | | | |
| **Tr.bond Pl 1** | 5,322 | 5,322 | 5,322 | **5,322** | 5,314 | 5,313 | 5,312 | 5,308 | 5,308 | 5,308 | 5,289 | 5,288 | 5,287 | 5,301 | 5,301 | 5,302 | **5,303** | **-0,019** |
| **Tr.bond Pl 2** | 5,239 | 5,239 | 5,239 | **5,239** | 5,232 | 5,233 | 5,233 | 5,227 | 5,229 | 5,229 | 5,197 | 5,196 | 5,196 | 5,225 | 5,225 | 5,224 | **5,221** | **-0,018** |
| **Tr.bond Pl 3** | 5,461 | 5,462 | 5,460 | **5,461** | 5,410 | 5,408 | 5,412 | 5,462 | 5,462 | 5,460 | 5,434 | 5,433 | 5,437 | 5,413 | 5,412 | 5,414 | **5,430** | **-0,031** |
| **Tr.bond Pl 4** | 5,299 | 5,298 | 5,298 | **5,298** | 5,287 | 5,287 | 5,289 | 5,258 | 5,260 | 5,260 | 5,262 | 5,262 | 5,262 | 5,261 | 5,262 | 5,257 | **5,267** | **-0,031** |
| **Tr.bond Pl 5** | 5,261 | 5,261 | 5,260 | **5,261** | 5,215 | 5,214 | 5,218 | 5,238 | 5,239 | 5,239 | 5,230 | 5,230 | 5,229 | 5,229 | 5,228 | 5,227 | **5,228** | **-0,033** |

## Table 6.11. Seven days recorded heights and reference points of five samples of Band-LoK cement at pH 2.74 (mm).

| pH 2,74 Beginning | Middle of cement | | | Mean | Upper acrylic reference point | | | Right acrylic reference point | | | Down acrylic reference point | | | Left acrylic reference point | | | Mean | Different |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Band-Lok 1** | 5,262 | 5,261 | 5,261 | **5,261** | 5,242 | 5,236 | 5,236 | 5,244 | 5,241 | 5,241 | 5,245 | 5,234 | 5,242 | 5,231 | 5,233 | 5,242 | **5,239** | **-0,022** |
| **Band-Lok 2** | 5,230 | 5,232 | 5,234 | **5,232** | 5,192 | 5,195 | 5,190 | 5,226 | 5,221 | 5,220 | 5,194 | 5,193 | 5,189 | 5,201 | 5,200 | 5,200 | **5,202** | **-0,030** |
| **Band-Lok 3** | 5,232 | 5,229 | 5,225 | **5,229** | 5,224 | 5,223 | 5,227 | 5,213 | 5,216 | 5,219 | 5,211 | 5,211 | 5,207 | 5,205 | 5,205 | 5,206 | **5,214** | **-0,015** |
| **Band-Lok 4** | 5,291 | 5,293 | 5,296 | **5,293** | 5,280 | 5,288 | 5,272 | 5,274 | 5,270 | 5,263 | 5,264 | 5,264 | 5,261 | 5,258 | 5,268 | 5,259 | **5,268** | **-0,025** |
| **Band-Lok 5** | 5,166 | 5,161 | 5,163 | **5,163** | 5,120 | 5,121 | 5,125 | 5,148 | 5,135 | 5,139 | 5,133 | 5,141 | 5,144 | 5,144 | 5,146 | 5,144 | **5,137** | **-0,027** |
| **pH 2,74 1.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,280 | 5,284 | 5,284 | **5,283** | 5,249 | 5,251 | 5,251 | 5,255 | 5,256 | 5,254 | 5,256 | 5,253 | 5,253 | 5,254 | 5,249 | 5,249 | **5,253** | **-0,030** |
| **Band-Lok 2** | 5,273 | 5,278 | 5,274 | **5,275** | 5,208 | 5,208 | 5,203 | 5,237 | 5,239 | 5,238 | 5,207 | 5,200 | 5,200 | 5,217 | 5,212 | 5,209 | **5,215** | **-0,060** |
| **Band-Lok 3** | 5,249 | 5,248 | 5,249 | **5,249** | 5,241 | 5,243 | 5,239 | 5,229 | 5,233 | 5,236 | 5,223 | 5,220 | 5,219 | 5,223 | 5,222 | 5,222 | **5,229** | **-0,019** |
| **Band-Lok 4** | 5,310 | 5,303 | 5,304 | **5,306** | 5,277 | 5,377 | 5,288 | 5,261 | 5,256 | 5,258 | 5,262 | 5,256 | 5,258 | 5,275 | 5,261 | 5,274 | **5,275** | **-0,030** |
| **Band-Lok 5** | 5,193 | 5,194 | 5,195 | **5,194** | 5,139 | 5,135 | 5,123 | 5,142 | 5,153 | 5,148 | 5,146 | 5,145 | 5,149 | 5,151 | 5,164 | 5,160 | **5,146** | **-0,048** |
| **pH 2,74 2.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,294 | 5,295 | 5,296 | **5,295** | 5,262 | 5,256 | 5,257 | 5,261 | 5,260 | 5,262 | 5,267 | 5,262 | 5,266 | 5,274 | 5,263 | 5,265 | **5,263** | **-0,032** |
| **Band-Lok 2** | 5,283 | 5,279 | 5,282 | **5,281** | 5,208 | 5,209 | 5,213 | 5,246 | 5,243 | 5,240 | 5,216 | 5,217 | 5,205 | 5,219 | 5,216 | 5,214 | **5,221** | **-0,061** |
| **Band-Lok 3** | 5,256 | 5,258 | 5,258 | **5,257** | 5,245 | 5,245 | 5,247 | 5,247 | 5,240 | 5,238 | 5,230 | 5,232 | 5,230 | 5,236 | 5,231 | 5,229 | **5,238** | **-0,020** |
| **Band-Lok 4** | 5,320 | 5,319 | 5,326 | **5,322** | 5,299 | 5,297 | 5,291 | 5,273 | 5,283 | 5,284 | 5,272 | 5,279 | 5,282 | 5,280 | 5,284 | 5,284 | **5,284** | **-0,038** |
| **Band-Lok 5** | 5,200 | 5,198 | 5,200 | **5,199** | 5,139 | 5,135 | 5,137 | 5,147 | 5,153 | 5,155 | 5,163 | 5,151 | 5,164 | 5,163 | 5,166 | 5,170 | **5,154** | **-0,046** |
| **pH 2,74 3.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,293 | 5,295 | 5,296 | **5,295** | 5,255 | 5,260 | 5,256 | 5,259 | 5,264 | 5,263 | 5,259 | 5,264 | 5,266 | 5,254 | 5,259 | 5,260 | **5,260** | **-0,035** |
| **Band-Lok 2** | 5,279 | 5,287 | 5,279 | **5,282** | 5,209 | 5,212 | 5,211 | 5,238 | 5,240 | 5,238 | 5,211 | 5,216 | 5,213 | 5,214 | 5,216 | 5,215 | **5,219** | **-0,062** |
| **Band-Lok 3** | 5,259 | 5,262 | 5,255 | **5,259** | 5,243 | 5,245 | 5,240 | 5,234 | 5,237 | 5,233 | 5,225 | 5,226 | 5,221 | 5,225 | 5,221 | 5,224 | **5,231** | **-0,027** |
| **Band-Lok 4** | 5,312 | 5,307 | 5,310 | **5,310** | 5,283 | 5,285 | 5,280 | 5,262 | 5,266 | 5,264 | 5,258 | 5,261 | 5,263 | 5,266 | 5,270 | 5,271 | **5,269** | **-0,041** |
| **Band-Lok 5** | 5,188 | 5,186 | 5,186 | **5,187** | 5,128 | 5,122 | 5,126 | 5,142 | 5,140 | 5,143 | 5,144 | 5,142 | 5,142 | 5,151 | 5,156 | 5,157 | **5,141** | **-0,046** |
| **pH 2,74 4.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,290 | 5,291 | 5,291 | **5,291** | 5,258 | 5,258 | 5,255 | 5,257 | 5,262 | 5,257 | 5,257 | 5,259 | 5,258 | 5,258 | 5,257 | 5,259 | **5,258** | **-0,033** |
| **Band-Lok 2** | 5,282 | 5,283 | 5,282 | **5,282** | 5,214 | 5,213 | 5,213 | 5,244 | 5,243 | 5,243 | 5,219 | 5,220 | 5,213 | 5,218 | 5,218 | 5,218 | **5,223** | **-0,059** |
| **Band-Lok 3** | 5,261 | 5,260 | 5,261 | **5,261** | 5,246 | 5,246 | 5,245 | 5,238 | 5,240 | 5,241 | 5,228 | 5,228 | 5,227 | 5,226 | 5,229 | 5,231 | **5,235** | **-0,025** |
| **Band-Lok 4** | 5,317 | 5,317 | 5,318 | **5,317** | 5,288 | 5,288 | 5,288 | 5,272 | 5,266 | 5,267 | 5,266 | 5,266 | 5,266 | 5,277 | 5,276 | 5,277 | **5,275** | **-0,043** |
| **Band-Lok 5** | 5,193 | 5,194 | 5,194 | **5,194** | 5,133 | 5,134 | 5,132 | 5,147 | 5,147 | 5,148 | 5,154 | 5,160 | 5,157 | 5,157 | 5,157 | 5,159 | **5,149** | **-0,045** |
| **pH 2,74 5.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,291 | 5,292 | 5,293 | **5,292** | 5,252 | 5,256 | 5,255 | 5,259 | 5,252 | 5,261 | 5,265 | 5,260 | 5,264 | 5,257 | 5,262 | 5,261 | **5,259** | **-0,033** |
| **Band-Lok 2** | 5,283 | 5,285 | 5,283 | **5,284** | 5,213 | 5,217 | 5,216 | 5,245 | 5,245 | 5,245 | 5,214 | 5,210 | 5,213 | 5,218 | 5,220 | 5,220 | **5,223** | **-0,061** |
| **Band-Lok 3** | 5,262 | 5,259 | 5,262 | **5,261** | 5,247 | 5,249 | 5,247 | 5,238 | 5,238 | 5,238 | 5,228 | 5,228 | 5,228 | 5,227 | 5,227 | 5,228 | **5,235** | **-0,026** |
| **Band-Lok 4** | 5,318 | 5,317 | 5,317 | **5,317** | 5,289 | 5,288 | 5,288 | 5,270 | 5,267 | 5,269 | 5,267 | 5,267 | 5,268 | 5,275 | 5,277 | 5,275 | **5,275** | **-0,042** |
| **Band-Lok 5** | 5,200 | 5,198 | 5,199 | **5,199** | 5,139 | 5,140 | 5,139 | 5,158 | 5,155 | 5,155 | 5,157 | 5,152 | 5,157 | 5,161 | 5,161 | 5,162 | **5,153** | **-0,046** |
| **pH 2,74 6.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,294 | 5,294 | 5,294 | **5,294** | 5,257 | 5,258 | 5,259 | 5,260 | 5,261 | 5,263 | 5,258 | 5,261 | 5,259 | 5,257 | 5,257 | 5,257 | **5,259** | **-0,035** |
| **Band-Lok 2** | 5,285 | 5,287 | 5,287 | **5,286** | 5,212 | 5,214 | 5,211 | 5,246 | 5,245 | 5,247 | 5,213 | 5,216 | 5,211 | 5,220 | 5,221 | 5,220 | **5,223** | **-0,063** |
| **Band-Lok 3** | 5,261 | 5,261 | 5,259 | **5,260** | 5,247 | 5,246 | 5,247 | 5,241 | 5,240 | 5,246 | 5,229 | 5,230 | 5,230 | 5,229 | 5,230 | 5,231 | **5,237** | **-0,023** |
| **Band-Lok 4** | 5,318 | 5,318 | 5,318 | **5,318** | 5,291 | 5,290 | 5,291 | 5,276 | 5,275 | 5,272 | 5,267 | 5,268 | 5,268 | 5,276 | 5,273 | 5,277 | **5,277** | **-0,041** |
| **Band-Lok 5** | 5,197 | 5,197 | 5,196 | **5,197** | 5,136 | 5,135 | 5,136 | 5,153 | 5,156 | 5,153 | 5,157 | 5,157 | 5,157 | 5,160 | 5,161 | 5,162 | **5,152** | **-0,045** |
| **pH 2,74 7.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,296 | 5,296 | 5,297 | **5,296** | 5,263 | 5,262 | 5,258 | 5,265 | 5,261 | 5,261 | 5,263 | 5,261 | 5,264 | 5,259 | 5,260 | 5,261 | **5,262** | **-0,035** |
| **Band-Lok 2** | 5,283 | 5,284 | 5,284 | **5,284** | 5,219 | 5,219 | 5,216 | 5,247 | 5,247 | 5,247 | 5,212 | 5,212 | 5,211 | 5,221 | 5,222 | 5,223 | **5,225** | **-0,059** |
| **Band-Lok 3** | 5,263 | 5,263 | 5,265 | **5,264** | 5,250 | 5,250 | 5,250 | 5,242 | 5,240 | 5,240 | 5,229 | 5,229 | 5,229 | 5,228 | 5,229 | 5,230 | **5,237** | **-0,026** |
| **Band-Lok 4** | 5,316 | 5,315 | 5,317 | **5,316** | 5,289 | 5,288 | 5,288 | 5,270 | 5,268 | 5,269 | 5,267 | 5,267 | 5,267 | 5,265 | 5,275 | 5,273 | **5,274** | **-0,042** |
| **Band-Lok 5** | 5,200 | 5,199 | 5,200 | **5,200** | 5,139 | 5,140 | 5,139 | 5,154 | 5,153 | 5,155 | 5,149 | 5,151 | 5,154 | 5,162 | 5,164 | 5,162 | **5,152** | **-0,048** |

**Table 6.12. Seven days recorded heights and reference points of five samples of Band-LoK cement at pH 4.0 (mm).**

| pH 4 Beginning | Middle of cement | | | Mean | Upper acrylic reference point | | | Right acrylic reference point | | | Down acrylic reference point | | | Left acrylic reference point | | | Mean | Different |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Band-Lok 1** | 5,165 | 5,166 | 5,169 | **5,167** | 5,160 | 5,158 | 5,155 | 5,129 | 5,136 | 5,132 | 5,140 | 5,149 | 5,144 | 5,154 | 5,159 | 5,158 | **5,148** | **-0,019** |
| **Band-Lok 2** | 5,239 | 5,236 | 5,239 | **5,238** | 5,185 | 5,186 | 5,191 | 5,234 | 5,233 | 5,260 | 5,226 | 5,230 | 5,232 | 5,215 | 5,220 | 5,220 | **5,219** | **-0,019** |
| **Band-Lok 3** | 5,212 | 5,219 | 5,219 | **5,217** | 5,190 | 5,190 | 5,188 | 5,192 | 5,194 | 5,192 | 5,191 | 5,195 | 5,194 | 5,186 | 5,189 | 5,185 | **5,191** | **-0,026** |
| **Band-Lok 4** | 5,231 | 5,230 | 5,234 | **5,232** | 5,198 | 5,203 | 5,199 | 5,230 | 5,232 | 5,228 | 5,215 | 5,223 | 5,226 | 5,160 | 5,165 | 5,162 | **5,203** | **-0,028** |
| **Band-Lok 5** | 5,476 | 5,469 | 5,477 | **5,474** | 5,444 | 5,451 | 5,456 | 5,467 | 5,463 | 5,466 | 5,455 | 5,446 | 5,444 | 5,442 | 5,447 | 5,443 | **5,452** | **-0,022** |
| **pH 4 1.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,179 | 5,177 | 5,180 | **5,179** | 5,171 | 5,170 | 5,163 | 5,144 | 5,142 | 5,142 | 5,151 | 5,157 | 5,152 | 5,162 | 5,166 | 5,159 | **5,157** | **-0,022** |
| **Band-Lok 2** | 5,239 | 5,241 | 5,236 | **5,239** | 5,173 | 5,173 | 5,168 | 5,232 | 5,231 | 5,229 | 5,222 | 5,226 | 5,222 | 5,215 | 5,215 | 5,207 | **5,209** | **-0,029** |
| **Band-Lok 3** | 5,216 | 5,221 | 5,223 | **5,220** | 5,191 | 5,197 | 5,185 | 5,189 | 5,196 | 5,197 | 5,169 | 5,175 | 5,174 | 5,169 | 5,173 | 5,174 | **5,182** | **-0,038** |
| **Band-Lok 4** | 5,253 | 5,250 | 5,252 | **5,252** | 5,217 | 5,218 | 5,217 | 5,250 | 5,247 | 5,252 | 5,233 | 5,233 | 5,241 | 5,175 | 5,185 | 5,183 | **5,221** | **-0,031** |
| **Band-Lok 5** | 5,480 | 5,486 | 5,477 | **5,481** | 5,443 | 5,444 | 5,438 | 5,465 | 5,460 | 5,468 | 5,453 | 5,440 | 5,443 | 5,442 | 5,436 | 5,435 | **5,447** | **-0,034** |
| **pH 4 2.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,181 | 5,181 | 5,177 | **5,180** | 5,156 | 5,157 | 5,160 | 5,137 | 5,143 | 5,133 | 5,149 | 5,152 | 5,141 | 5,157 | 5,155 | 5,147 | **5,149** | **-0,031** |
| **Band-Lok 2** | 5,238 | 5,244 | 5,290 | **5,257** | 5,181 | 5,175 | 5,171 | 5,230 | 5,226 | 5,228 | 5,234 | 5,226 | 5,227 | 5,222 | 5,214 | 5,218 | **5,213** | **-0,045** |
| **Band-Lok 3** | 5,223 | 5,223 | 5,223 | **5,223** | 5,193 | 5,191 | 5,194 | 5,199 | 5,200 | 5,200 | 5,170 | 5,171 | 5,165 | 5,170 | 5,168 | 5,172 | **5,183** | **-0,040** |
| **Band-Lok 4** | 5,260 | 5,259 | 5,252 | **5,257** | 5,217 | 5,218 | 5,224 | 5,249 | 5,254 | 5,247 | 5,233 | 5,230 | 5,233 | 5,183 | 5,178 | 5,179 | **5,220** | **-0,037** |
| **Band-Lok 5** | 5,485 | 5,480 | 5,484 | **5,483** | 5,448 | 5,443 | 5,443 | 5,470 | 5,474 | 5,467 | 5,455 | 5,450 | 5,445 | 5,436 | 5,440 | 5,446 | **5,451** | **-0,032** |
| **pH 4 3.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,186 | 5,189 | 5,189 | **5,188** | 5,170 | 5,170 | 5,167 | 5,145 | 5,147 | 5,149 | 5,153 | 5,159 | 5,160 | 5,167 | 5,162 | 5,169 | **5,160** | **-0,028** |
| **Band-Lok 2** | 5,236 | 5,236 | 5,242 | **5,238** | 5,170 | 5,169 | 5,164 | 5,220 | 5,229 | 5,224 | 5,223 | 5,228 | 5,220 | 5,211 | 5,211 | 5,213 | **5,207** | **-0,031** |
| **Band-Lok 3** | 5,224 | 5,221 | 5,222 | **5,222** | 5,187 | 5,188 | 5,190 | 5,195 | 5,191 | 5,191 | 5,176 | 5,171 | 5,171 | 5,166 | 5,163 | 5,166 | **5,180** | **-0,043** |
| **Band-Lok 4** | 5,282 | 5,279 | 5,270 | **5,277** | 5,222 | 5,216 | 5,215 | 5,251 | 5,252 | 5,254 | 5,239 | 5,240 | 5,141 | 5,173 | 5,177 | 5,179 | **5,213** | **-0,064** |
| **Band-Lok 5** | 5,487 | 5,491 | 5,495 | **5,491** | 5,456 | 5,452 | 5,450 | 5,477 | 5,480 | 5,481 | 5,457 | 5,459 | 5,462 | 5,445 | 5,450 | 5,461 | **5,461** | **-0,030** |
| **pH 4 4.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,190 | 5,190 | 5,190 | **5,190** | 5,163 | 5,163 | 5,162 | 5,147 | 5,146 | 5,147 | 5,156 | 5,154 | 5,156 | 5,158 | 5,160 | 5,160 | **5,156** | **-0,034** |
| **Band-Lok 2** | 5,240 | 5,241 | 5,242 | **5,241** | 5,171 | 5,176 | 5,177 | 5,226 | 5,227 | 5,227 | 5,224 | 5,226 | 5,230 | 5,214 | 5,213 | 5,215 | **5,211** | **-0,031** |
| **Band-Lok 3** | 5,226 | 5,226 | 5,226 | **5,226** | 5,191 | 5,192 | 5,191 | 5,197 | 5,198 | 5,196 | 5,184 | 5,181 | 5,179 | 5,178 | 5,177 | 5,173 | **5,186** | **-0,040** |
| **Band-Lok 4** | 5,272 | 5,274 | 5,275 | **5,274** | 5,223 | 5,222 | 5,222 | 5,254 | 5,254 | 5,253 | 5,248 | 5,247 | 5,247 | 5,188 | 5,189 | 5,190 | **5,228** | **-0,046** |
| **Band-Lok 5** | 5,488 | 5,488 | 5,487 | **5,488** | 5,454 | 5,455 | 5,453 | 5,480 | 5,481 | 5,481 | 5,460 | 5,463 | 5,465 | 5,443 | 5,448 | 5,444 | **5,461** | **-0,027** |
| **pH 4 5.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,191 | 5,191 | 5,192 | **5,191** | 5,168 | 5,166 | 5,165 | 5,147 | 5,145 | 5,145 | 5,155 | 5,155 | 5,154 | 5,164 | 5,162 | 5,162 | **5,157** | **-0,034** |
| **Band-Lok 2** | 5,245 | 5,245 | 5,245 | **5,245** | 5,176 | 5,178 | 5,174 | 5,231 | 5,230 | 5,230 | 5,227 | 5,227 | 5,228 | 5,214 | 5,215 | 5,215 | **5,212** | **-0,033** |
| **Band-Lok 3** | 5,225 | 5,225 | 5,226 | **5,225** | 5,192 | 5,191 | 5,192 | 5,196 | 5,197 | 5,196 | 5,177 | 5,167 | 5,174 | 5,176 | 5,170 | 5,175 | **5,184** | **-0,042** |
| **Band-Lok 4** | 5,284 | 5,285 | 5,285 | **5,285** | 5,222 | 5,222 | 5,221 | 5,254 | 5,256 | 5,256 | 5,235 | 5,236 | 5,241 | 5,185 | 5,188 | 5,188 | **5,225** | **-0,059** |
| **Band-Lok 5** | 5,488 | 5,486 | 5,486 | **5,487** | 5,452 | 5,448 | 5,454 | 5,474 | 5,473 | 5,474 | 5,451 | 5,456 | 5,455 | 5,453 | 5,451 | 5,453 | **5,458** | **-0,029** |
| **pH 4 6.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,195 | 5,195 | 5,196 | **5,195** | 5,167 | 5,168 | 5,168 | 5,149 | 5,149 | 5,151 | 5,160 | 5,158 | 5,160 | 5,162 | 5,161 | 5,161 | **5,160** | **-0,036** |
| **Band-Lok 2** | 5,246 | 5,245 | 5,245 | **5,245** | 5,178 | 5,174 | 5,171 | 5,231 | 5,230 | 5,230 | 5,224 | 5,226 | 5,224 | 5,215 | 5,215 | 5,216 | **5,211** | **-0,034** |
| **Band-Lok 3** | 5,232 | 5,232 | 5,232 | **5,232** | 5,200 | 5,199 | 5,200 | 5,205 | 5,205 | 5,204 | 5,178 | 5,172 | 5,178 | 5,174 | 5,173 | 5,177 | **5,189** | **-0,043** |
| **Band-Lok 4** | 5,293 | 5,293 | 5,294 | **5,293** | 5,226 | 5,227 | 5,226 | 5,259 | 5,258 | 5,256 | 5,240 | 5,245 | 5,243 | 5,184 | 5,183 | 5,181 | **5,227** | **-0,066** |
| **Band-Lok 5** | 5,488 | 5,487 | 5,489 | **5,488** | 5,447 | 5,451 | 5,446 | 5,483 | 5,483 | 5,484 | 5,459 | 5,457 | 5,460 | 5,442 | 5,445 | 5,449 | **5,459** | **-0,029** |
| **pH 4 7.Day** | | | | | | | | | | | | | | | | | | |
| **Band-Lok 1** | 5,189 | 5,192 | 5,191 | **5,191** | 5,169 | 5,168 | 5,167 | 5,147 | 5,146 | 5,146 | 5,155 | 5,155 | 5,156 | 5,170 | 5,169 | 5,165 | **5,159** | **-0,031** |
| **Band-Lok 2** | 5,247 | 5,247 | 5,246 | **5,247** | 5,182 | 5,177 | 5,181 | 5,229 | 5,229 | 5,229 | 5,228 | 5,225 | 5,229 | 5,216 | 5,216 | 5,215 | **5,213** | **-0,034** |
| **Band-Lok 3** | 5,227 | 5,228 | 5,228 | **5,228** | 5,195 | 5,194 | 5,196 | 5,198 | 5,198 | 5,200 | 5,176 | 5,175 | 5,181 | 5,172 | 5,178 | 5,183 | **5,187** | **-0,041** |
| **Band-Lok 4** | 5,294 | 5,296 | 5,295 | **5,295** | 5,226 | 5,226 | 5,227 | 5,263 | 5,261 | 5,261 | 5,242 | 5,240 | 5,239 | 5,188 | 5,190 | 5,193 | **5,230** | **-0,065** |
| **Band-Lok 5** | 5,495 | 5,492 | 5,494 | **5,494** | 5,454 | 5,455 | 5,456 | 5,478 | 5,479 | 5,476 | 5,453 | 5,453 | 5,456 | 5,454 | 5,451 | 5,451 | **5,460** | **-0,034** |

**Table 6.13. Seven days recorded amounts of cement loss or gain of Zinc phosphate cement at pH 2.74 and 4.0 (µm).**

| Zinc Phosphate Cement<br>pH 2.74 | 1.Day | 2.Day | 3.Day | 4.Day | 5.Day | 6.Day | 7.Day |
|---|---|---|---|---|---|---|---|
| **Sample 1** | 119,00 | 229,92 | 314,75 | 348,17 | 415,75 | 446,92 | 478,83 |
| **Sample 2** | 135,00 | 258,58 | 329,75 | 398,50 | 483,33 | 542,58 | 592,75 |
| **Sample 3** | 118,67 | 237,42 | 326,08 | 385,17 | 432,00 | 481,42 | 522,83 |
| **Sample 4** | 120,67 | 229,00 | 312,25 | 391,25 | 440,17 | 477,75 | 525,42 |
| **Sample 5** | 122,25 | 233,67 | 326,58 | 395,58 | 440,67 | 485,00 | 553,50 |
| **Mean** | **123,12** | **237,72** | **321,88** | **383,73** | **442,38** | **486,73** | **534,67** |
| **pH 4** | | | | | | | |
| **Sample 1** | 53,58 | 109,92 | 148,25 | 183,67 | 207,75 | 233,50 | 247,75 |
| **Sample 2** | 50,33 | 33,67 | 138,92 | 174,92 | 186,17 | 227,17 | 245,50 |
| **Sample 3** | -25,92 | 87,08 | 129,67 | 159,50 | 178,58 | 210,50 | 217,75 |
| **Sample 4** | 44,17 | 102,00 | 144,08 | 176,25 | 204,58 | 228,83 | 254,33 |
| **Sample 5** | 50,42 | 80,17 | 136,25 | 170,17 | 191,50 | 214,25 | 232,42 |
| **Mean** | **34,52** | **82,57** | **139,43** | **172,90** | **193,72** | **222,85** | **239,55** |

**Table 6.14. Seven days recorded amounts of cement loss or gain of Multi cure glass ionomer cement at pH 2.74 and 4.0 (µm).**

| Multi Cure Glass Ionomer<br>pH 2.74 | 1.Day | 2.Day | 3.Day | 4.Day | 5.Day | 6.Day | 7.Day |
|---|---|---|---|---|---|---|---|
| **Sample 1** | -16,25 | -16,08 | -20,50 | -16,25 | -16,00 | -8,25 | -11,75 |
| **Sample 2** | -12,92 | -14,17 | -17,67 | -7,33 | -13,33 | -5,58 | -3,25 |
| **Sample 3** | -35,75 | -41,58 | -46,42 | -39,08 | -46,33 | -32,33 | -34,67 |
| **Sample 4** | -17,50 | -11,42 | -13,42 | -12,08 | -13,42 | -1,08 | -0,83 |
| **Sample 5** | -42,67 | -42,08 | -52,25 | -48,67 | -46,17 | -37,50 | -32,75 |
| **Mean** | **-25,02** | **-25,07** | **-30,05** | **-24,68** | **-27,05** | **-16,95** | **-16,65** |
| **pH 4** | | | | | | | |
| **Sample 1** | -18,50 | -23,83 | -26,75 | -29,25 | -25,83 | -19,25 | -28,08 |
| **Sample 2** | -1,42 | -2,08 | 1,17 | -3,67 | -6,92 | -1,33 | 3,17 |
| **Sample 3** | 5,33 | 3,33 | -1,42 | 1,17 | 0,92 | 5,08 | 10,58 |
| **Sample 4** | -3,83 | 79,25 | -8,67 | -5,92 | -5,08 | 0,92 | 7,08 |
| **Sample 5** | -1,08 | 9,92 | 1,25 | 2,25 | -0,33 | 10,25 | 3,08 |
| **Mean** | **-3,90** | **13,32** | **-6,88** | **-7,08** | **-7,45** | **-0,87** | **-0,83** |

Negative values=cement gain
Positive values=cement loss

**Table 6.15. Seven days recorded amounts of cement loss or gain of Ultra band LoK cement at pH 2.74 and 4.0 (µm).**

| Ultra Band Lok<br>pH 2.74 | 1.Day | 2.Day | 3.Day | 4.Day | 5.Day | 6.Day | 7.Day |
|---|---|---|---|---|---|---|---|
| **Sample 1** | -7,17 | -9,33 | -15,25 | -15,00 | -16,83 | -17,25 | -20,17 |
| **Sample 2** | -5,17 | -4,50 | -6,08 | -3,67 | -5,92 | -4,25 | -5,00 |
| **Sample 3** | -9,67 | -12,17 | -16,00 | -14,17 | -16,75 | -16,17 | -17,92 |
| **Sample 4** | -32,75 | -36,33 | -35,83 | -35,50 | -36,50 | -35,83 | -36,42 |
| **Sample 5** | -4,00 | -5,08 | -8,42 | -9,42 | -9,92 | -12,42 | -12,67 |
| **Mean** | **-11,75** | **-13,48** | **-16,32** | **-15,55** | **-17,18** | **-17,18** | **-18,43** |
| **pH 4** | | | | | | | |
| **Sample 1** | -13,92 | -12,25 | -12,08 | -14,50 | -15,58 | -15,92 | -16,33 |
| **Sample 2** | -3,25 | -5,42 | -5,25 | -7,33 | -9,75 | -11,50 | -12,33 |
| **Sample 3** | -11,83 | -12,92 | -13,25 | -12,83 | -13,67 | -12,42 | -12,92 |
| **Sample 4** | -8,33 | -12,50 | -4,92 | -13,33 | -13,00 | -14,17 | -18,00 |
| **Sample 5** | -6,67 | -7,50 | -7,33 | -10,08 | -9,42 | -10,00 | -9,67 |
| **Mean** | **-8,80** | **-10,12** | **-8,57** | **-11,62** | **-12,28** | **-12,80** | **-13,85** |

**Table 6.16. Seven days recorded amounts of cement loss or gain of MR LOCK cement at pH 2.74 and 4.0 (µm).**

| MR Lock<br>pH 2.74 | 1.Day | 2.Day | 3.Day | 4.Day | 5.Day | 6.Day | 7.Day |
|---|---|---|---|---|---|---|---|
| **Sample 1** | -3,25 | -7,33 | -4,25 | -7,50 | -8,00 | -7,42 | -9,67 |
| **Sample 2** | 0,42 | -1,67 | -5,42 | -4,33 | -7,75 | -6,33 | -5,92 |
| **Sample 3** | -25,83 | -31,25 | -27,25 | -33,58 | -32,58 | -34,08 | -33,25 |
| **Sample 4** | -5,33 | -11,75 | -10,42 | -12,58 | -12,58 | -12,42 | -13,00 |
| **Sample 5** | -3,42 | -9,08 | -11,08 | -15,17 | -16,17 | -16,00 | -15,17 |
| **Mean** | **-7,48** | **-12,22** | **-11,68** | **-14,63** | **-15,42** | **-15,25** | **-15,40** |
| **pH 4** | | | | | | | |
| **Sample 1** | -4,92 | -13,67 | -13,17 | -17,50 | -18,25 | -17,33 | -17,58 |
| **Sample 2** | -1,83 | -4,08 | -3,67 | -3,67 | -4,58 | -4,33 | -4,58 |
| **Sample 3** | -7,00 | -10,00 | -8,33 | -9,58 | -6,25 | -7,33 | -6,83 |
| **Sample 4** | -0,75 | -1,08 | -3,83 | -4,75 | -4,33 | -4,75 | -5,33 |
| **Sample 5** | -4,08 | -5,00 | -6,92 | -7,25 | -7,17 | -6,17 | -7,33 |
| **Mean** | **-3,72** | **-6,77** | **-7,18** | **-8,55** | **-8,12** | **-7,98** | **-8,33** |

Negative values=cement gain
Positive values=cement loss

**Table 6.17. Seven days recorded amounts of cement loss or gain of Transbond plus cement at pH 2.74 and 4.0 (µm).**

| Transbond Plus<br>pH 2.74 | 1.Day | 2.Day | 3.Day | 4.Day | 5.Day | 6.Day | 7.Day |
|---|---|---|---|---|---|---|---|
| **Sample 1** | -1,00 | -4,58 | -7,42 | -9,00 | -11,67 | -12,33 | -15,17 |
| **Sample 2** | -7,92 | -10,50 | -10,83 | -8,92 | -10,17 | -10,08 | -10,17 |
| **Sample 3** | 2,92 | 1,17 | 1,17 | 1,67 | 0,83 | -0,58 | -2,83 |
| **Sample 4** | 0,67 | 2,17 | 1,33 | 2,42 | 1,25 | -0,67 | 1,00 |
| **Sample 5** | -6,83 | -10,00 | -9,17 | -8,33 | -10,00 | -16,33 | -12,58 |
| **Mean** | **-2,43** | **-4,35** | **-4,98** | **-4,43** | **-5,95** | **-8,00** | **-7,95** |
| **pH 4** | | | | | | | |
| **Sample 1** | 4,42 | 2,67 | 1,75 | 1,58 | 1,75 | 0,67 | -0,33 |
| **Sample 2** | -3,75 | -3,92 | -8,33 | -4,08 | -5,17 | -6,25 | -6,00 |
| **Sample 3** | 2,92 | 0,83 | 0,92 | 1,17 | 0,67 | -0,58 | -2,33 |
| **Sample 4** | -4,67 | -4,92 | -8,25 | -6,67 | -8,58 | -9,58 | -9,58 |
| **Sample 5** | -4,83 | -6,42 | -12,58 | -10,42 | -11,08 | -10,92 | -14,08 |
| **Mean** | **-1,18** | **-2,35** | **-5,30** | **-3,68** | **-4,48** | **-5,33** | **-6,47** |

**Table 6.18. Seven days recorded amounts of cement loss or gain of Band-LoK cement at pH 2.74 and 4.0 (µm).**

| Band-Lok<br>pH 2.74 | 1.Day | 2.Day | 3.Day | 4.Day | 5.Day | 6.Day | 7.Day |
|---|---|---|---|---|---|---|---|
| **Sample 1** | -7,75 | -9,67 | -12,33 | -10,33 | -10,92 | -12,67 | -12,42 |
| **Sample 2** | -29,92 | -30,58 | -32,00 | -29,08 | -30,42 | -33,08 | -28,75 |
| **Sample 3** | -4,75 | -5,08 | -12,75 | -10,50 | -11,00 | -8,42 | -11,75 |
| **Sample 4** | -5,50 | -12,75 | -15,67 | -17,67 | -17,42 | -16,08 | -17,25 |
| **Sample 5** | -21,08 | -19,08 | -18,92 | -18,25 | -19,33 | -18,08 | -21,17 |
| **Mean** | **-13,80** | **-15,43** | **-18,33** | **-17,17** | **-17,82** | **-17,67** | **-18,27** |
| **pH 4** | | | | | | | |
| **Sample 1** | -3,25 | -11,92 | -9,33 | -15,17 | -15,17 | -17,00 | -12,42 |
| **Sample 2** | -10,58 | -26,00 | -12,50 | -11,83 | -14,25 | -15,50 | -15,00 |
| **Sample 3** | -11,42 | -14,08 | -16,58 | -13,42 | -15,58 | -17,08 | -14,33 |
| **Sample 4** | -2,50 | -8,33 | -35,50 | -17,33 | -31,08 | -37,75 | -37,08 |
| **Sample 5** | -11,75 | -9,58 | -8,17 | -5,08 | -6,83 | -7,17 | -12,00 |
| **Mean** | **-7,90** | **-13,98** | **-16,42** | **-12,57** | **-16,58** | **-18,90** | **-18,17** |

Negative values=cement gain
Positive values=cement loss

**Table 6.19. Seven days vertical cement loss means and standard deviation of 6 different tested cements**

| | | 1.Day | 2.Day | 3.Day | 4.Day | 5.Day | 6.Day | 7.Day |
|---|---|---|---|---|---|---|---|---|
| **Zinc Phosphate Cemen** | **pH 2.74** | 123,12±6,8 | 237,72±12,13 | 321,88±7,83 | 383,73±20,51 | 442,38±25,01 | 486,73±34,7 | 534,67±42,05 |
| | **pH 4** | 34,52±33,96 | 82,57±29,76 | 139,43±7,16 | 172,9±8,92 | 193,72±12,31 | 222,85±9,93 | 239,55±14,55 |
| **Multi Cure Glass Ionomer** | **pH 2.74** | -25,02±13,29 | -25,07±15,4 | -30,05±17,9 | -24,68±18,12 | -27,05±17,56 | -16,95±16,7 | -16,65±16,11 |
| | **pH 4** | -3,9±8,84 | 13,32±38,97 | -6,88±11,82 | -7,08±12,84 | -7,45±10,78 | -0,87±11,18 | -0,83±15,55 |
| **Ultra Band Lok** | **pH 2.74** | -11,75±11,93 | -13,48±13,16 | -16,32±11,72 | -15,55±12,03 | -17,18±11,76 | -17,18±11,61 | -18,43±11,62 |
| | **pH 4** | -8,8±4,21 | -10,12±3,43 | -8,57±3,88 | -11,62±2,89 | -12,28±2,64 | -12,8±2,31 | -13,85±3,32 |
| **MR Lock** | **pH 2.74** | -7,48±10,47 | -12,22±11,26 | -11,68±9,2 | -14,63±11,41 | -15,42±10,21 | -15,25±11,23 | -15,4±10,57 |
| | **pH 4** | -3,72±2,49 | -6,77±5,02 | -7,18±3,9 | -8,55±5,5 | -8,12±5,79 | -7,98±5,36 | -8,33±5,29 |
| **Transbond Plus** | **pH 2.74** | -2,43±4,74 | -4,35±5,97 | -4,98±5,82 | -4,43±5,92 | -5,95±6,42 | -8±7,09 | -7,95±6,8 |
| | **pH 4** | -1,18±4,48 | -2,35±3,9 | -5,3±6,31 | -3,68±5,14 | -4,48±5,62 | -5,33±5,21 | -6,47±5,54 |
| **Band-Lok** | **pH 2.74** | -13,8±11,18 | -15,43±9,88 | -18,33±8,08 | -17,17±7,66 | -17,82±7,99 | -17,67±9,37 | -18,27±7 |
| | **pH 4** | -7,9±4,61 | -13,98±7,07 | -16,42±11,16 | -12,57±4,66 | -16,58±8,86 | -18,9±11,31 | -18,17±10,65 |

**Table 6.20. Two way ANOVA**

| | Degree of Free | Mean Square | F Ratio | P Value |
|---|---|---|---|---|
| **Between Groups** | | | | |
| Siman | 5 | 849577,977 | 242,176 | **0,0001** |
| pH | 1 | 85196,024 | 24,286 | **0,0001** |
| Siman*pH | 6 | 17431,611 | 4,969 | **0,0001** |
| **Repeated Time** | | | | |
| Time | 6 | 472026,413 | 35,235 | **0,0001** |
| Time *Siman | 30 | 849577,977 | 63,418 | **0,0001** |
| Time * pH | 6 | 85196,024 | 6,360 | **0,001** |
| Time*pH*Siman | 30 | 13396,542 | 58,987 | **0,001** |

**Table 6.21. Tukey's Multiple Comparison Test**

| Tukey's Multiple Comparison Test | 1.Day | 2.Day | 3.Day | 4.Day | 5.Day | 6.Day | 7.Day |
|---|---|---|---|---|---|---|---|
| Zinc Phosphate Cement /Multi Cure Glass Ionomer | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** |
| Zinc Phosphate Cement/Ultra Band Lok | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** |
| Zinc Phosphate Cement/ MR Lock | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** |
| Zinc Phosphate Cement/ Transbond Plus | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** |
| Zinc Phosphate Cement/ Band-Lok | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** | **0,0001** |
| Multi Cure Glass Ionomer/Ultra Band Lok | 0,998 | 0,999 | 0,999 | 0,999 | 0,999 | 0,999 | 0,999 |
| Multi Cure Glass Ionomer/MR Lock | 0,952 | 0,998 | 0,995 | 0,999 | 0,999 | 0,999 | 0,999 |
| Multi Cure Glass Ionomer/Transbond Plus | 0,813 | 0,998 | 0,972 | 0,991 | 0,995 | 0,995 | 0,995 |
| Multi Cure Glass Ionomer/Band-Lok | 0,999 | 0,995 | 0,998 | 0,998 | 0,998 | 0,999 | 0,999 |
| Ultra Band Lok/MR Lock | 0,997 | 0,998 | 0,998 | 0,998 | 0,998 | 0,995 | 0,995 |
| Ultra Band Lok/Transbond Plus | 0,96 | 0,996 | 0,998 | 0,997 | 0,998 | 0,999 | 0,999 |
| Ultra Band Lok/Band-Lok | 0,998 | 0,998 | 0,998 | 0,998 | 0,998 | 0,995 | 0,995 |
| MR Lock/Transbond Plus | 0,999 | 0,999 | 0,998 | 0,999 | 0,998 | 0,995 | 0,995 |
| MR Lock/Band-Lok | 0,995 | 0,998 | 0,998 | 0,998 | 0,998 | 0,995 | 0,995 |
| Transbond Plus/Band-Lok | 0,947 | 0,983 | 0,981 | 0,994 | 0,995 | 0,997 | 0,999 |

Table 6.22. **Newman-Keuls Multiple Comparison Test**

| Newman-Keuls Multiple Comparison Test | Zinc Phosphate Cement | Multi Cure Glass Ionomer | Ultra Band Lok | MR Lock | Transbond Plus | Band-Lok |
|---|---|---|---|---|---|---|
| **1.Day / 2.Day** | **0,007** | 0,237 | **0,034** | **0,002** | **0,014** | **0,049** |
| **1.Day / 3.Day** | **0,0001** | **0,059** | **0,028** | **0,003** | **0,002** | **0,048** |
| **1.Day / 4.Day** | **0,0001** | 0,405 | **0,047** | **0,001** | **0,039** | 0,126 |
| **1.Day / 5.Day** | **0,0001** | 0,086 | **0,001** | 0,806 | **0,011** | 0,072 |
| **1.Day / 6.Day** | **0,0001** | **0,009** | **0,004** | **0,001** | **0,002** | 0,068 |
| **1.Day / 7.Day** | **0,0001** | **0,029** | **0,004** | **0,001** | **0,004** | 0,72 |
| **2.Day / 3.Day** | **0,007** | 0,179 | 0,51 | 0,947 | **0,024** | 0,459 |
| **2.Day / 4.Day** | **0,031** | 0,256 | 0,13 | **0,017** | 0,325 | 0,941 |
| **2.Day / 5.Day** | **0,0001** | 0,193 | **0,005** | 0,632 | 0,052 | 0,415 |
| **2.Day / 6.Day** | **0,0001** | 0,716 | **0,016** | **0,04** | **0,004** | 0,32 |
| **2.Day / 7.Day** | **0,0001** | 0,709 | **0,007** | **0,019** | **0,007** | 0,385 |
| **3.Day / 4.Day** | **0,0001** | **0,044** | 0,176 | **0,017** | 0,057 | 0,249 |
| **3.Day / 5.Day** | **0,0001** | 0,343 | **0,009** | 0,606 | 0,894 | 0,855 |
| **3.Day / 6.Day** | **0,031** | **0,0001** | **0,032** | **0,014** | 0,09 | 0,332 |
| **3.Day / 7.Day** | 0,349 | **0,001** | **0,02** | **0,008** | **0,047** | 0,389 |
| **4.Day / 5.Day** | **0,003** | 0,251 | 0,708 | 0,386 | **0,001** | 0,289 |
| **4.Day / 6.Day** | **0,0001** | **0,0001** | 0,795 | 0,94 | **0,003** | 0,104 |
| **4.Day / 7.Day** | **0,0001** | **0,003** | 0,822 | 0,515 | **0,0001** | 0,445 |
| **5.Day / 6.Day** | **0,0001** | **0,0001** | 0,568 | 0,38 | **0,036** | 0,186 |
| **5.Day / 7.Day** | **0,0001** | **0,001** | 0,062 | 0,346 | **0,002** | 0,371 |
| **6.Day / 7.Day** | 0,349 | 0,929 | **0,03** | 0,46 | 0,453 | 0,346 |

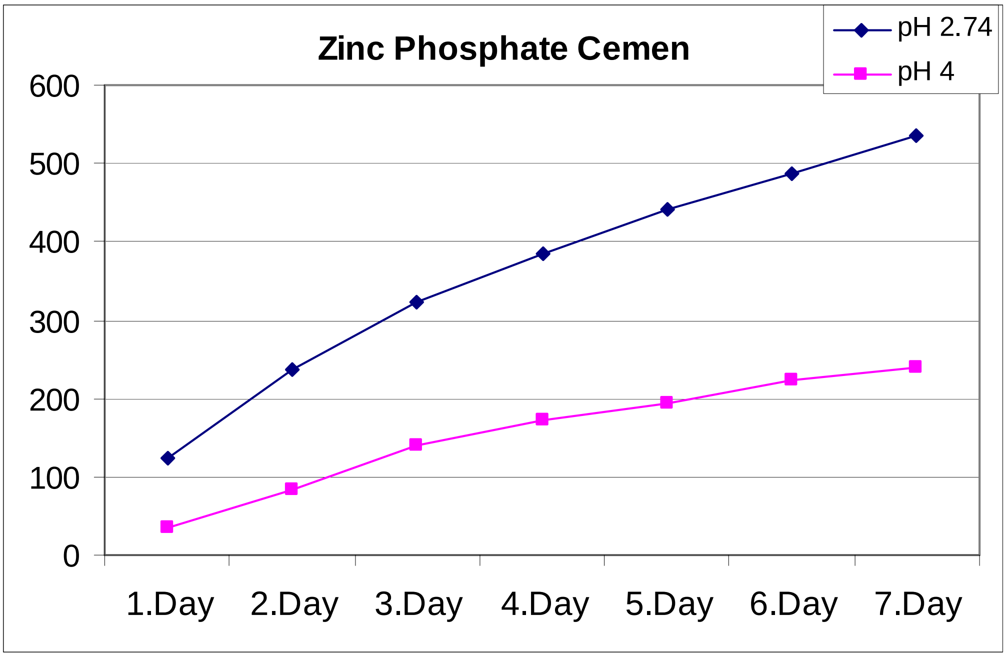



**Figure 6.1. Depth loss of Zinc phosphate cement over time**

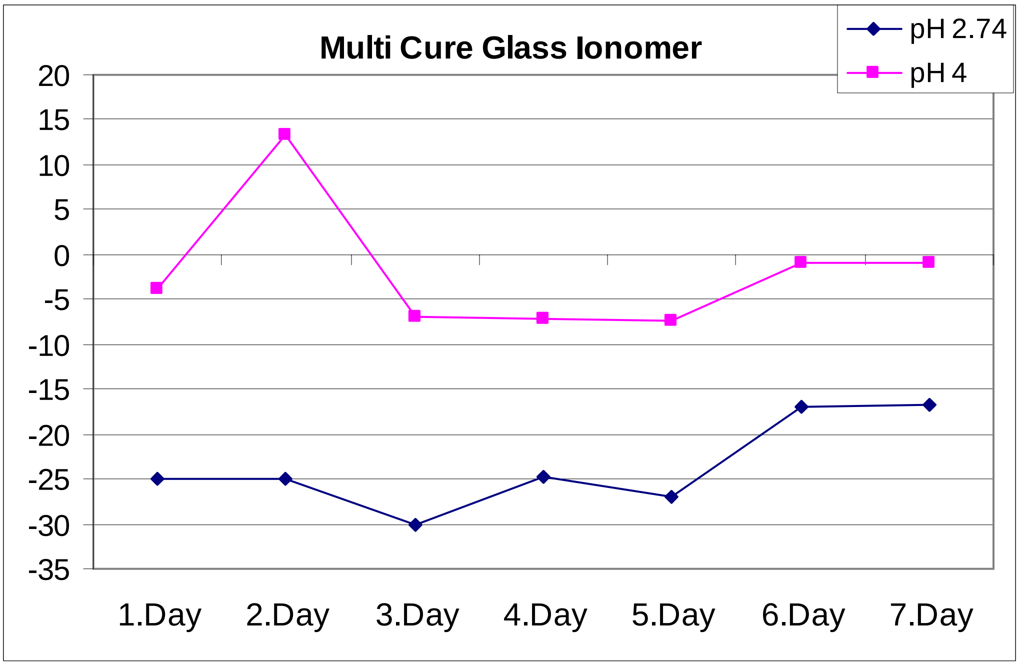



**Figure 6.2. Depth loss of Multi cure glass ionomer cement over time**

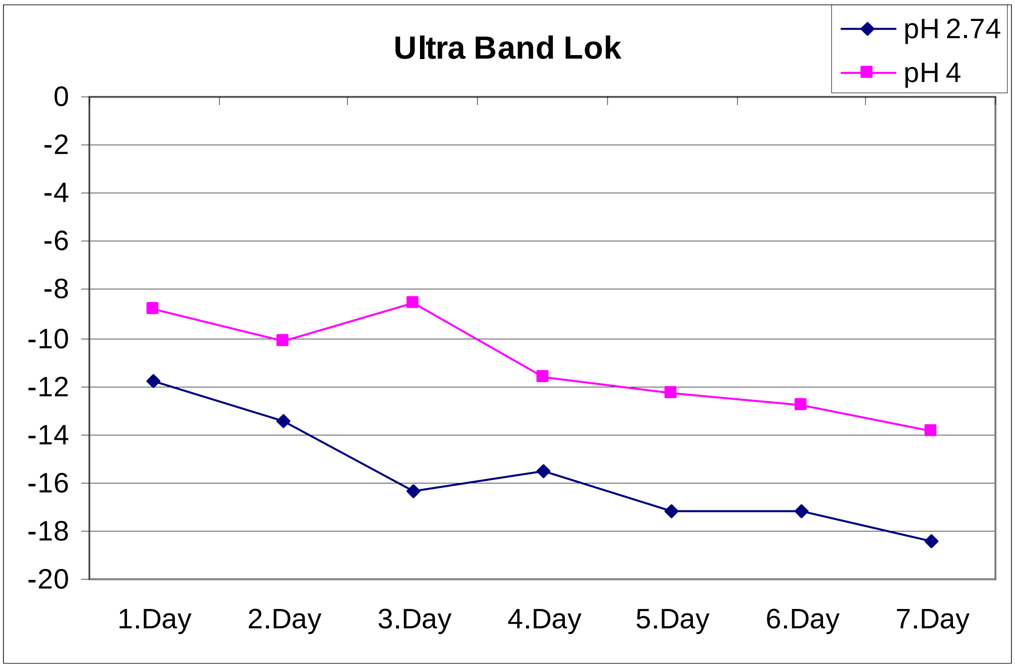



**Figure 6.3. Depth loss of Ultra band LoK cement over time**

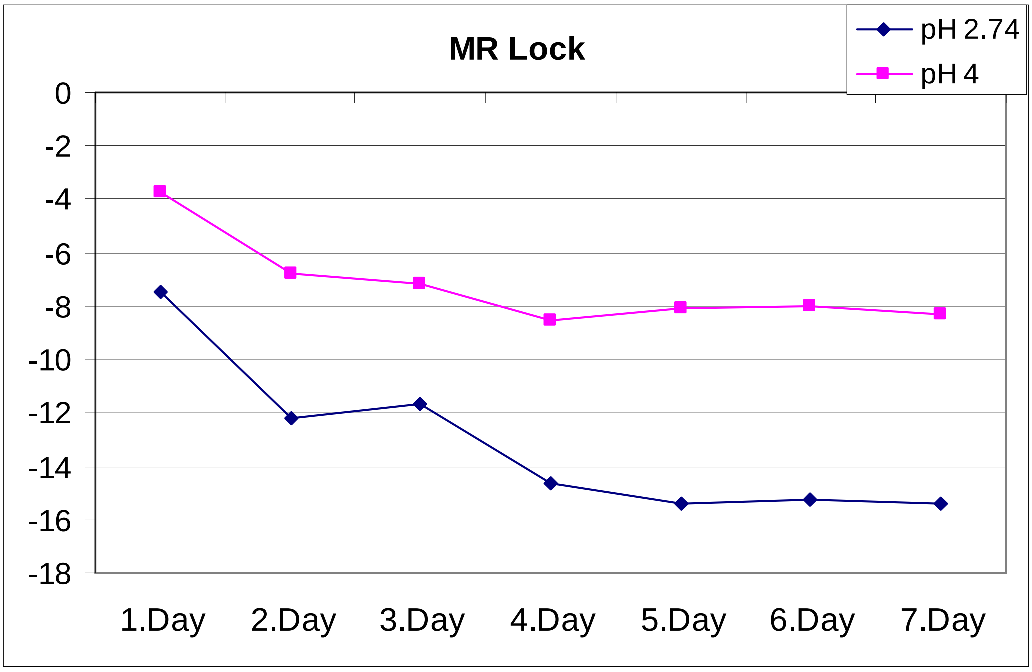



**Figure 6.4. Depth loss of MR LOCK cement over time**

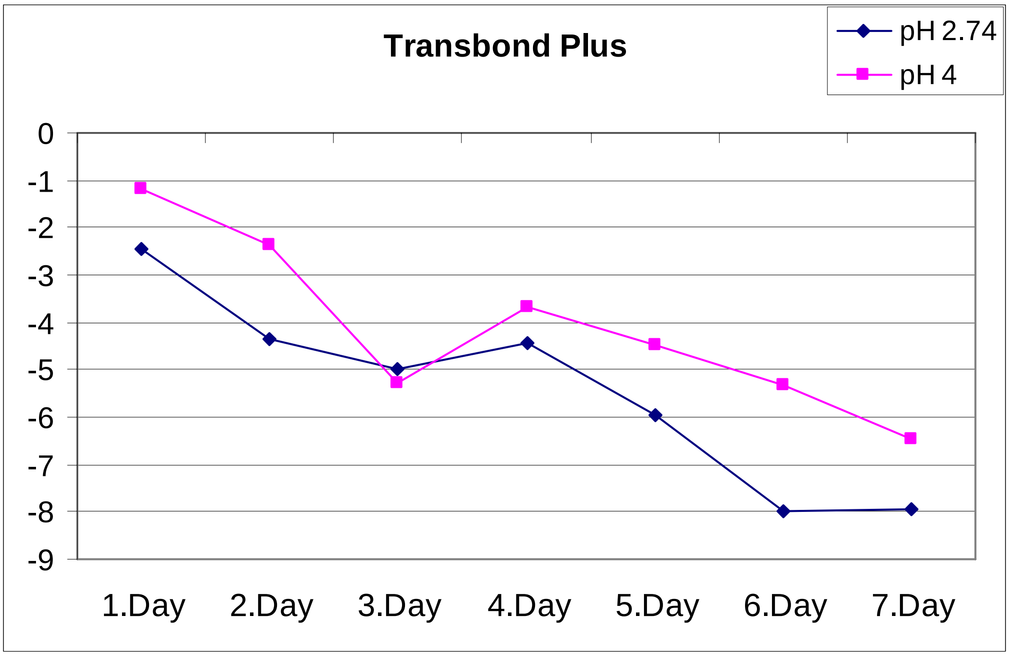



**Figure 6.5. Depth loss of Transbond plus cement over time**

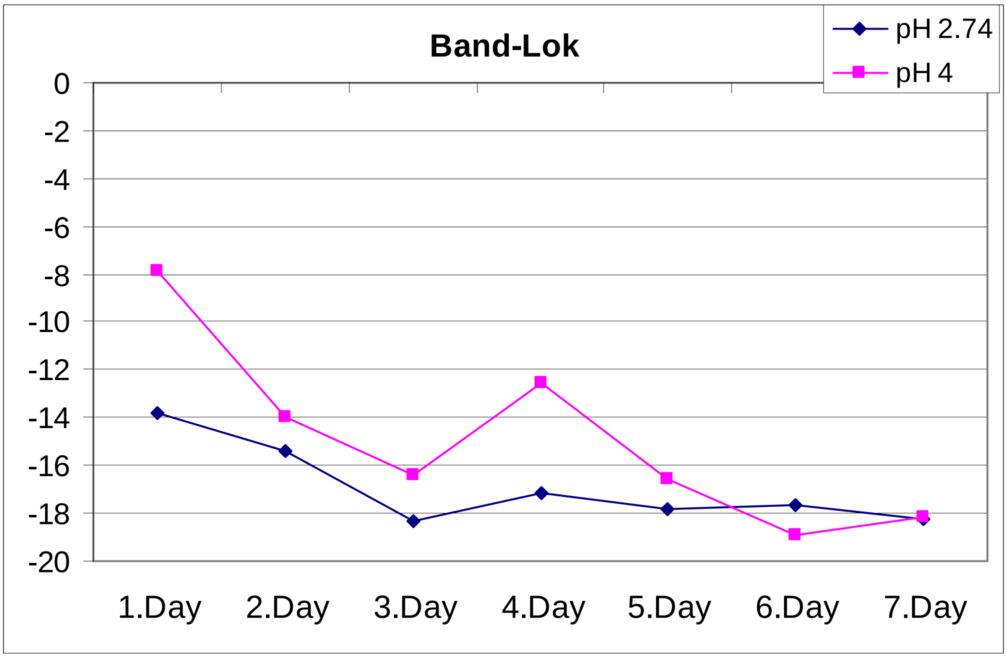
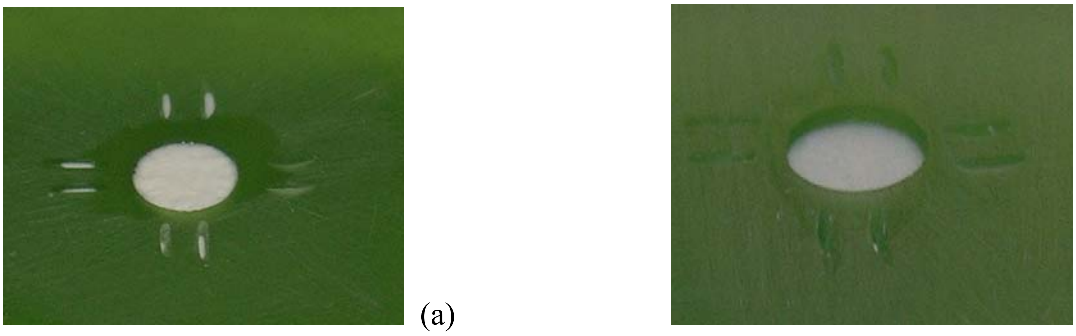
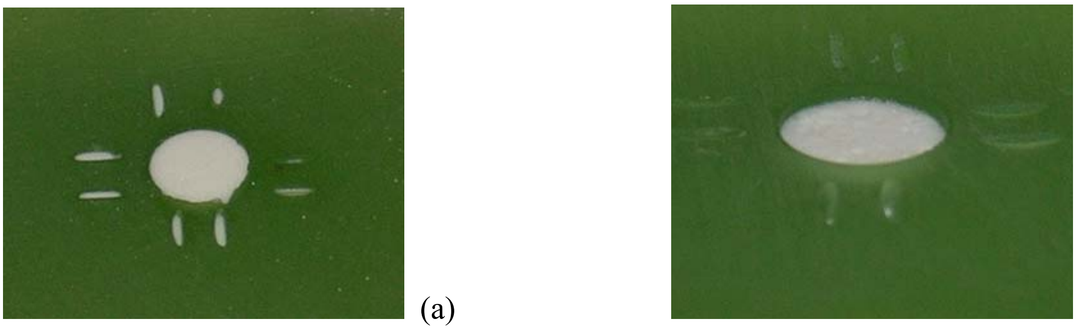



**Figure 6.6. Depth loss of Band-LoK cement over time**



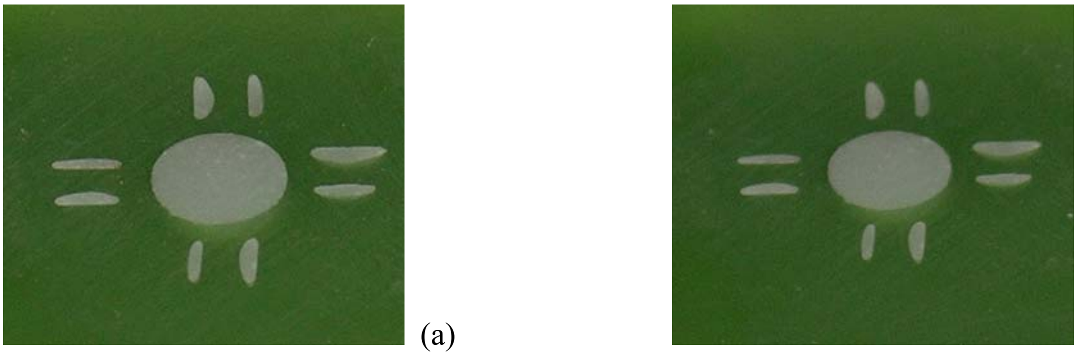
(a) (b)

**Figure 6. 14. Zinc phosphate Cement surface (a) at the beginning (b) after 7 day immersion in (pH 2.74)**



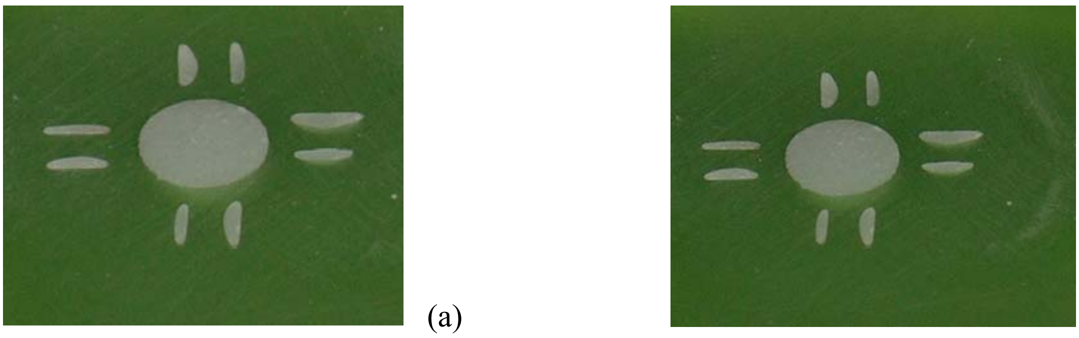
(a) (b)

**Figure 6. 14. Zinc phosphate Cement surface (a) at the beginning (b) after 7 day immersion in (pH 4.0)**



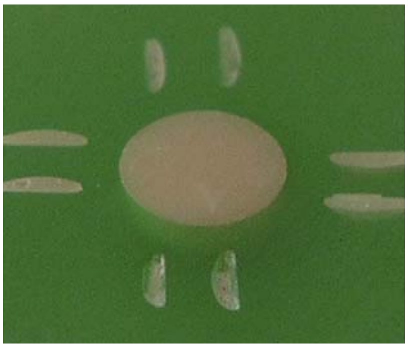
(a) (b)

**Figure 6. 14 Multi cure Glass ionomer cementt surface (a) at the beginning (b) after 7 day immersion in (pH 2.74)**



(a) (b)

**Figure 6. 14 Multi cure Glass ionomer cementt surface (a) at the beginning (b) after 7 day immersion in (pH 4.0)**

 (a)

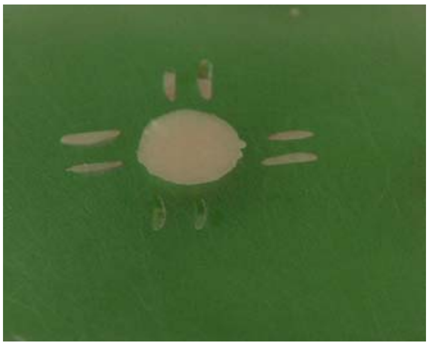
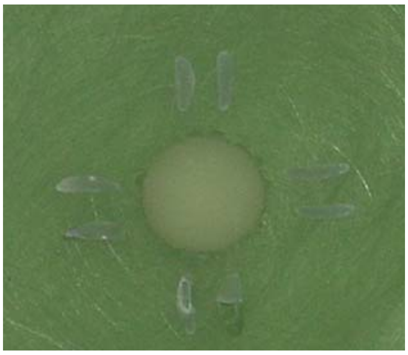
 (b)

**Figure 6.7. Band LoK cement surface (a) at the beginning (b) after 7 day immersion in (pH 2.74)**

 (a)

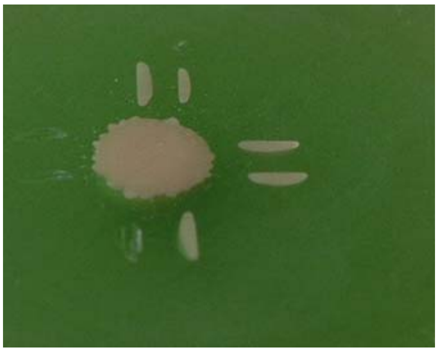
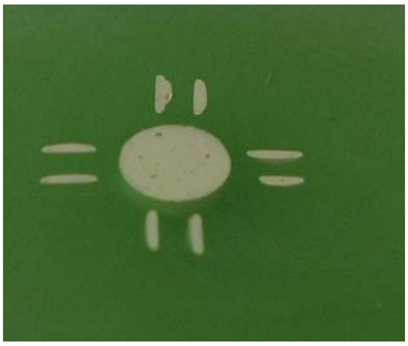
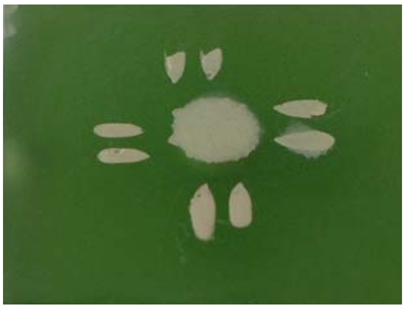
 (b)

**Figure 6.8 Band LoK cement surface (a) at the beginning (b) after 7 day immersion in (pH 4.0**

 (a)

 (b)

**Figure 6.9 Ultra Band LoK cement surface (a) at the beginning (b) after 7 day immersion in (pH 2.74)**

 (a)

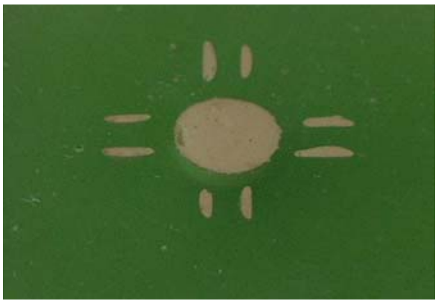
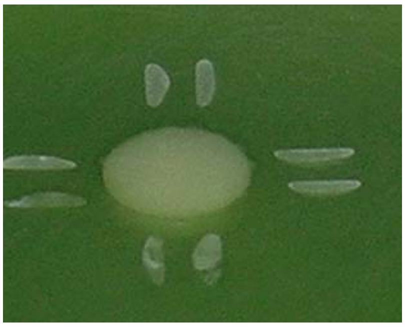
 (b)

**Figure 6.10 Ultra Band LoK cement surface (a) at the beginning (b) after 7 day immersion in (pH 4.0)**



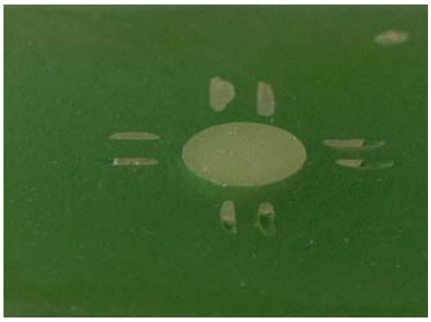
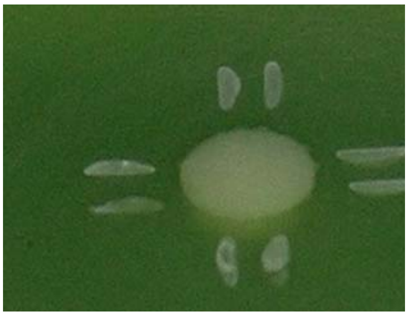
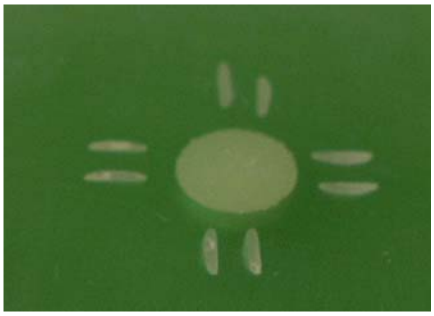


**Figure 6.11. MR LOCL LC cement surface (a) at the beginning (b) after 7 day immersion in (pH 2.7)**



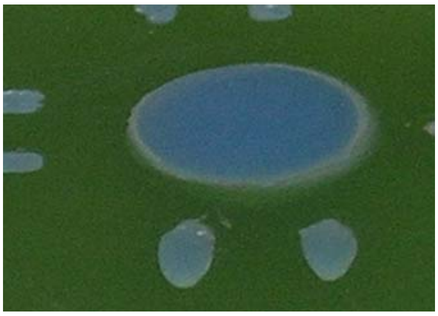
(a)



(b)

**Figure 6.12. MR LOCL LC cement surface (a) at the beginning (b) after 7 day immersion in (pH 4.0)**

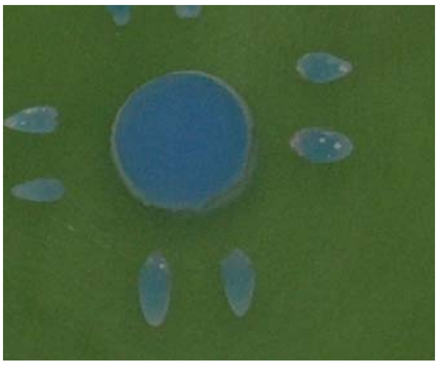
(a)



(b)

**Figure 6.13. Transbond Plus cement surface (a) at the beginning (b) after 7 day immersion in (pH 2.74)**

(a)



(b)

**Figure 6.14. Transbond Plus cement surface (a) at the beginning (b) after 7 day immersion in (pH 4.0)**

## 7. DISCUSSION

The objective of any in vitro test method is to attempt to reproduce the type of erosion encountered in vivo but over a reduced time period. There are some data available in the literatures about the in vivo solubility and disintegration of dental cements (Richter and Ueno. 1975: Mitchem and Gronas. 1978: Osborne et al. 1978: Pluim et al. 1984). The conclusion of in vivo results give a ranking order in terms of disintegration (starting with the most resistant) of glass polyalkenoate, silicate, silicophosphate, zinc phosphate, zinc Polycarboxylate, and zinc oxide eugenol cements. The position of zinc phosphate and zinc Polycarboxylate cements were reversed in the work of Osborne et al (74, 94, 104).

Chemical analysis and weight analysis used by other authors have the disadvantage that data from different cements are difficult to compare. In case of weight analysis, residual humidity in cement samples might contribute to the experimental error. The problem with many tests of erosion is the lack of a mild abrasive element to remove loosely bound surface debris. Crisps et al, used gentle brushing with a wet toothbrush to remove surface debris at the end of a seven-day erosion period. While this dose remove loose debris, it only dose so at the end of the period of erosion, and the force of brushing must be arbitrary (19). One of the authors, McCabe utilizes a flask-shaker to agitate specimens sufficiently to cause movement of the storage medium over the specimens surface without disturbing the specimen. A significant increase in erosion was demonstrated under these agitated conditions (67). Beech and Bandyopadhyay allowed the scouring effect of a falling column of liquid to remove any debris (5). These methods utilized weight loss of the specimen to measure the quantity of material eroded. Comparison of erosion within a single cement type may be valid using such a technique; however, there is marked variation in the rate and magnitude of water uptake and loss between different cement types (19), which would add an

extra element of inaccuracy to the test result. It is thus advantageous to be able to obtain direct measurement of the quantity of material lost.
Mesu developed a technique to examine degradation in thin film of luting cement by direct visualization; unfortunately, his technique would not applicable to cements mixed at higher powder: liquid ratios required for filling material, due to their greater film thickness. He noted that the rate of erosion increased when the specimens were raised and lowered within their storage media (70).
In a study designed to measure brushing abrasion of luting cements, specimens were subjected to repeated tooth brush abrasion after storage in acid solution at pH 3.0 and pH 6.8. Abrasion was higher for zinc phosphate cement than for glass ionomer cements. Only very little effect was observed on resin based cement samples, unfortunately, the method did not differentiate between material loss by erosion and by abrasion (7).

The method employed in the present study assesses surface erosion of cement specimens directly and utilizes the surface of the specimen-holder as a fixed datum point to permit direct measurement of the quantity of material lost with the help of digital micrometer at the single exposed surface. Rinsing the specimen with distilled water and gentle washing action induced by the repeated immersion and removal of the specimens from their eroding medium removes any loosely bound surface debris at each time measurement, thus exposing a fresh cement surface throughout the test sequence, without any possible abrasive action by a brush or tissue.
The result of the current study showed a higher amount of cement loss in acidic condition for zinc phosphate cement compared to the other tested cements
Additionally, linearity of the erosion over time for zinc phosphate cement could be proven. Similar findings have been reported by other researches (129, 142).

Immersion of resin based cement specimens resulted in a small gain of surface profile after immersion in sodium lactate/lactic acid buffer at two different pH. This effect can be attributed to a water sorption of the resin. Knobloch et al, found a water sorption of the composite cement in the range of 2-4% (59).

The results achieved with this study clearly differentiate between the different cement types table 6.13 to 6.18.

Except Zinc phosphate cement all cements used in the current study show variable amounts of expansion.

The maximum amount of expansion or cement gain was recorded at third day immersion of multi cure glass ionomer cement at pH 2.74.

The expansion of hybrid cements occurs mainly due to water sorption (11, 26, 38, 41, 43, 57, 59).

Water sorption is different in the studied material and there are several factors influencing water uptake values. Water sorption is a diffusion-controlled process that occurs in the organic resin matrixes, and it mainly depends on the resin compositions. Hydrophilic constituents such as hydroxyethylmethacrylate (HEMA) or resin molecules that contain hydrophilic moieties clearly increased water sorption values, as observed in all hybrid tested cement particularly multi-cure glass ionomer cement that have shown the higher water sorption values at 1, 2, 3, 4, and 5 days, while at the 6 and 7 days of test period the water sorption vales declined gradually.

Many studies followed ANSI/ADA specification# 27 for resin based material to assess sorption and solubility. The specification requires that the specimen first be placed in a desiccator after 10 minutes of bench curing and removal from the polypropylene mold. A recent study suggested a modification to the specification, where the specimens would be immediately placed in solution after preparation and not desiccated first (57). The rational behind this modification is that water is a requirement for the setting reaction of the resin-modified glass-ionomer cements and the initial desiccation of the specimens could remove water essential for setting reaction. In the present study, ANSI/ADA specification #27 was modified by waiting 24 hours to insure complete set of all tested material; the same modification was done by LA Knobloch et al (59).

Interestingly one of the resin modified glass-ionomer cement (multi cure glass-ionomer cement used in the current study exhibited not significantly higher water sorption compared to other composite resins only at 1, 2, 3, 4, and 5 days then the amount of water sorption declined up to the 7 day. This finding was opposite to the previous study that suggested resin-modified glass-ionomer cements exhibited significantly higher water sorption compared to the composite cements (59).

In this study Hygroscopic expansion has been shown to occur in all tested cements except zinc phosphate cement. While the initial effect of hygroscopic expansion may be beneficial by compensating for polymerization shrinkage, one study has been shown that the expansion and positive pressure due to water sorption continued to increase over a period of six months, suggesting some causes of clinical concern (79). Similar finding was found in the current study that tested cement except zinc phosphate cement has shown gradual increase in the amount of expansion from the first day up to the 7 days. (Table 6.13 to 6.18).

The present result of the influence of time on the sorption and solubility behavior of hybrid cements can be confirmed by the previous studies (4,117) However, the present study also concerned the effect of other storage media than water, several studies of the degradation process of composite resin material have concerned storage media such as enzyme or food-simulating-liquid. Söderholm et al (118) showed a higher leakage of filler elements from composites stored in a solution simulating saliva, than from composites stored in distilled water. Chadwick et al (14) reported that a low pH of the storage solution has negative effect on water resistance composite restorative materials. As shown by the results of the present study the solubility and sorption of

all tested cement was affected by the pH of the solution used. Immersion of the specimens in 0.1 M aqueous sodium lactate/lactic acid buffer at pH 2.74 shown higher amounts of solubility and sorption than immersion of the specimens in sodium lactate/lactic acid buffer at pH 4.0.
A strong linear relationship has been demonstrated between erosion and time for zinc phosphate cement with marked lost of the material at pH 2.74 (534, 67µm) after 7 days test period, whereas at pH 4.0 (239, 55 µm).

Multi cure glass ionomer cement shown less amount of expansion at pH 4.0(-0,83 µm), whereas at pH 2.74 the amount of expansion were increased particularly at the first 5 days (-30 µm) , then the amount gradually decreased up to (-16,65 µm).

Ultra Band LoK cement show high amount of expansion at pH 2.74 (-18,43) whereas, at pH 4.0 the amount of expansion was (-13.85 µm).

MR LOCK LC cement show high amount of expansion at pH 2.74 (-15,40 µm) whereas, at pH 4.0 the amount of expansion was (-8,33 µm)
Transbond Plus shows approximately the same amount of expansion at both different pH used (-7,95 µm at pH 2.74, and -6,47 µm at pH 4.0).
Band LoK cement also shows approximately the same amount of expansion at both different pH values (-18,27 µm at pH 2.74, and -18,17 µm at pH 4.0).
Analysis the date with analysis of variance shown that the cement type, pH of the eroding solution and the time are all significantly different. Turkey's Multiple Comparison Test was done to know which kind of tested cements was significantly different. From the table 6.21, we can show clearly that, only depth loss of zinc phosphate cement was significantly different (p0,0001).

Newman-Keuls Multiple Comparison Test was done to know that in which day or days of the tested period the depth loss was significant different. From table 6.22 we can show that the depth loss of zinc phosphate cement was significantly different between all 7 days except that between day3/day 7, and day6/day7. This exception may be due to minor statistical error.

## 8.Conclusion

the conclusion of in vitro evaluation of acidic solubility of 6 different orthodontic band cements immersed in lactic acid buffer solutions of two different pH storage media could be drawn as the following.

Zinc phosphate cement tested shows the highest amount of depth loss and significantly affected by pH of the storage solution, showing decreased depth loss(239,55) at pH 4.0 and increased depth loss(534,67) at pH 2.74.

With exception of zinc phosphate cement all other hybrid cements tested show non significant variable amount of water sorption (hygroscopic expansion).

Ultra Band LoK cement at day 7 show the highest amount of expansion (-18,43) at pH 2.74.

Multi cure glass-ionomer cement at day 7 show the lowest amount of expansion (-0,83) at pH 4.0.

The sorption behavior of hybrid cements tested was influenced by storage time.

The sensitivity of the sorption and solubility versus time and pH seems to be related to the hydrophilieity of the matrix and the chemical composition of the fillers used .

Although there is a need for further evidence to confirm a good correlation between clinically obtained data and laboratory obtained data, we wish to take these laboratory results into account when deciding upon the choice of orthodontic band cements.

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## 10. BIOGRAPHY

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