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Supplementary Report - 3

**Effect of Natural Pozzolans and Fly Ash on
Alkali-Silica Reactivity**

**Development of a Type IP
Cement**

**Study SD91-11
Final Report**

Prepared by
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16. Abstract Alkali-silica reactivity (ASR) produces a major problem in concrete structures. This report presents an experimental investigation to identify a natural pozzolan and to determine the optimum quantity that can be blended with cement to produce a Type IP cement for inhibiting the ASR. For comparative evaluation a Class F fly ash has also been investigated along with the pozzolans. Two methods, ASTM P214 and ASTM C227 were adopted for assessing the effectiveness of the pozzolans in controlling the ASR. Three percentages of 10%, 20% and 30% replacements of cement with fly ash were investigated. A total of 30 natural pozzolans were collected in the Black Hills area. Their chemical and mineralogical compositions and some physical properties such as fineness, and density were determined. The strength activity test (ASTM C311) was used in eliminating the pozzolans that would adversely affect the strength of concrete. Based on this test, ten pozzolans were selected for detailed study. The ASR expansions measured using the ASTM P214 test method had shown that two pozzolans were more effective than the Class F fly ash in inhibiting the ASR expansion. The effectiveness of pozzolan in controlling the ASR expansion depended on the type, moisture content, quality, and quantity of pozzolan blended with cement. Calcining the pozzolans has improved the strength activity index.					
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ABSTRACT

Alkali-silica reactivity (ASR) produces a major problem in concrete structures due to the cracks formed by the expansive reaction between the alkalis in cement and certain reactive minerals present in the aggregates. This thesis presents an experimental investigation to identify a natural pozzolan and to determine the optimum quantity that can be blended with cement to produce a Type IP cement for inhibiting the ASR.

For comparative evaluation a Class F fly ash has also been investigated along with the pozzolans. Two methods, ASTM P214 and ASTM C227 were adopted for assessing the effectiveness of the pozzolans in controlling the ASR. This thesis also presents an investigation of the effectiveness of the Class F fly ash in controlling the ASR expansions of mortar bars made with five reactive sands available in South Dakota. Three percentages of 10%, 20% and 30% replacements of cement with fly ash were investigated.

A total of 30 natural pozzolans were collected in the Black Hills area. They were ground to a fine powder (90% passing through No. 325 sieve) and their chemical and mineralogical compositions were determined. Some physical properties such as fineness, and density were determined. The strength activity test (ASTM C311) was used in eliminating the pozzolans that would adversely affect the strength of concrete. Based on this test, ten pozzolans were selected for detailed study. The ASR expansions measured using the ASTM P214 test method had shown that two pozzolans were more effective than the Class F fly ash in inhibiting the ASR expansion.

The effectiveness of pozzolan in controlling the ASR expansion depended on the type, moisture content, quality, and quantity of pozzolan blended with cement. Calcining the pozzolans has improved the strength activity index.

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1. INTRODUCTION

1.1. General

Alkali reactive sands or coarse aggregates, when used in concrete structures, produce severe deterioration. It is known that certain internal chemical reactions between the cement alkalies and the aggregates (AAR) cause harmful expansions. It is also now understood that highly variable and different expansions develop within concrete in the long term as a result of alkali-silica reactions (ASR). The ASR expansion reaction is characterized by production of a gel-like reaction product. ASR occurs in concrete structures when three requirements have been met: (1) reactive forms of silica or silicate in the aggregates; (2) sufficient alkali (sodium and potassium) primarily from the cement, and (3) sufficient available moisture in the concrete. If one of these requirements is not met, then expansion due to ASR cannot occur.

The potential ASR problem has gained a lot of attention from transportation engineers, product suppliers, and state highway departments in nearly every state. Even though this problem has had worldwide attention for the past 50 years, effective measures for inhibiting the alkali-aggregate and alkali-silica reactions have not been found until recent times. It is important to find out such measures to improve the durability of concrete structures.

In order to prevent these deleterious expansions the following three options are available.

- 1) Use low alkali cement,
- 2) Avoid reactive aggregates, and
- 3) Partially replace cement with a mineral admixture or pozzolan.

Low-alkali cements had been used nationwide to mitigate AAR in concrete. However, it is known that low-alkali cements have also been associated with severe AAR in pavements because the use of salts for highway deicing increases the total available alkali in concrete. Further, low-alkali cement may not always be available.

The depletion of good quality aggregate near construction sites has created a need to develop methods that will permit the successful use of marginal aggregates. Therefore, the last option is more attractive.

1.2. Literature Survey

1.2.1. Historical Background

The use of concrete for all types of constructions has steadily increased over the past 40 years. However the increase in the use of concrete has not been without problems in regard to durability. Deterioration of concrete structures due to alkali-aggregate reaction (AAR) has gained world wide attention in the recent 10 years. Additional information on AAR can be obtained from the publications included in the bibliography. The alkali-aggregate reaction was first recognized by Stanton Walker in 1940, and since

then, many researchers and scientists have contributed to a better understanding of the phenomena of AAR. Even though the construction industry was not fully aware of the impact of AAR in the forties, researchers (1 to 4) had fully recognized the impending disaster that would be caused by AAR. Investigations had shown that argillaceous limestones and cherts had been causing a serious menace to durability in many regions. Because of its concern with design, construction and maintenance of hundreds of concrete structures, the Bureau of Reclamation had realized the importance of research directed towards the discovery of the causes for the deterioration phenomena, and means of controlling it. In 1940, a research program was initiated in the Denver Laboratories to provide this information. A number of other agencies (2) also took part in this program. Even though significant understanding of the phenomena was achieved through the investigations, the problem was not solved fully. However at this stage, it was concluded that the deterioration of concrete due to AAR is due to the chemical reaction between the aggregates and the constituents of the portland cement (1 to 4). Petrographic examination of concrete, chemical analysis of samples of gel taken from various concrete structures, physical methods, and metallographic microscopes were utilized in the study of the AAR phenomena (2,3,4).

In the past, only a few researchers were concerned about the problem of AAR. Now with the recognition of the

deterioration of concrete structures in many parts of the world due to AAR, the situation has changed dramatically. Now AAR has become one of the primary concerns of the engineering community. The first international conference held on AAR about a decade ago had attracted only six countries and 26 engineers for the conference. However with the gaining importance of AAR, in the 7th International conference held in Ottawa, Canada in 1986, over 200 engineers from 26 countries had participated.

1.2.2. Cause of Alkali-Aggregate Reaction

The alkali-aggregate reaction (AAR) is due to the chemical reaction between the alkalies (sodium and potassium) present in the cement and certain minerals present in the aggregates which are used in concrete (2). Abundant field and laboratory experience has demonstrated that the alkalies released during hydration of high alkali portland cement react with certain rocks and minerals of aggregate. These reactions produce a gel and result in the deterioration of concrete. The factors contributing to the reaction are the presence of sufficient alkali, availability of moisture and the presence of potentially reactive silica (5).

In a study made by Alasali and Malhotra (6), it was observed that making concrete with a low alkali cement does not effectively prevent aggregates from reacting when concrete is used in a severe alkaline environment.

1.2.3. Types of Alkali-Aggregate Reaction

Three types of AAR have been recognized and these are based on the type of mineral causing the expansion (7).

1. Alkali-Silica Reaction: The rocks and minerals involved in this type of AAR are the vitreous poorly crystalline and strained forms of silica which occur in sedimentary, igneous, and metamorphic rocks in the form of opal, chert, chalcedony and quartz. Expansion has also been found to result from the use of some volcanic rocks when silicate glasses or crypto-crystalline minerals are present. The expansions caused by these forms of silica have been found to be significantly slower than that caused by opal. The mechanism involved in the alkali-silica reaction is the formation of a siliceous gel formed by the reaction between the cement alkalies and the silica minerals which absorb water and exerts a swelling pressure leading to cracks in concrete.

2. Alkali-Carbonate Reaction: This was first described in the 1960's when it was recognized. It is an expansive mechanism but is different from the alkali-silica reaction. In this type of reaction, dolomite has been found to be the main rock causing the reaction. A detailed study of this effect was done by Grattan-Bellew and Gillott (7). It was found that in this type of reaction the gel was absent but volume increase was found to be causing the expansion.

3. Alkali-Silicate Reaction: Some silicate rocks like low grade metamorphic greywackes, phyllites, and argillites have

been attributed to this type of reaction.

It is suggested by Farbiarz and Carrasquillo (8) that the main factor contributing to the alkali-silica reaction is the amount of alkali present in the cement. The alkalies are sodium or potassium ions which are present in the cement in the form of salts and double salts such as potassium sulphate. When these salts go into solution and the sulphate or chloride ions react with certain components such as C_3A (tri-calcium aluminate), the hydroxyl ion is available to rise the pH value and render the solution aggressive to reactive silica. Another source of alkalies is from the de-icing salts ($NaCl$). Curing conditions leading to concentration of soluble alkalies at the surface contribute to the enhancement of AAR in concrete.

1.2.4 Methods of Controlling Alkali-Aggregate Reaction

There are three methods of reducing AAR expansion in concrete to acceptable levels:

1. The use of non reactive aggregates: This solution may not always be possible since the identification of reactive components in a sample of aggregate is not always feasible and on many occasions an acceptable source of aggregate may not be locally available and transportation may increase the cost of concrete.
2. The use of a cement with less than 0.60% of alkalies expressed as Na_2O equivalent in concrete containing reactive aggregates: Even though this is an alternative, it may not be possible to limit the amount of alkalies in cement. In

addition to the alkalies present in cement the alkali concentration can be altered by several factors such as moisture migration within the concrete, the use of de-icing salt which adds to the alkalies already present. It has been observed in many pavements that were built using a low alkali cement, the alkali concentration at the top layer of the pavement increased to levels at which the alkali aggregate reaction caused unacceptable expansion and damage to the concrete as a result of wetting and drying.

3. The use of adequate amounts of certain admixtures such as fly ash and other pozzolans to replace a portion of the cement when both high alkali cement and reactive aggregate are used: The use of adequate amounts of admixtures has become the most suitable solution in recent times and investigations by a number of researchers have provided an acceptable solution to the AAR problem (9 to 28).

A pozzolan is defined as any siliceous material, natural or artificial, processed or unprocessed, which in the presence of lime and water develops cementitious properties.

Pozzolans which have been found to reduce the expansion caused by AAR in concrete or mortar have been classified into three categories (19):

1. Materials containing amorphous siliceous and aluminous substances which include some opals and highly opaline rocks, certain volcanic ashes, diatomaceous earth and calcined clays of the kaolin type. Also included in this

category are fly ashes, some of which significantly reduce the expansion caused by alkali aggregate reaction and others which do not.

2. Calcined clays of the montmorillonite type. These are crystalline and contain the calcium ion such as Bentonite clays.

3. Combination of the above two categories which include such materials as siliceous shales such as Monterey shale, altered Pumicites, which are mixtures of montmorillonite clays and volcanic ashes.

The amount of suitable pozzolan required in concrete to control the AAR varies with individual aggregates, alkali content of cement, alkali content of pozzolan and fineness of the pozzolan. It has been found that ample protection can normally be obtained by replacement quantities ranging from 20 to 35 percentage by weight of cement.

Among the various types of pozzolans, fly ash is the most widely used admixture for controlling AAR because of its availability. Mainly two types of fly ashes are used.

1. Class F fly ash: Fly ash normally produced from burning anthracite or bituminous coal.

2. Class C fly ash: Fly ash normally produced from lignite or subbituminous coal.

For some high calcium fly ashes having more than 1.5% available alkali content, a "pessimum limit" was observed (8, 16, 20). Such a limit represents a percent replacement

below which the addition of fly ash causes equal or greater expansions in the mortar bars than that of the mixture without fly ash and above which the expansions are reduced. In some instances more than one "pessimum limit" was detected for a given combination of materials.

In general, it was observed that for higher fly ash replacement, a larger reduction in expansion was achieved (8, 9). The effectiveness of the admixture used depends on the type of admixture, type of cement used and the amount of admixture. It is very essential that proper laboratory testing be done when an mineral admixture is to be used to suppress alkali-aggregate reaction in concrete (26).

1.3. Problem Statement

Even though fly ashes and natural pozzolans like pumice, volcanic ash, diatomaceous earth, and siliceous shales have been used to control AAR, there are problems associated with homogeneity, variability in composition and uniformity and anomolous expansion and difficulties in maintaining quality control. Under these circumstances, the use of natural pozzolan blended Type IP cement is an attractive solution. There are adequate supplies of natural pozzolans near Rapid City, South Dakota and State-owned South Dakota Cement Plant located in Rapid City could manufacture the Type IP Cement. Therefore, the feasibility of obtaining such a natural pozzolan needs to be investigated.

Cracks were observed on the pavements in South Dakota

due to the use of sands which are prone to Alkali-Aggregate Reaction. Testing some of the sands by the South Dakota Department of Transportation (SDDOT) using ASTM C289 method has indicated the possibility of deleterious nature of the sands used for the construction of the pavements. Further testing was done at SDSM&T (9) for 10 sands supplied by the SDDOT using the Accelerated Method Based on NBRI (the same method has been later included in the 1990 edition of the "Annual Book of ASTM Standards" as a proposal under ASTM P214) and ASTM C227 Mortar Bar Test Method (29). The results from these two tests have shown that 5 sands were reactive in nature. Further use of these sands in their present condition would only aggravate the problem of durability of the pavements. There is a need to examine the possibility of controlling the reaction between the sand and the cement used for the pavements by replacing part of the cement with pozzolan in different percentages to determine the optimum amount for effectiveness in controlling the cracks.

1.4. Objectives

1.4.1. Primary Objectives:

1. To find a pozzolan which is more efficient, effective and economical than fly ash in reducing the deleterious expansion due to ASR.
2. To find the optimum quantity of pozzolan that can be blended with cement to produce a Type IP Cement for minimizing the ASR.

3. The selected pozzolan for blending should not in any way adversely effect the fresh and hardened properties of cement, mortar, and concrete.

1.4.2. Secondary Objectives:

1. To identify suitable pozzolan sources.
2. To determine the physical properties, chemical and mineralogical contents of the pozzolans.
3. To determine the strength activity index with cement, of the natural pozzolans.
4. To study the effect of pozzolan addition on ASR by using ASTM P214 and ASTM C227 test methods.
5. To determine the effectiveness of a Class F fly ash in controlling the expansions by using ASTM C227 test method for five reactive sands.
6. To compare the effect of fly ash replacements on the expansions obtained by using ASTM C227 and ASTM P214 Test Methods.
7. To evaluate the effect of fly ash replacements on the compressive strength of mortar cubes.

2. MATERIALS, MIXTURE DESIGNATIONS, PROPORTIONS, AND TEST SPECIMEN

2.1. Materials

Cement: The cement used was ASTM Type I/II, conforming to ASTM C150 specifications. It was manufactured locally in the South Dakota Cement Plant. The chemical analysis and physical properties are given in Table 1.

Fly Ash: The fly ash used was a low-calcium, ASTM class F

and was obtained from a source in North Dakota, and was supplied by the South Dakota Department of Transportation. Its chemical analysis and other properties are given in Table 1.

Pozzolans: Different types of natural pozzolans collected by Rohn Holm of the geology department, South Dakota School of Mines and Technology, were used in this investigation. The location, deposit and description of the pozzolans are given in Table 2. Table 2a contains the chemical compositions determined by using Inductively Coupled Plasma (ICP) Spectrometer. In the ICP method, the samples are subjected to a high temperature which causes the sample to disassociate into individual atoms and ions. These atoms and ions emit light at wavelengths characteristic of the elements present. The spectrometer sorts the various wavelengths and measures the intensity of the specific spectral lines. These intensities are directly proportional to elemental concentrations in the sample. Table 2aa gives the chemical compositions obtained by using Scanning Electron Microscope (SEM). The physical properties, density and the fineness by # 325 of the pozzolans are given in Table 2b. The Blaine fineness of selected pozzolans is also given in Table 2c.

Aggregates: A highly reactive fine aggregate (Opperman Herrick Pit) provided by the South Dakota Department of Transportation was used for all mixes for studying the effect of natural pozzolans on alkali-aggregate reaction by

accelerated test method (ASTM P214) and ASTM C227 test method.

Five sands found to be reactive were used to determine the effectiveness of Class F fly ash in eliminating or reducing the AAR. The mineralogical contents of these sands, determined by rim analysis are given in Table 3.

Water: The water used was tap water from the Rapid City municipal supply system.

2.2. Mixture Designations

Table 4 contains the mixture designations of the 10 different natural pozzolans used for the accelerated test method and ASTM C227 test method. The mixture designations of the sands used for ASTM C227 mortar bar test method and accelerated test method for testing the effect of fly ash are given in Table 5. Table 6 contains the mixture designations used for determining the cube compressive strength with various percentages of fly ash replacements. Table 7 gives the water cement ratios used for strength activity index and Table 8 gives the designations for the strength activity index.

2.3. Mixture Proportions

2.3.1. ASTM P214 Test Method

The mixture proportions were selected according to ASTM P214 as 1 part of cement and 2.25 parts of graded aggregate. The cement was replaced by the pozzolan with 10%, 15% and 25% by weight of cement in the test mixtures. For the fly ash, two additional percentages of 30% and 40% were also

included. The water/cement ratio used was 0.44 for all mixtures. The aggregate was washed, cleaned and graded and appropriate size quantities were weighed and mixed to obtain a uniform gradation as shown in Table 9.

2.3.2. ASTM C227 Mortar Bar Method

The mixture proportions were selected according to ASTM C227 standards. One part of cement+pozzolan and 2.25 parts by weight of the test aggregate were used. For the mix without pozzolan, 600 grams of cement and 1350 grams of fine sand were used. For mixes with pozzolan replacements, for 10% by weight, 60 grams of pozzolan and 540 grams of cement were blended uniformly and 1350 grams of fine sand were used. Similarly, for 15% and 25% replacements, 90 grams of pozzolan, 510 grams of cement and 150 grams of pozzolan and 450 grams of cement were used respectively. The pozzolan and cement were thoroughly blended in a twin shell blender, prior to placing in the mixer.

When fly ash was used for making mortar bars, to study its effect on the reactive sands, the cement was replaced with 10%, 20% and 30% of fly ash by weight. The water to cement+admixture ratio was kept at 0.44 for all the mixes.

2.3.3. Strength Activity Index with Cement

The mixture proportions were selected according to ASTM C311. For control mixture, 250 grams of cement and 687.5 grams of sand were used for molding three specimens. One hundred and twenty one (121) ml of water was used with a water cement ratio of 0.484. For test mixture, 20% of the

cement used in the control mixture was replaced by the test sample. Two hundred (200) grams of cement and 50 grams of the test sample were used, with the fine aggregate remaining the same at 687.5 grams. For the test mix, the water added was such that adequate workability was achieved. The water/(cement+pozzolan) ratios are given in Table 7.

2.3.4. Cube Compressive Strength

Mix proportions were 1 part of cement+fly ash and 2.75 parts of sand proportioned by weighing. The water to cement+fly ash ratio was maintained at 0.44 for all the mixes. The cement was replaced with fly ash by 10% to 70% by weight of cement with an increment of 10%.

2.4. Test Specimen

Four mortar bar specimens were prepared from each mix for the ASTM C227 test method and ASTM P214 test method.

For strength activity index, three cubes of size two inches were cast for each mix. For cube compressive strength with fly ash replacement, 12 cubes of size 2 inches were cast for testing three cubes each at ages 3, 7, 28, and 56 days for every 10% increase of fly ash replacement.

3. TEST PROCEDURES

3.1. ASTM P214 Test Method

The test method adopted was the proposed test method for accelerated detection of potentially deleterious expansion of mortar bars due to alkali-silica reaction (Proposal P214). The test method allows for detecting within 16 days the potential for deleterious expansion of

mortar bars due to alkali-silica reaction. The mixing of the quantities were done according to ASTM C305. The molds were filled in two approximately equal layers, each layer being tamped with a rubber tamper. The mortar was tamped into the corners, around the gage studs, and along the surfaces of the mold with the tamper until a homogenous specimen was obtained. The excess top layer was smoothened with a few strokes of the trowel. The specimens were kept in the molds for 24 hours. The specimens were removed from the molds and the initial length was measured using the length comparator. After the initial measurement, the specimens were transferred to a plastic container and were completely immersed in tap water. The container was stored in an oven with the temperature controlled at 80°C (176°F) for a period of 24 hours. The containers were removed one at a time from the oven, and the length of the mortar bars were measured. This reading was noted as the zero day measurement. After the zero day measurement, the water in the container was replaced with 1N NaOH solution and in sufficient quantities to completely immerse the specimens. The container was then returned to the oven maintained at 80°C. Subsequent measurements were taken at 3, 7, 11, and 14 days (from the zero day) at approximately same time of the day. The difference between the length at zero day of the specimen and the lengths at each period of measurement were calculated for that period and the averages for all specimens expressed to the nearest 0.001% were computed.

3.2. ASTM C227 Test Method

This test method covers the determination of the susceptibility of cement-aggregate reaction combinations to expansive reactions involving hydroxyl ions associated with alkalies (sodium and potassium) by measurement of the increase in length of mortar bars. The mixing was done according to ASTM C305. Molds conforming to ASTM C490 specification were used. The specimens were removed from the molds after 24 hours and the zero day or the initial day reading was recorded using a length comparator with an accuracy of 0.00005 inches. The specimens were then stored in a plastic container lined with a wick. Water was filled up to 1 inch and the specimens were kept over wooden pieces. Care was taken to ensure that the specimens were never in direct contact with the water. The container was sealed airtight such that 100% relative humidity was maintained. The container was stored in a room maintained at 38°C (100°F) for 14 days and removed for the first reading. After the first reading the container was returned to the temperature controlled room and similarly subsequent readings were monitored every 30 days for a period of 360 days. The expansions were calculated with respect to the initial reading and expressed as percentage expansion.

3.3. Strength Activity Index with Cement

Two inch cubes were cast from control mixture and from each of the test mixtures in accordance with test method ASTM C109. The molded specimens were covered with polythene

sheets and were stored for 24 hours at 73°F (23°C) and the cubes were removed from the molds and cured in lime saturated water for 28 days. The compressive strength was determined for both the control and test mixtures according to ASTM C109. A specimen calculation of the strength activity index with portland cement is shown in Table 10. For studying the effect of calcining, the pozzolans were calcined at different temperatures as shown in Table 8a and the strength activity index was determined at an age of 7 days for the calcined pozzolans.

3.4. Density

According to the specifications of ASTM C311, 50 grams of mineral admixture was used in place of 64 grams of cement, and the density was determined according to the test procedure specified in ASTM C188. A Le-Chatelier flask was filled with kerosene up to a point on the stem between the zero and the one ml mark, and the reading was noted as the first reading. Fifty (50) grams of the pozzolan was added and the level of the kerosene was noted as the final reading. The difference between the first reading and the final reading was calculated as the volume of liquid displaced by the 50 grams of the pozzolan used. The mass of sample which is 50 grams was divided by the volume of the liquid displaced and the value was recorded as the density of the sample expressed as gm/cm^3 .

3.5. Fineness by No. 325 Sieve

The raw pozzolan materials were crushed, using different sizes of crushing machines and ground in a ball mill to obtain the pozzolan in a fine powder form.

The fineness of each of the pozzolans was determined by calculating the amount of pozzolan retained when wet sieved on No. 325 sieve in accordance with test method ASTM C430.

3.6. Blaine Fineness

The fineness by the air permeability apparatus (ASTM C204) was adopted for the determination of the Blaine fineness of the pozzolans and fly ash. Since the materials were not cement, the constant "b", necessary in the equation for the determination of the Blaine fineness was obtained. The procedure for calculating the constant "b" was according to the appendix given in ASTM C204 test procedure. The Blaine fineness for the samples were determined according to ASTM C204.

3.7. Cube Compressive Strength With Fly Ash

Standard test method for compressive strength of hydraulic cement mortar (ASTM C109) was basically adopted for the procedure. This test method covers the determination of the compressive strength of cement mortars, using 2 inch cubes. Mixing was done according to ASTM C305. The specimens were removed from the molds after 24 hours and then placed in lime saturated water in the curing tank until the test age. The cubes were tested at 3, 7, 28, and 56 days.

4. TEST RESULTS AND DISCUSSION

4.1. Density

The densities of all the pozzolans, portland cement and Class F fly ash are given in Table 2b. The density for all pozzolans were less than that of the cement. The densities of the pozzolans varied between 2.13 gm/c.c and 2.84 gm/c.c.

4.2 Fineness

The fineness obtained by wet sieving through No. 325 sieve for all pozzolans was above 90% passing. The fineness of the pozzolans are given in Table 2b. This fineness was achieved by initially running the raw material through different sizes of crushing machines. The crushed material was then powdered to a fine form by using a ball mill. The objective of obtaining a pozzolan, finer than 90% passing through No. 325 sieve was therefore achieved. The fly ash was used as received without further grinding. The fineness of the fly ash is also given in Table 2b.

The Blaine fineness for the pozzolans are given in Table 2c. The Blaine fineness was determined only for the pozzolans selected for conducting concrete tests. The Blaine fineness indicated that the procedure used for obtaining the pozzolans in a fine form was adequate.

4.3. Strength Activity Index With Portland Cement

The strength activity index results are given in Table 8. The strength activity index was used as a pre-screening method for selecting the pozzolans for further testing. The pozzolans had a wide range of strength activity index. The

values varied between 19.78% and 91.72%. Based on the strength activity index test results, 10 pozzolans were selected for blending with cement and they were tested for their effectiveness in controlling the expansions due to ASR. The pozzolans selected for further testing had a strength activity index of at least 60% except for MW1. Some of the pozzolans were from similar geological formations (for example, VA1, VA2, and LK1, LK2). In such cases one from each geological formation was selected for testing. Pozzolan ERC1, having a strength activity index of 67.01% was eliminated from further testing due to unsuitable mining conditions. The fly ash used in this investigation had a strength activity index of 75.06%.

4.4. Effect of Calcining on the Strength Activity Index with Portland Cement

The strength activity index for some of the pozzolans was low. Therefore the effect of calcining the pozzolans on the strength activity index was studied. For this investigation, MW1, PS1E (expanded shale) and CT1 were selected. The strength activity index for MW1 was 45.27% without calcining. The pozzolan sample was calcined at three temperatures of 350°C, 700°C, and 1050°C. The effect of calcining was very evident for this pozzolan. The results are given in Table 8a. The strength had increased depending on the temperature at which it was calcined. For the pozzolan CT1, the strength activity index increased from 62.00% to 88.78% when the pozzolan was heated at 1050°C.

The strength activity index for PS1E (expanded shale) given in Table 8, was the percentage obtained when the sample was calcined at about 1050°C. Therefore, for PS1, the strength activity index was determined when the pozzolan was treated at lower temperatures of 115°C, 350°C, and 700°C. The results showed that there was a decrease in the strength activity index when treated at 115°C and 350°C. However there was no significant difference in the strength activity index when treated at 700°C compared to the pozzolan calcined at 1050°C.

Hence, from the results obtained, it can be concluded that the calcination of the pozzolans influence the strength activity index with portland cement. This may be due to the removal of moisture from the pozzolans by the calcining process.

4.5. Effect of Pozzolans on Expansions Using ASTM P214

Test Method

The length measurements of the mortar bars used in the the ASTM P214 test method are given in Table 11 and the mortar bar percentage expansions are given in Table 12. The comparison of expansions of mortar bars made with a reactive sand and cements without and with 10%, 15% and 25% by weight replacements with pozzolans are shown in Figures 1 to 11. According to ASTM P214, when the mean expansions of the test specimens exceed 0.20% at 16 days after casting, it is indicative of potentially deleterious expansion. When the expansion is between 0.10% and 0.20%, the results are not

conclusive, and when the mean expansion of the test specimens is less than 0.10%, it is indicative of innocuous behavior. Bar charts showing the comparison of the total expansions at 16 days for the mortar bar made without and with blended cements are given in Figures 12 to 22.

The test results indicated that 10% replacement of cement with LK2 and PS1E pozzolans had decreased the expansions below 0.1%. All other pozzolans except VA2 and PRC1, when blended with cement at 10% replacement level had decreased the expansions. However the total expansions at 16 days after casting were in between 0.1% and 0.2% expansion ranges. When the cement was replaced with pozzolans at 15% by weight, all the pozzolans except VA2 and PRC1 had decreased the ASR expansions to an innocuous level (below 0.1%). When the cements were blended with pozzolan at 25% replacement, all the pozzolans except VA2 had decreased the total expansions below 0.1%. Therefore all pozzolans except VA2 are suitable for blending with cement to effectively inhibit the ASR expansions in concrete. In the case of pozzolan VA2, its influence on the ASR expansions was entirely different from that of the other pozzolans. When pozzolan VA2 was blended with cement at 10%, 15% and 25% replacement levels, the mortar bar expansions had actually increased compared to the expansions in mortar bars made with unblended cements. This is described as the "pessimism phenomenon". A "pessimism limit" has been observed by other researchers (8,16,20) when certain types of fly ash were

added to cement. This limit represents a percent replacement of cement below which the addition of fly ash or pozzolan causes equal or greater expansions in the mortar bars than that of the mortar bars without fly ash or pozzolan. When cement is blended with fly ash at a percentage above the "pessimum limit", then the expansions are reduced. The 10% replacement of cement with PRC1 pozzolan had given higher expansions than the mortar bars without pozzolan. However at higher percentage of cement replacement with PRC1 pozzolan, the ASR expansions were reduced. The comparisons of ASR expansions in mortar bars with different types of pozzolans, showed that the total expansions at 16 days after casting were below 0.1% in the case of mortar bars made with all pozzolan (except VA2 and PRC1) blended cements.

When a Class F fly ash was blended with cement at 10 to 40% by weight replacement levels, it was effective in reducing the ASR expansion. However when the quantity of fly ash blended was less than 20% by weight, the total expansions at 16 days were still higher than the innocuous level (0.1%). The expansions were reduced below the innocuous level only when the fly ash blended was higher than 25% by weight.

4.6. Effect of Pozzolans on the Expansions Using the ASTM C227 Test Method

The length measurements of the mortar bars used in the ASTM C227 test method are given in Table 13 and the mortar

bar percentage expansions are given in Table 14. The comparison of the expansions of the mortar bars are shown in Figures 23 to 32. Bar charts showing the comparison of the total expansions at 360 days for the mortar bar made without and with blended cements are given in Figures 33 to 42.

The effectiveness of the pozzolans varied with the type and quantity of pozzolan added. The test results indicated that three pozzolans, LK2, PS1E, and US1 had significantly reduced the percentage expansions for the three percentages (10%, 15%, and 25%). When pozzolans CT1, SM2, F3, CB1, and MW1 were blended with cement, there was only a slight decrease in the percentage expansions. In case of pozzolan PRC1, when 10% of the pozzolan was blended with cement, the percentage expansions were higher than the expansions of the mortar bars made with unblended cement. At 15% and 25% replacement levels, the expansions were less than the mortar bars made without pozzolan. Therefore the pessimum limit for pozzolan PRC1 is 15%. When pozzolan VA2 was blended with cement, no significant decrease in the expansions was observed.

4.7. Comparison of Expansions Measured in ASTM C227 and ASTM P214 Test Methods

The comparison of the percentage expansions of the mortar bars made at 16 days obtained from ASTM P214 and the percentage expansions at 360 days from the ASTM C227 are shown in Figures 43 to 52. The comparison is shown for unblended cement and the cement blended with each of the ten

pozzolans in different percentages. Table 14a compares the percentage reduction of the percentage expansions of the mortar bars obtained from ASTM P214 and ASTM C227 test methods.

The comparison shows that the trend of the percentage expansions obtained from ASTM P214 and ASTM C227 test methods is similar. However, since the percentage expansions of the mortar bars made without any pozzolan replacement was high in ASTM P214 test method compared to C227 test method, a higher percentage of reduction in the percentage expansions was observed in the ASTM P214 test method.

4.8. Mechanism By Which The Pozzolans Effectively Control

The Expansions Due to Alkali Aggregate Reactions

Although the mechanism by which the pozzolans reduce the alkali-aggregate expansions are not clearly understood, it is positive that both the physical and chemical properties of the pozzolan affect its effectiveness in reducing AAR expansion in concrete. Since it is known that the presence of moisture increases the AAR, it is possible that the pozzolans are able to reduce the permeability and therefore reduce the AAR expansions.

In a study made by Larbi and Bijen (21) on the effect of mineral admixtures on the cement paste-aggregate interface, it was stated that by the use of fly ash or other similar mineral admixture, the migration of the hydroxyl ions are reduced due to the densification and the thinning

of the interfacial region preventing or reducing the penetration of ions into the reactive grain, and leading to a reduction in the alkali-aggregate reaction in concrete.

As for the chemical properties, it has been suggested that the pozzolans reduce or eliminate the AAR expansion by its pozzolanic reaction and by producing lower C/S mole ratio calcium silicate hydrates by reacting with the higher C/S mole ratio hydrates. These new hydrates can absorb large amounts of alkali into their structure, retaining them and therefore reducing their availability for reaction with the silica in the aggregate.

4.9. Effect of Fly Ash on the ASR Expansions Using ASTM

C227 Method

The length measurements of the mortar bars made with the five sands, (Everist Hawarden, Harry Perry Pit, Opperman Herrick Pit, Everist Brooking and Mission Hills) and cements with fly ash replacement levels of 10%, 20%, and 30% are given in Table 15. The percentage expansions calculated up to 360 days for the mortar bars made with the sands and cement+fly ash are given in Table 16. For comparison, the expansions of the mortar bars made with the five sands and cement without any fly ash, are given in Table 17 (9). The percentage expansion versus time in days with various percentages of fly ash and without fly ash are shown in Figures 53 to 57 for Everist Hawarden, Harry Perry pit, Opperman Herrick pit, Everist Brookings and Mission Hills sand respectively. Bar charts showing the comparison of the

total expansions at 360 days for the mortar bar made without and with blended cements are given in Figures 58 to 62.

It was observed that the 10% and 20% replacement of cement with fly ash had very less or no effect in reducing the expansions of mortar bars made with the five sands. The 30% replacement of cement with fly ash proved very effective in reducing the expansions of mortar bars.

The quantity of fly ash to be used varies widely and it depends upon many factors such as type of fly ash, type of aggregate and the cement. In this investigation 30% replacement of cement with Class F fly ash was found to be effective in reducing the ASR expansions.

4.10. Comparison of Expansions Measured in ASTM C227 and ASTM P214 Test Methods

The expansions of mortar bars measured (9) in the accelerated test procedure (ASTM P214) are given in table 18. A comparison of the expansions of mortar bars made with the five sands and with 0%, 10%, 20%, and 30% replacement of the cement with fly ash obtained using ASTM C227 and ASTM P214 test methods are given in Figures 63 to 67. From the comparison, it is seen that the expansions for the mortar bars without fly ash measured in ASTM C227 method were much smaller than those obtained from accelerated test method (ASTM P214). However, when the same comparison was made between the two methods for mortar bars with fly ash additions, no clear trend could be seen. This is because, in the Accelerated test method, the fly ash replacements of

10% and 20% showed a decrease in expansions whereas from the ASTM C227 test method, only 30% replacement of fly ash was effectively reducing the expansions. The expansions for some of the sands with 10% and 20% fly ash had higher expansions tested by the ASTM C227 test method than the expansions obtained in the accelerated test method. The ASTM C227 test method showed that only 30% replacement was effectively controlling the expansions. The expansions obtained by the two methods with 30% replacement were nearly the same and the expansions were very much reduced when compared to the expansions of mortar bars without fly ash.

4.11. Effect of Fly Ash on Cube Compressive Strength

The compressive strength test results for mortar cubes made with cement blended with 10% to 70% of fly ash and without fly ash are given in Table 19. The comparison of 3-day, 7-day, 28-day, and 56-day compressive strengths without and with various percentages of fly ash in the cement are shown in Figures 68 to 71 respectively. The comparison shows that there was no decrease in strength with the replacement of part of the cement with fly ash. Only 20% replacement had shown a decrease of the 3-day compressive strength.

CONCLUSIONS

1. Two pozzolans, a gray, highly siliceous "fireclay" from the Lakota formation (LK2) and Pierre shale which is a dark gray to black noncalcareous shale which was expanded (calcined) at 1700 to 2000°F (PS1E) are the

most effective for controlling the alkali-silica reaction. The expansions of the mortar bars made with 10%, 15% and 25% replacement of cement with pozzolans LK2 and PS1E were below 0.1% making the sand innocuous. Only one pozzolan, a white volcanic ash (VA2) was found to be unsuitable in controlling the expansions. The expansions of the mortar bars made by replacing the cement with 10%, 15%, and 25% of pozzolan VA2 had higher expansions than the mortar bars without the pozzolan. From the results obtained by ASTM P214 test method with different types of pozzolans, it can be concluded that higher percentage replacement (15% and 25%) was more effective in reducing the ASR than 10% replacement.

The pozzolans LK2 and PS1E were more effective in controlling the expansions than the Class F fly ash investigated. Hence it can be positively stated that natural pozzolans are available in the Black Hills area that could be used to effectively inhibit the expansions due to alkali-silica reactions. These pozzolans when added in smaller quantities than a class F or C fly ash are more effective in reducing the ASR expansions.

2. Using the conventional crushing and grinding operations it was possible to produce pozzolans up to the required fineness which is above 90% passing through sieve No. 325.

3. The Strength activity index with portland cement of the pozzolans investigated had a wide range of values varying between 19.78% and 91.72%. Based on the results obtained from this test, it can be stated that some pozzolans when blended with the cement would adversely affect the strength of concrete. Such pozzolans, even when they are effective in inhibiting the ASR expansions, should not be used for blending with cement.
4. The study on the affect of calcination of pozzolans on the strength of mortar cubes made with calcined pozzolan blended cements has shown that the strength activity index increases with an increase in the temperature of calcination. Uncalcined pozzolan Mowry Shale, which is dark gray to black, fissile shale formed in shallow seas (MW1) had a strength activity index of 45.27%. The strength activity index had increased to 92.24%, when the pozzolan was calcined at 1050°C. For pozzolan CT1, which is like a siltstone the strength activity index increased from 62.00% to 88.78% when it was calcined at 1050°C.
5. The ASTM C227 test results indicated that the pozzolans LK2, PS1E and US1 were most effective in reducing the percentage expansions of the mortar bars. There was only a slight decrease in the percentage expansions when pozzolans CT1, SM2, F3, CB1 and MW1 were blended with cement and there was no significant decrease in

the expansions when pozzolan VA2 was blended with cement.

6. Comparison of the expansions obtained by the ASTM CP214 and ASTM C227 test methods shows that there was a higher percentage of reduction in the percentage expansions from ASTM P214 test method. Both the test methods indicated that the pozzolans LK2 and PS1E are most suitable for blending with cement to reduce the alkali-silica reactivity.
7. In the accelerated test method (ASTM P214) the fly ash investigated was found effective in reducing the ASR expansions of mortar bars made with reactive sand and fly ash blended cement below 0.1% when the cement was replaced 25% by weight with fly ash.
8. In the ASTM C227 test procedure, the Class F fly ash used for controlling the expansions of the mortar bars made with the five reactive sands was effective in reducing the ASR expansions to an innocuous level when above 25% replacement of cement with the fly ash was used.
9. The expansions of the mortar bars determined by using ASTM C227 method had lower expansions for 0% and 10% replacement with fly ash than the expansions of the mortar bars obtained by the accelerated test method. The expansions for 20% replacement varied depending on the type of sand used. For 30% replacement, the expansions observed by both the methods were nearly the

same.

10. The compressive strength of mortar cubes made with fly ash blended cements was not affected when part of the cement (upto 40% by weight) was replaced with a Class F fly ash.

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TABLE 1 - CHEMICAL AND PHYSICAL PROPERTIES OF
CEMENT AND FLY ASH

	PORTLAND CEMENT	FLY ASH
<u>CHEMICAL ANALYSIS(%)</u>		
SiO ₂	22.74	52.66
Al ₂ O ₃	4.75	18.69
Fe ₂ O ₃	3.40	4.65
CaO	63.91	3.12
MgO	1.20	2.79
SO ₃	2.10	-
TiO ₂	-	5.29
Na ₂ O	0.15	0.40
K ₂ O	0.59	2.52
MnO	-	0.28
Moisture Content		0.02
Loss on Ignition	1.50	0.02
<u>Physical Test Results</u>		
Fineness Blaine(m ² /kg)	387	-
Fineness Retained on #325 sieve	-	16.72
Soundness		
Autoclave Expansion(%)	-0.01	0.09
<u>Bogue Potential</u>		
<u>Compounds</u>		
C ₃ S	44.57	
C ₂ S	31.58	
C ₃ A	6.83	
C ₄ AF	10.35	

TABLE 2. DESIGNATION, LOCATION, DEPOSIT AND DESCRIPTION OF POZZOLANS

SAMPLE	DATE COLLECTED	INVEST-IGATORS	LOCATION	DEPOSIT	DESCRIPTION
1 PR1	1990	HAIYU SHI et.al.	WANBLEE	ROCKYFORD ASH	LIGHT GRAY TUFF ("ZEOLITE")
2 F1	6.10.91	PERRY RAHN RON HOLM	BELOW TOWER 1 MI.S.OF RC SW1/4 SW1/4 SEC11,TIN, R7E	FUSON SHALE OF DAKOTA FM	GRAY CLAY WEATHERED TO NODULES
3 F2	6.10.91	PERRY RAHN RON HOLM	TOWER ROAD 1 MI.S OF RC SW1/4 SW1/4 SEC 11,TIN, R7E	FUSON SHALE OF DAKOTA FM	REDDISH (BURNT COLOR) SHALE YELLOWISH COAT ON WEATHERED SURFACE
4 W1	6.12.91	HAYAU SHI PERRY RAHN RON HOLM	2 MI NE OF WANBLEE SW1/4 NE1/4 SEC23 T42N;R37W	SHARPS FM JUST ABOVE ROCKY FORD ASH MEMBER	WHITE TO LIGHT GRAY, VERY HARD, RESISTANT TO WEATHERING
5 W2	6.12.91	HAYAU SHI PERRY RAHN RON HOLM	2 MI NE OF WANBLEE SW1/4 NE1/4 SEC23 T42N;R37W	ROCKY FORD ASH MEMBER OF SHARPS FM	VERY WHITE ZEOLITIC TUFF

TABLE 2 CONTD.,

SAMPLE	DATE COLLECTED	INVEST-IGATORS	LOCATION	DEPOSIT	DESCRIPTION
6 MW1	6.19.91	PERRY RAHN RON HOLM	HAINES AVE 1.5 MI N.OF RCMALL SE1/4 NW1/4 NW1/4 SEC 13 T2N; R8E	MOWRY SHALE	SHALE, DARK GRAY WEATHERS MEDIUM GRAY
7 MW2	6.19.91	PERRY RAHN RON HOLM	HAINES AVE SAME AS MW1 BUT EAST OF HAINES AVE	MOWRY SHALE	WEATHERED SAMPLE
8 SM1	6.27.91	PERRY RAHN RON HOLM	S.PART OF SHEEP MNT. TABLE SE1/4 NE1/4 SW1/4 SEC 28 T43N. R44W	UPPER PART OF ROCKY FORD ASH	WEATHERED; LIGHT GRAY VOLCANIC TUFF
9 SM2	6.27.91	PERRY RAHN RON HOLM	1/2 MI S.OF SM1 LOCATION	LOWER PART OF ROCKY FORD ASH	V.WHITE, HARD VOLCANIC TUFF
10 CB1	6.27.91	PERRY RAHN RON HOLM	2 MI W.OF STIRK TABLE NW1/4 SW1/4 SW1/4 SEC15 T4W;R44W	ROCKY FORD ASH	WHITE ASH (TUFF)

TABLE 2 CONTD.,

SAMPLE	DATE COLLECTED	INVEST-IGATORS	LOCATION	DEPOSIT	DESCRIPTION
11 CT1	6.27.91	PERRY RAHN RON HOLM	S.H OF CUNY TABLE CENTER OF SEC 20; T41N;R45W	SHARPS FM 10-15 FT ABOVE ROCKY FORD ASH	LIGHT GRAY-MORE LIKE A SILTSTONE
12 US1	7.10.91	RON HOLM	5MI SW OF SHARPS CORNER SEC 20 T39N; R43W	UPPER UNIT OF SHARPS FM (TYPE LOCALITY)	WHITE TO GRAY SILTSTONE
13 ERC1	7.10.91	RON HOLM	EAST OF ROCKY FORD CHURCH SW1/4 SE1/4 SEC 33;T41N; R43W	ROCKYFORD ASH	HIGHLY WEATHERED MORE LIKE A PUMICE
14 PRC1	7.10.91	RON HOLM	PORCUPINE ROAD CUT 2.5MI S OF SHARPS CORNER SW 1/4 SW1/4 NW1/4 SEC14 T39N;R43W	PROBABLY MIDDLE OF SHARPS FM	WHITISH GRAY; V.HARD;F.GRAINED CONTAINED MANY 1 INCH ORSMALLER VUGS W/CHALK VUGS
15 FE1	7.17.91	PERRY RAHN RON HOLM	1 MI NE OF FAIRBURN SE1/4 SE1/4 SW1/4 SEC17; T4S;R8E	WHITE RIVER GROUP (BASAL CHADRON FM)	BROWNISH GRAY CLAY SAMPLE IS FAIRLY WEATHERED

TABLE 2 CONTD.,

SAMPLE	DATE COLLECTED	INVEST-IGATORS	LOCATION	DEPOSIT	DESCRIPTION
16 FE2	7.17.91	PERRY RAHN RON HOLM	3MI W.OF ARGYLE,SD NEAR SECOVER SEC 12;T65 R3E	BRULE FM OF WHITE RIVER GROUP	LIGHT BROWN WEATHERED CLAY
17 FE3	7.17.91	PERRY RAHN RON HOLM	2.5 MI SSW OF REPTILE GARDENS NE1/4 NE1/4 SEC.21 T1S R7E	BRULE FM	BROWN CLAY
18 VA1	7.17.91	PERRY RAHN RON HOLM	3 MI W.OF AREYLE NEAR SE CORNER SEC12;T6S; R3E	BRULE FM	WHITE PURE ASH
19 BG1	7.17.91	PERRY RAHN RON HOLM	2MI S OF BUFFALO GAP E1/2 OF NE1/4 SEC8;T7S;R7E	PIERRE SHALES	YELLOWISH;HIGHLY WEATHERED BENTONITE
20 AC1	8.23.91	RON HOLM	AMERICAN COLLOID PLANT 2MI W.OF BELLE FOURCHE	BELLE FOURCHE SHALES	GRAY BENTONITE

TABLE 2 CONTD.,

SAMPLE	DATE COLLECTED	INVEST-IGATORS	LOCATION	DEPOSIT	DESCRIPTION
21 TH1	7.31.91	PERRY RAHN	BY TOMAHAWK COUNTRY CLUB NEAR DEADWOOD	TOMAHAWK VOLCANIC AREA	YELLOW TO LIGHT BROWN RHYOLITIC LITHIC TUFF CONTAINING SEVERAL XENOLITHS
22 F3	8.23.91	RON HOLM	SW OF BELLE FOURCHE	FUSON SHALE	LIGHT GRAY, NODULAR CLAY
23 F4	8.23.91	RON HOLM	SW OF BELLE FOURCHE	FUSON SHALE	REDDISH FISSILE SHALE
24 MO1	8.27.91	PERRY RAHN RON HOLM DAN JOHNSTON	2MI NE OF REPTILE GARDENS	MORRISON FM	GREENISH SHALE
25 VA2	8.27.91	PERRY RAHN RON HOLM DAN JOHNSTON	2MI NE OF REPTILE GARDENS	APPEARS TO BE IN MORRISON FM	WHITE VOLCANIC ASH
26 WW1	8.22.91	PERRY RAHN	NEAR WRIGHT WY.	CLINKER FROM COAL MINE	LIGHT RED IN COLOR
27 MOU	2.17.92	RON HOLM	BELOW M-HILL IN THE GAP, R.C. NE1/4, SW1/4, SW1/4 SEC. 35, T2N, R7E	LATE JURASSIC MORRISON FM.	VOLCANIC TUFF

TABLE 2 CONTD.,

SAMPLE	DATE COLLECTED	INVEST- IGATORS	LOCATION	DEPOSIT	DESCRIPTION
28 PS1E	10.20.91	RON HOLM PRASAD NUNNA	DAKOTA BLOCK PLANT, R.C. PIT LOCATED IN BOX ELDER AREA	UPPER CRETACEOUS	BROWN SHALE; EXPANDED PIERRE SHALE BY KILN HEATING
29 LK1	1.20.92	RON HOLM	SKYLINE DRIVE RAPID CITY NW1/4, SW1/4, SW1/4 SEC. 2 T1N, R7E	EARLY CRETACEOUS LAKOTA FM.	SILICIFIED VOLCANIC TUFF
30 LK2	1.30.92	RON HOLM	SOUTH SIDE OF MAIN ST. IN THE GAP, RAPID CITY NE1/4, NE1/4, NW1/4, SEC. 2, T1N, R7E	EARLY CRET. LAKOTA FM.	SILICIFIED VOLCANIC TUFF

**TABLE 2a CHEMICAL COMPOSITIONS, SODIUM OXIDE AND POTASSIUM OXIDE
CONCENTRATIONS (%) OF POZZOLAN SAMPLES USING ICP⁺**

SAMPLE	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	TiO ₂	SO ₃	MnO	BaO	NiO	H ₂ O	L I [*]	TOTAL
SM2	61.29	9.88	1.62	4.23	0.61	0.52	5.19	0.23	0.30	0.40	0.60	BDL	5.25	7.56	96.68
CB1	65.47	10.13	1.46	3.48	0.66	0.38	5.13	0.20	0.17	0.03	0.05	BDL	4.22	8.42	99.80
CT1	58.82	10.43	2.39	5.84	1.16	0.30	3.37	0.38	0.03	0.05	0.09	BDL	5.96	7.53	96.45
MW1	57.23	14.51	4.12	0.96	1.58	0.05	2.61	0.62	0.27	0.04	0.01	BDL	5.50	6.52	94.02
PRC1	63.76	10.96	2.89	3.98	1.19	0.34	5.16	0.45	0.20	0.04	0.05	BDL	3.75	4.45	97.22
PS1E	58.98	16.59	6.29	1.57	2.11	0.02	4.53	0.70	1.01	0.05	0.05	BDL	0.15	1.10	93.15
US1	65.24	12.09	3.12	3.24	1.61	0.39	3.52	0.50	0.09	0.04	0.04	BDL	4.90	4.21	98.99
F3	75.00	7.44	1.73	0.95	0.65	0.04	0.92	0.68	0.16	BDL	BDL	BDL	6.00	4.28	97.85
LK2	79.94	7.58	1.11	0.25	0.15	0.01	1.53	0.35	0.13	BDL	BDL	BDL	0.81	4.37	96.23
F1	-	-	-	-	-	0.01	4.12	-	-	-	-	-	-	-	-
F2	-	-	-	-	-	0.03	2.84	-	-	-	-	-	-	-	-
LK1	-	-	-	-	-	0.01	1.71	-	-	-	-	-	-	-	-
MO1	-	-	-	-	-	0.04	6.54	-	-	-	-	-	-	-	-

L I* - Loss on Ignition

ICP+ - Inductively Coupled Plasma

BDL - Below detection level

SiO₂ and SO₃ were determined using wet chemistry technique.

TABLE 2a CONTD.,

SAMPLE	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	TiO ₂	SO ₃	MnO	BaO	NiO	H ₂ O	L I *	TOTAL
MOU1	-	-	-	-	-	BDL	1.88	-	-	-	-	-	-	-	-
PR1	-	-	-	-	-	0.62	6.19	-	-	-	-	-	-	-	-
W1	-	-	-	-	-	0.40	4.07	-	-	-	-	-	-	-	-
W2	-	-	-	-	-	0.34	4.22	-	-	-	-	-	-	-	-
SM1	-	-	-	-	-	0.32	5.58	-	-	-	-	-	-	-	-
ERC1	-	-	-	-	-	0.58	3.93	-	-	-	-	-	-	-	-
AC1	-	-	-	-	-	0.54	1.28	-	-	-	-	-	-	-	-
BG1	-	-	-	-	-	0.34	1.01	-	-	-	-	-	-	-	-
FE2	-	-	-	-	-	0.19	2.36	-	-	-	-	-	-	-	-
VA1	-	-	-	-	-	0.34	5.98	-	-	-	-	-	-	-	-
VA2	-	-	-	-	-	BDL	2.08	-	-	-	-	-	-	-	-
WW1	-	-	-	-	-	0.27	3.58	-	-	-	-	-	-	-	-
TH1	-	-	-	-	-	0.51	3.55	-	-	-	-	-	-	-	-

L I* - Loss on Ignition

ICP+ - Inductively Coupled Plasma

BDL - Below detection level

SiO₂ and SO₃ were determined using wet chemistry technique.

TABLE 2aa CHEMICAL COMPOSITIONS, SODIUM OXIDE AND POTASSIUM OXIDE
CONCENTRATIONS (%) OF POZZOLAN SAMPLES USING SEM⁺

SAMPLE	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	TiO ₂	SO ₃	MnO	Cl	P ₂ O ₅	H ₂ O	L I *	TOTAL
SM2	64.28	11.84	2.06	3.85	0.78	2.03	4.04	0.25	0.10	0.00	BDL	BDL	4.05	6.72	100.0
CB1	63.95	11.46	1.54	3.08	0.99	1.44	4.53	0.29	0.08	0.00	BDL	BDL	4.22	8.42	100.0
CT1	55.52	12.75	4.36	9.70	1.84	1.05	3.20	0.82	0.17	0.29	0.07	0.39	2.31	7.53	100.0
MW1	56.21	19.29	6.26	1.47	1.68	0.48	2.80	1.15	0.86	0.00	0.00	0.35	2.93	6.52	100.0
PRC1	61.99	11.97	4.58	5.17	1.13	1.12	5.10	0.75	0.11	0.27	0.00	0.43	2.75	4.45	100.0
PS1E	56.21	19.48	9.52	2.74	2.31	0.91	3.85	1.04	1.86	0.08	0.07	0.68	0.15	1.10	100.0
US1	60.22	14.58	4.80	5.08	2.53	1.12	3.11	0.60	0.10	0.25	0.13	0.46	2.81	4.21	100.0
LK2	82.77	8.67	0.97	0.38	0.67	0.35	0.47	0.38	0.16	0.00	BDL	BDL	0.81	4.37	100.0
F3	73.62	11.60	3.44	1.38	1.03	0.19	0.22	1.02	0.17	0.00	BDL	BDL	2.88	4.28	100.0

NiO and BaO were below detection level

SEM⁺ - Scanning Electron Microscope

BDL - Below detection level

TABLE 2b DENSITY AND FINENESS OF POZZOLANS AND FLY ASH

SAMPLE	DENSITY gm/cm ³	FINENESS (%) PASSING NO.325 SIEVE
	ASTM C188	ASTM C430
CEMENT	3.13	95.26
F1	2.62	92.25
F2	2.84	91.79
W1	2.73	95.51
W2	2.32	94.89
MW1	2.41	92.41
SM1	2.50	94.43
SM2	2.22	93.19
CB1	2.13	93.96
CT1	2.30	97.05
US1	2.36	96.90
ERC1	2.42	93.80
FE2	2.33	92.26
TH1	2.59	91.50

TABLE 2b CONTD.,

SAMPLE	DENSITY gm/cm ³	FINENESS (%) PASSING NO.325 SIEVE
	ASTM C188	ASTM C430
PR1	2.27	90.71
BG1	2.54	95.36
MO1	2.42	96.60
WW1	2.39	96.60
PRC1	2.38	93.80
VA1	2.53	95.05
VA2	2.48	97.99
AC1	2.59	93.96
F3	2.34	91.79
PS1E	2.34	98.77
LK1	2.30	93.65
LK2	2.27	98.30
MOU	2.25	92.25
FLYASH	2.67	83.80

TABLE 2c BLAINE FINENESS OF SELECTED POZZOLANS

SAMPLE	BULK VOLUME cm ³	DENSITY gm/cm ²	CONSTANT "b"	TIME Seconds	FINENESS cm ² /gm
CEMENT-1	1.816	3.15	0.90	87.61	4030
CEMENT-2				86.24	3990
CEMENT-3				84.68	3960
MEAN					3990
S.D.					35.11
%C.V.					0.879
FLYASH-1	1.777	2.67	0.92	65.32	3504
FLYASH-2				66.29	3530
FLYASH-3				67.39	3560
MEAN					3530
S.D.					28.02
%C.V.					3.568
LK2-1	2.130	2.27	1.26	108.39	3290
LK2-2				103.76	3218
LK2-3				110.02	3313
MEAN					3270
S.D.					49.56
%C.V.					1.513
PS1E-1	1.935	2.34	1.07	142.60	4875
PS1E-2				150.00	4997
PS1E-3				142.32	4867
MEAN					4910
S.D.					72.85
%C.V.					1.483
SM2-1	2.680	2.22	1.86	158.33	4394
SM2-2				160.04	4419
SM2-3				161.97	4443
MEAN					4420
S.D.					24.50
%C.V.					0.554

TABLE 2c CONTD.,

SAMPLE	BULK VOLUME cm ³	DENSITY gm/cm ²	CONSTANT "b"	TIME Seconds	FINENESS cm ² /gm
MW1-1	2.000	2.41	1.34	128.37	3578
MW1-2				120.94	3471
MW1-3				118.64	3439
MEAN					3500
S.D.					72.79
%C.V.					2.082
CT1-1	2.016	2.30	1.14	93.60	3577
CT1-2				97.77	3655
CT1-3				89.24	3492
MEAN					3570
S.D.					81.52
%C.V.					2.280

TABLE 3 - CHEMICAL COMPOSITION OF SANDS

COMPOUND NAME	SAMPLE NAME				
	EVERIST HAWARDEN	HARRY PERRY PIT	OPPERMAN HERRICK PIT	EVERIST BROOKINGS	MISSION HILLS
SiO ₂ %	55.71	86.11	74.61	37.02	55.92
Si %	26.05	40.26	34.89	17.31	26.15
Al ₂ O ₃ %	7.040	4.880	13.33	7.110	6.730
Al %	3.720	2.580	7.050	3.760	3.560
Na ₂ O %	2.010	.7800	2.710	1.850	1.670
Na %	1.490	.5800	2.010	1.370	1.240
K ₂ O %	1.950	2.650	5.860	1.500	2.210
K %	1.610	2.220	4.870	1.240	1.840
CaO %	14.46	2.570	1.950	19.56	13.30
Ca %	10.33	1.830	1.390	13.98	9.510
FeO %	.6500	.0500	.0500	.9800	.7500
Fe %	.5000	.0400	.0400	.7600	.5800
Fe ₂ O ₃ %	.2200	.7000	.1400	.0800	.5600
Fe ₂	.1500	.4900	.0900	.0500	.3900
MgO %	2.700	.0400	.0400	7.450	3.920
Mg %	1.630	.0200	.0200	4.490	2.370

TABLE 3 CONTD.,

COMPOUND NAME	SAMPLE NAME				
	EVERIST HAWARDEN	HARRY PERRY PIT	OPPERMAN HERRICK PIT	EVERIST BROOKINGS	MISSION HILLS
H ₂ O %	.5400	.1100	.2300	.4400	.1800
H %	.0600	.0100	.0680	.0400	.0200
CO ₂ %	14.32	1.940	.6800	23.59	14.40
C %	3.900	.5300	.1800	.5500	4.260
MnO %	.2500	.0400	.0100	.0500	.3200
Mn %	.2000	.0300	.0100	.0300	.2400
TiO ₂ %	.0200	-	.0900	.1100	.0500
Ti %	.0100	-	.0500	.0600	.0300
NiO %	.0200	-	-	-	.0300
Ni %	.0100	-	-	-	.0200
BaO %	.0100	.0200	.0200	.0200	-
Ba %	.0100	.0200	.0100	.0100	-
OXIDE % TOTAL	98.99	99.88	99.74	99.68	99.84
ELEMENT% TOTAL	49.75	48.65	50.71	50.99	50.53

NOTE : RESULTS FOR ALL SAND SAMPLES WERE OBTAINED BY
REFERENCE INTENSITY METHOD (RIM) OF QUANTITATIVE
X-RAY ANALYSIS.

TABLE 4 DESIGNATIONS OF POZZOLANS TESTED BY ASTM C227 AND
ASTM P214 TEST METHODS

SAMPLE	PERCENTAGE OF POZZOLAN		
	10%	15%	25%
SM2	SM21	SM22	SM23
CB1	CB11	CB12	CB13
CT1	CT11	CT12	CT13
US1	US11	US12	US13
PRC1	PRC11	PRC12	PRC13
MW1	MW11	MW12	MW13
VA2	VA21	VA22	VA23
F3	F31	F32	F33
PS1E	PS1E1	PS1E2	PS1E3
LK2	LK21	LK22	LK23

- Note: 1. Designations for mortar bars made with fly ash replacements for ASTM C9 P214 test method are F10, F15, F25, F30, AND F40 for 10%, 15%, 25%, 30% and 40% replacements respectively.
2. Mortar bars made without pozzolan replacement are designated as "RS".

**TABLE 5 SAND SAMPLES AND MIXTURE DESIGNATIONS FOR
ASTM C227 METHOD AND ASTM P214**

SAND SAMPLE	FLY ASH CONTENT							
	ASTM C227				ASTM C9 P214			
	0%	10%	20%	30%	0%	10%	20%	30%
EVERIST HAWARDEN	M1A	MA1	MA2	MA3	M1R	M1B	M1C	M1D
HARRY PERRY PIT	M2A	MB1	MB2	MB3	M2R	M2B	M2C	M2D
OPPERMAN HERRICK PIT	M3A	MC1	MC2	MC3	M3R	M3B	M3C	M3D
EVERIST BROOKINGS	M6A	MD1	MD2	MD3	M6R	M6B	M6C	M6D
MISSION HILLS	M7A	ME1	ME2	ME3	M7R	M7B	M7C	M7D

**TABLE 6 MIXTURE DESIGNATIONS AND PROPORTIONS FOR CUBES
WITH CEMENT REPLACED WITH DIFFERENT % OF FLY ASH**

MIX DESIGNATION	SAND-CEMENT RATIO	WATER-CEMENT RATIO	FLY ASH %
C0	2.25	0.44	0
C1	2.25	0.44	10
C2	2.25	0.44	20
C3	2.25	0.44	30
C4	2.25	0.44	40
C5	2.25	0.44	50
C6	2.25	0.44	60
C7	2.25	0.44	70

Note: Fly Ash % is with respect to cement by weight.

TABLE 7 WATER CEMENT RATIOS USED FOR STRENGTH ACTIVITY
INDEX OF NATURAL POZZOLANS AND FLY ASH WITH
PORTLAND CEMENT

Sample	Water
	Cement + Pozzolan
CEMENT	0.48
F1	0.47
F2	0.45
W1	0.50
W2	0.50
MW1	0.50
SM1	0.50
SM2	0.50
CB1	0.50
CT1	0.45
US1	0.45
ERC1	0.50
FE2	0.45
TH1	0.47
PR1	0.48
BG1	0.55
MO1	0.48
WW1	0.48
PRC1	0.46
VA1	0.46
VA2	0.44
AC1	0.44
F3	0.46
PS1E	0.46
LK1	0.47
LK2	0.46
MOU	0.46
Fly Ash	0.44

**TABLE 8 COMPRESSIVE STRENGTH AND STRENGTH ACTIVITY INDEX
OF NATURAL POZZOLANS WITH PORTLAND CEMENT**

Sample	Load lbs	Compressive Strength, Psi at age 28 days	Strength Activity Index with Cement in percent
C01	26900	6725	-
C02	26500	6625	
C03	28500	7125	
MEAN	27300	6825	
S.D.	1058.3	264.5	
C.V.	0.0387	0.038	
F1-1	11800	2950	48.64
F1-2	14500	3625	
F1-3	13500	3375	
MEAN	13266	3320	
S.D.	1365.0	341.2	
C.V.	0.1028	0.102	
F2-1	12500	3125	44.40
F2-2	12900	3225	
F2-3	11000	2750	
MEAN	12133	3030	
S.D.	1001.6	250.4	
C.V.	0.0825	0.082	
W1-1	11500	2875	50.00
W1-2	18500	4625	
W1-3	10900	2725	
MEAN	13633	3410	
S.D.	4225.3	1056.3	
C.V.	0.3100	0.310	
W2-1	15400	3850	53.11
W2-2	14100	3525	
W2-3	14000	3500	
MEAN	14500	3625	
S.D.	781.0	195.2	
C.V.	0.0538	0.053	
MW1-1	11200	2800	45.27
MW1-2	12600	3150	
MW1-3	13300	3325	
MEAN	12366	3090	
S.D.	1069.2	267.3	
C.V.	0.0864	0.086	

S.D. - Standard Deviation, C.V. - Coefficient of Variation

TABLE 8 CONTD.

Sample	Load lbs	Compressive Strength, Psi at age 28 days	Strength Activity Index with Cement in percent
SM1-1 SM1-2 SM1-3 MEAN S.D. C.V.	19100 18500 18500 18700 346.4 0.0185	4775 4625 4625 4675 86.6 0.018	68.5
SM2-1 SM2-2 SM2-3 MEAN S.D. C.V.	19000 19500 18500 19000 500.0 0.0263	4750 4875 4625 4750 125.0 0.026	69.60
CB1-1 CB1-2 CB1-3 MEAN S.D. C.V.	21200 23000 21400 21866 986.5 0.0451	5300 5750 5350 5470 246.6 0.045	80.15
CT1-1 CT1-2 CT1-3 MEAN S.D. C.V.	18100 14700 18000 16933 1934.7 0.1142	4525 3675 4500 4230 483.7 0.114	62.00
US1-1 US1-2 US1-3 MEAN S.D. C.V.	17800 16200 18100 17366 1021.4 0.0588	4450 4050 4525 4340 255.3 0.058	63.60
ERC1-1 ERC1-2 ERC1-3 MEAN S.D. C.V.	20100 18900 17500 19133 1761.6 0.0920	5025 4725 4375 4708 325.3 0.069	69.01

TABLE 8 CONTD.

Sample	Load lbs	Compressive Strength, Psi at age 28 days	Strength Activity Index with Cement in percent
FE2-1 FE2-2 FE2-3 MEAN S.D. C.V.	5400 5800 5000 5400 400.3 0.074	1350 1450 1250 1350 100.5 0.074	19.78
TH1-1 TH1-2 TH1-3 MEAN S.D. C.V.	8400 8600 11200 9400 1562.0 0.1661	2100 2150 2800 2350 390.5 0.166	34.43
PR1-1 PR1-2 PR1-3 MEAN S.D. C.V.	12800 16400 14300 14500 1808.3 0.1242	3200 4100 3575 3625 452.0 0.124	53.11
BG1-1 BG1-2 BG1-3 MEAN S.D. C.V.	15400 16000 15400 15600 346.4 0.0226	3850 4000 3850 3900 86.6 0.022	57.14
MO1-1 MO1-2 MO1-3 MEAN S.D. C.V.	10000 12000 14300 12100 2151.7 0.1776	2500 3000 3575 3025 537.9 0.177	44.32
WW1-1 WW1-2 WW1-3 MEAN S.D. C.V.	14300 10400 15200 13300 2551.3 0.1915	3575 2600 3800 3325 637.8 0.191	48.71

TABLE 8 CONTD.

Sample	Load lbs	Compressive Strength, Psi at age 28 days	Strength Activity Index with Cement in percent
LK1-1	20900	5225	85.12
LK1-2	22700	5675	
LK1-3	26100	6525	
MEAN	23233	5810	
S.D.	2640.8	660.1	
C.V.	0.1132	0.113	
LK2-1	24200	6050	82.93
LK2-2	23600	5900	
LK2-3	20100	5025	
MEAN	22633	5660	
S.D.	2214.4	553.5	
C.V.	0.0978	0.097	
MOU-1	15400	3850	55.23
MOU-2	14600	3650	
MOU-3	15200	3800	
MEAN	15066	3770	
S.D.	416.3	104.0	
C.V.	0.0274	0.027	
PRC1-1	19000	4750	71.43
PRC1-2	18500	4625	
PRC1-3	21000	5250	
MEAN	19500	4875	
S.D.	1322.8	330.7	
C.V.	0.0674	0.067	
VA1-1	17400	4350	72.67
VA1-2	20100	5025	
VA1-3	22000	5500	
MEAN	19833	4960	
S.D.	2311.8	577.8	
C.V.	0.1164	0.116	
VA2-1	22900	5725	85.56
VA2-2	24000	6000	
VA2-3	23200	5800	
MEAN	23366	5840	
S.D.	568.6	142.1	
C.V.	0.0246	0.024	

TABLE 8 CONTD.,

Sample	Load lbs	Compressive Strength, Psi at age 28 days	Strength Activity Index with Cement in percent
AC1-1	17800	4450	55.10
AC1-2	14000	3500	
AC1-3	13300	3325	
MEAN	15033	3760	
S.D.	2421.2	605.3	
C.V.	0.1612	0.161	
F3-1	24400	6100	78.75
F3-2	17900	4475	
F3-3	22200	5550	
MEAN	21500	5375	
S.D.	3306.7	826.5	
C.V.	0.1534	0.153	
PS1E-1	25400	6350	91.72
PS1E-2	22100	5525	
PS1E-3	27600	6900	
MEAN	25033	6260	
S.D.	2768.7	692.0	
C.V.	0.1105	0.110	
FLYASH-1	23700	5920	75.06
FLYASH-2	20600	5150	
FLYASH-3	18400	4600	
MEAN	20900	5125	
S.D.	2662.7	810.3	
C.V.	0.1274	0.158	

**TABLE 8a COMPRESSIVE STRENGTH AND STRENGTH ACTIVITY INDEX
WITH CEMENT FOR CALCINED AND UNCALCINED POZZOLANS**

Sample	Load lbs	Compressive Strength, Psi age 7 days	Strength Activity Index with Cement in percent	TREATMENT TEMPERATURE °C
CEMENT1	17300	4325	-	-
CEMENT2	20400	5100		
CEMENT3	19500	4875		
MEAN	19066	4770		
S.D.	1594.7	398.69		
C.V.	0.0836	0.0836		
MW1A-1	14100	3525	71.48	350
MW1A-2	13000	3250		
MW1A-3	13800	3450		
MEAN	13633	3410		
S.D.	568.6	142.15		
C.V.	0.0417	0.0417		
MW1B-1	15100	3775	82.81	700
MW1B-2	16000	4000		
MW1B-3	16300	4075		
MEAN	15800	3950		
S.D.	624.49	156.1		
C.V.	0.0395	0.0395		
MW1C-1	17200	4300	92.24	1050
MW1C-2	18600	4650		
MW1C-3	17000	4250		
MEAN	17600	4440		
S.D.	871.77	217.94		
C.V.	0.0495	0.0495		
PS1A -1	15300	3825	84.38	115
PS1A -2	16200	4050		
PS1A -3	16800	4200		
MEAN	16100	4025		
S.D.	754.98	188.75		
C.V.	0.0468	0.0468		
PS1B -1	16000	4000	86.79	350
PS1B -2	16200	4050		
PS1B -3	17500	4375		
MEAN	16566	4140		
S.D.	814.45	203.61		
C.V.	0.0491	0.0491		

S.D. - Standard Deviation, C.V. - Coefficient of Variation

TABLE 8a CONTD.,

Sample	Load lbs	Compressive Strength, Psi age 7 days	Strength Activity Index with Cement in percent	TREATMENT TEMPERATURE °C
PS1C -1	17300	4325	95.17	700
PS1C -2	19000	4750		
PS1C -3	18200	4550		
MEAN	18166	4540		
S.D.	850.49	212.6		
C.V.	0.0468	0.0468		
CT1A-1	16200	4050	88.78	950
CT1A-2	16600	4150		
CT1A-3	18000	4500		
MEAN	16933	4235		
S.D.	945.1	236.3		
C.V.	0.0558	0.0558		

TABLE 9 GRADATION OF AGGREGATES USED FOR ASTM C227
AND ASTM P214

Sieve Size		Weight %
Passing	Retained on	
No. 4	No. 8	10
No. 8	No. 16	25
No. 16	No. 30	25
No. 30	No. 50	25
No. 50	No. 100	15

TABLE 10 SAMPLE CALCULATION OF STRENGTH ACTIVITY INDEX
WITH PORTLAND CEMENT

Test Sample Name - F1

Average Compressive Strength of

test specimen (A) = 3320 psi

Average compressive Strength of

Control specimen (B) = 6825 psi

Strength activity index with cement = $(A/B) \times 100$

= $(3320/6825) \times 100$

= 48.64%

**TABLE 11 LENGTH MEASUREMENTS OF MORTAR BARS FROM ASTM P214
TEST METHOD WITH POZZOLANS**

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
SM21-1	11.62530	11.63420	11.63540	11.63600	11.64230	11.64570
SM21-2	11.64065	11.64995	11.65110	11.65160	11.65855	11.66060
SM21-3	11.62325	11.63180	11.63265	11.63360	11.64230	11.64470
SM21-4	11.63900	11.64655	11.64715	11.64800	11.65880	11.65955

POZZOLAN SAMPLE: SM2
 PERCENTAGE OF POZZOLAN: 10
 SAMPLE DESIGNATION: SM21
 DATE OF MIXING: 04/13/92
 TIME OF MIXING: 4 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
SM22-1	11.57950	11.58720	11.58830	11.58900	11.58990	11.59085
SM22-2	11.58495	11.59185	11.59300	11.59385	11.59470	11.59575
SM22-3	11.58345	11.58865	11.59000	11.59045	11.59100	11.59280
SM22-4	11.62180	11.62755	11.62875	11.62925	11.63105	11.63245

POZZOLAN SAMPLE: SM2
 PERCENTAGE OF POZZOLAN: 15%
 SAMPLE DESIGNATION: SM22
 DATE OF MIXING: 04/13/92
 TIME OF MIXING: 4 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
SM23-1	11.56155	11.56540	11.56760	11.56885	11.56970	11.56970
SM23-2	11.54105	11.54535	11.54770	11.54810	11.54995	11.54995
SM23-3	11.55320	11.55620	11.55780	11.55860	11.55920	11.56030
SM23-4	11.56170	11.56400	11.56620	11.56860	11.56950	11.56950

POZZOLAN SAMPLE: SM2
 PERCENTAGE OF POZZOLAN: 25%
 SAMPLE DESIGNATION: SM23
 DATE OF MIXING: 04/13/92
 TIME OF MIXING: 4 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
CB11-1	11.64970	11.65265	11.65395	11.65975	11.66135	11.66315
CB11-2	11.64635	11.65080	11.65190	11.65465	11.65660	11.66020
CB11-3	11.65010	11.65255	11.65405	11.65780	11.66180	11.66495
CB11-4	11.64875	11.65235	11.65380	11.65545	11.65950	11.66385

POZZOLAN SAMPLE: CB1
 PERCENTAGE OF POZZOLAN: 10%
 SAMPLE DESIGNATION: CB11
 DATE OF MIXING: 04/14/92
 TIME OF MIXING: 4 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
CB12-1	11.61380	11.61680	11.61885	11.62210	11.62315	11.62875
CB12-2	11.57670	11.58040	11.58190	11.58260	11.58445	11.58935
CB12-3	11.60815	11.61070	11.61205	11.61330	11.61440	11.61965
CB12-4	11.59045	11.59440	11.59585	11.59680	11.59860	11.60300

POZZOLAN SAMPLE: CB1
 PERCENTAGE OF POZZOLAN: 15%
 SAMPLE DESIGNATION: CB12
 DATE OF MIXING: 04/14/92
 TIME OF MIXING: 5 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
CB13-1	11.51970	11.52255	11.52315	11.52395	11.52535	11.52765
CB13-2	11.55710	11.55920	11.55990	11.56040	11.56160	11.56445
CB13-3	11.65800	11.65850	11.65910	11.65990	11.66225	11.66450
CB13-4	11.57530	11.57630	11.57710	11.57790	11.57970	11.58255

POZZOLAN SAMPLE: CB1
 PERCENTAGE OF POZZOLAN: 25%
 SAMPLE DESIGNATION: CB13
 DATE OF MIXING: 04/14/92
 TIME OF MIXING: 5 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
CT11-1	11.58490	11.59130	11.59550	11.59780	11.59955	11.60325
CT11-2	11.58700	11.59440	11.59820	11.60040	11.60490	11.60590
CT11-3	11.55825	11.56215	11.56615	11.56835	11.57330	11.57680
CT11-4	11.55290	11.55640	11.55940	11.56000	11.56545	11.56695

POZZOLAN SAMPLE: CT1
 PERCENTAGE OF POZZOLAN: 10%
 SAMPLE DESIGNATION: CT11
 DATE OF MIXING: 04/15/92
 TIME OF MIXING: 4 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
CT12-1	11.58485	11.59310	11.59525	11.59615	11.59810	11.59820
CT12-2	11.59060	11.59490	11.59730	11.59765	11.60020	11.60225
CT12-3	11.52365	11.53000	11.53200	11.53200	11.53525	11.53655
CT12-4	11.58600	11.59165	11.59385	11.59570	11.59715	11.60180

POZZOLAN SAMPLE: CT1
 PERCENTAGE OF POZZOLAN: 15%
 SAMPLE DESIGNATION: CT12
 DATE OF MIXING: 04/15/92
 TIME OF MIXING: 4.30 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
CT13-1	11.56540	11.57020	11.57620	11.57770	11.57860	11.57920
CT13-2	11.56070	11.56595	11.57175	11.57375	11.57425	11.57525
CT13-3	11.58140	11.58615	11.59225	11.59315	11.59415	11.59565
CT13-4	11.56540	11.56860	11.57470	11.57580	11.57720	11.57760

POZZOLAN SAMPLE: CT1
 PERCENTAGE OF POZZOLAN: 25%
 SAMPLE DESIGNATION: CT13
 DATE OF MIXING: 04/15/92
 TIME OF MIXING: 5 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
US11-1	11.58720	11.58920	11.59190	11.59595	11.60310	11.60345
US11-2	11.57825	11.58100	11.58370	11.58660	11.59325	11.59335
US11-3	11.58400	11.58865	11.59085	11.59420	11.60130	11.60135

POZZOLAN SAMPLE: US1
 PERCENTAGE OF POZZOLAN: 10%
 SAMPLE DESIGNATION: US11
 DATE OF MIXING: 04/17/92
 TIME OF MIXING: 4 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
US12-1	11.54105	11.54580	11.54855	11.54895	11.55460	11.55600
US12-2	11.56750	11.57040	11.57270	11.57395	11.57845	11.57955
US12-3	11.56790	11.57210	11.57450	11.57400	11.57905	11.58100

POZZOLAN SAMPLE: US1
 PERCENTAGE OF POZZOLAN: 15%
 SAMPLE DESIGNATION: US12
 DATE OF MIXING: 04/17/92
 TIME OF MIXING: 4.30 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
US13-1	11.66375	11.66790	11.66870	11.66940	11.66960	11.67020
US13-2	11.64535	11.64900	11.65020	11.65080	11.65090	11.65120
US13-3	11.58465	11.58865	11.58995	11.58995	11.59025	11.59065
US13-4	11.64140	11.64535	11.64635	11.64675	11.64705	11.64735

POZZOLAN SAMPLE: US1
 PERCENTAGE OF POZZOLAN: 25%
 SAMPLE DESIGNATION: US13
 DATE OF MIXING: 04/17/92
 TIME OF MIXING: 5 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
MW11-1	11.57885	11.58320	11.59010	11.59100	11.59270	11.59745
MW11-2	11.55020	11.55625	11.56165	11.56185	11.56280	11.56965
MW11-3	11.54980	11.55475	11.56065	11.56070	11.56210	11.56920
MW11-4	11.59450	11.60025	11.60520	11.60530	11.60710	11.61530

POZZOLAN SAMPLE: MW1
 PERCENTAGE OF POZZOLAN: 10%
 SAMPLE DESIGNATION: MW11
 DATE OF MIXING: 04/16/92
 TIME OF MIXING: 4 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
MW12-1	11.56595	11.57185	11.57785	11.57845	11.57885	11.58325
MW12-2	11.53790	11.54285	11.54825	11.54895	11.54975	11.55315
MW12-3	11.58180	11.58810	11.59390	11.59490	11.59570	11.59790
MW12-4	11.59760	11.60565	11.61195	11.61265	11.61315	11.61525

POZZOLAN SAMPLE: MW1
 PERCENTAGE OF POZZOLAN: 15%
 SAMPLE DESIGNATION: MW12
 DATE OF MIXING: 04/16/92
 TIME OF MIXING: 4.30 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
MW13-1	11.56215	11.56810	11.57160	11.57190	11.57250	11.57625
MW13-2	11.57495	11.58180	11.58480	11.58540	11.58580	11.58735
MW13-3	11.57225	11.57985	11.58295	11.58385	11.58435	11.58465
MW13-4	11.60275	11.60795	11.61115	11.61185	11.61235	11.61540

POZZOLAN SAMPLE: MW1
 PERCENTAGE OF POZZOLAN: 25%
 SAMPLE DESIGNATION: MW13
 DATE OF MIXING: 04/16/92
 TIME OF MIXING: 5 p.m.

SPECIMEN #	LENGTH IN INCHES IN DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
PRC11-1	11.56695	11.56935	11.57295	11.58245	11.58605	11.59520
PRC11-2	11.54955	11.55200	11.55700	11.56235	11.56915	11.57315
PRC11-3	11.57005	11.57180	11.57445	11.58270	11.58990	11.59625

POZZOLAN SAMPLE: PRC1
 PERCENTAGE OF POZZOLAN: 10%
 SAMPLE DESIGNATION: PRC11
 DATE OF MIXING: 05/07/92
 TIME OF MIXING: 4 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
PRC12-1	11.65370	11.65545	11.65715	11.65975	11.66460	11.67230
PRC12-2	11.65355	11.65510	11.65665	11.65750	11.66455	11.67120
PRC12-3	11.63130	11.63255	11.63395	11.63675	11.64020	11.64740

POZZOLAN SAMPLE: PRC1
 PERCENTAGE OF POZZOLAN: 15%
 SAMPLE DESIGNATION: PRC11
 DATE OF MIXING: 05/07/92
 TIME OF MIXING: 4.30 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
PRC13-1	11.60100	11.60225	11.60405	11.60510	11.60775	11.61170
PRC13-2	11.59095	11.59205	11.59345	11.59755	11.59765	11.60360
PRC13-3	11.57150	11.57990	11.58155	11.58265	11.58440	11.58760
PRC13-4	11.52905	11.53025	11.53205	11.53380	11.53545	11.54065

POZZOLAN SAMPLE: PRC1
 PERCENTAGE OF POZZOLAN: 25%
 SAMPLE DESIGNATION: PRC13
 DATE OF MIXING: 05/07/92
 TIME OF MIXING: 5 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
VA21-1	11.52165	11.52465	11.52605	11.53600	11.54560	11.54890
VA21-2	11.63580	11.63870	11.64145	11.65525	11.66225	11.66620
VA21-3	11.66900	11.66935	11.67240	11.68575	11.69335	11.69560

POZZOLAN SAMPLE: VA2
 PERCENTAGE OF POZZOLAN: 10%
 SAMPLE DESIGNATION: VA21
 DATE OF MIXING: 05/15/92
 TIME OF MIXING: 4 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
VA22-1	11.62705	11.62845	11.63170	11.64620	11.65650	11.66170
VA22-2	11.61995	11.62135	11.62455	11.63860	11.64770	11.65180
VA22-3	11.59580	11.59745	11.59885	11.61345	11.62290	11.62860

POZZOLAN SAMPLE: VA2
 PERCENTAGE OF POZZOLAN: 15%
 SAMPLE DESIGNATION: VA22
 DATE OF MIXING: 05/15/92
 TIME OF MIXING: 4.30 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
VA23-1	11.53475	11.53860	11.54110	11.55630	11.56860	11.56955
VA23-2	11.60245	11.60700	11.60865	11.62000	11.63075	11.63475
VA23-3	11.57180	11.57485	11.57970	11.59115	11.60175	11.60645
VA23-4	11.53180	11.53455	11.53750	11.55090	11.56185	11.56630

POZZOLAN SAMPLE: VA2
 PERCENTAGE OF POZZOLAN: 25%
 SAMPLE DESIGNATION: VA23
 DATE OF MIXING: 05/15/92
 TIME OF MIXING: 5 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
F31-1	11.62050	11.62450	11.63025	11.63450	11.63940	11.63970
F31-2	11.59450	11.59800	11.60615	11.60840	11.61715	11.61830
F31-3	11.59145	11.59655	11.60405	11.60725	11.61180	11.61300
F31-4	11.59095	11.59395	11.61435	11.61750	11.62210	11.62380

POZZOLAN SAMPLE: F3
 PERCENTAGE OF POZZOLAN: 10%
 SAMPLE DESIGNATION: F31
 DATE OF MIXING: 05/14/92
 TIME OF MIXING: 4 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
F32-1	11.56280	11.56575	11.56775	11.56875	11.57620	11.57680
F32-2	11.59340	11.59945	11.60140	11.60215	11.60735	11.60785
F32-3	11.59705	11.60280	11.60440	11.60540	11.60945	11.60995

POZZOLAN SAMPLE: F3
 PERCENTAGE OF POZZOLAN: 15%
 SAMPLE DESIGNATION: F32
 DATE OF MIXING: 05/14/92
 TIME OF MIXING: 4.30 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
F33-1	11.59040	11.59385	11.59780	11.59785	11.60275	11.60300
F33-2	11.55270	11.55370	11.55875	11.55920	11.56555	11.56590
F33-3	11.58185	11.58555	11.58940	11.58960	11.59400	11.59430
F33-4	11.63655	11.64005	11.64325	11.64465	11.64800	11.64830

POZZOLAN SAMPLE: F3
 PERCENTAGE OF POZZOLAN: 25%
 SAMPLE DESIGNATION: F33
 DATE OF MIXING: 05/14/92
 TIME OF MIXING: 5 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
PS1E1-1	11.54540	11.55165	11.55370	11.55830	11.55890	11.56270
PS1E1-2	11.52740	11.53150	11.53345	11.53800	11.53960	11.54085
PS1E1-3	11.53805	11.54330	11.54505	11.54980	11.55150	11.55300

POZZOLAN SAMPLE: PS1E
 PERCENTAGE OF POZZOLAN: 10%
 SAMPLE DESIGNATION: PS1E1
 DATE OF MIXING: 05/13/92
 TIME OF MIXING: 4 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
PS1E2-1	11.49035	11.49575	11.49595	11.49835	11.49845	11.49920
PS1E2-2	11.57685	11.58345	11.58370	11.58850	11.58865	11.58985
PS1E2-3	11.57875	11.58440	11.58480	11.58975	11.58985	11.59175
PS1E2-4	11.59325	11.59835	11.59865	11.60310	11.60325	11.60480

POZZOLAN SAMPLE: PS1E
 PERCENTAGE OF POZZOLAN: 15%
 SAMPLE DESIGNATION: PS1E2
 DATE OF MIXING: 04/13/92
 TIME OF MIXING: 4.30 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
PS1E3-1	11.58835	11.59550	11.59550	11.59905	11.59915	11.59995
PS1E3-2	11.58160	11.58880	11.58915	11.59230	11.59245	11.59305
PS1E3-3	11.57950	11.58705	11.58715	11.58955	11.58975	11.59000

POZZOLAN SAMPLE: PS1E
 PERCENTAGE OF POZZOLAN: 25%
 SAMPLE DESIGNATION: PS1E3
 DATE OF MIXING: 04/13/92
 TIME OF MIXING: 5 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
LK21-1	11.57930	11.58375	11.58515	11.58605	11.58635	11.58765
LK21-2	11.58010	11.58670	11.58780	11.58870	11.58950	11.59080
LK21-3	11.53500	11.54340	11.54460	11.54530	11.54580	11.54770
LK21-4	11.55660	11.56235	11.56335	11.56435	11.56495	11.56605

POZZOLAN SAMPLE: LK2
 PERCENTAGE OF POZZOLAN: 10%
 SAMPLE DESIGNATION: LK21
 DATE OF MIXING: 04/22/92
 TIME OF MIXING: 4 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
LK22-1	11.57890	11.58500	11.58600	11.58680	11.58740	11.58780
LK22-2	11.59385	11.59910	11.60060	11.60100	11.60140	11.60210
LK22-3	11.58625	11.58995	11.59125	11.59195	11.59265	11.59325
LK22-4	11.63045	11.63580	11.63700	11.63760	11.63810	11.63890

POZZOLAN SAMPLE: LK2
 PERCENTAGE OF POZZOLAN: 15%
 SAMPLE DESIGNATION: LK22
 DATE OF MIXING: 04/22/92
 TIME OF MIXING: 4.30 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
LK23-1	11.56825	11.57440	11.57510	11.57540	11.57560	11.57600
LK23-2	11.57860	11.58335	11.58395	11.58445	11.58455	11.58515
LK23-3	11.58100	11.58655	11.58735	11.58745	11.58795	11.58815
LK23-4	11.56785	11.57300	11.57360	11.57390	11.57420	11.57450

POZZOLAN SAMPLE: LK2
 PERCENTAGE OF POZZOLAN: 25%
 SAMPLE DESIGNATION: LK23
 DATE OF MIXING: 04/22/92
 TIME OF MIXING: 5 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
F10-1	11.64910	11.65570	11.66140	11.66340	11.66790	11.67210
F10-2	11.64680	11.65435	11.65800	11.66185	11.66215	11.66820
F10-3	11.62850	11.63435	11.64025	11.64125	11.64525	11.64875
F10-4	11.64260	11.65005	11.65370	11.65665	11.66985	11.67155

POZZOLAN SAMPLE: FLY ASH
 PERCENTAGE OF POZZOLAN: 10%
 SAMPLE DESIGNATION: F10
 DATE OF MIXING: 05/22/92
 TIME OF MIXING: 4 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
F15-1	11.58955	11.59850	11.60295	11.60295	11.60295	11.60965
F15-2	11.60275	11.61055	11.61510	11.61525	11.61550	11.62105
F15-3	11.63525	11.64310	11.64675	11.64750	11.64875	11.65390
F15-4	11.59475	11.60120	11.60640	11.60725	11.60785	11.61375

POZZOLAN SAMPLE: FLY ASH
 PERCENTAGE OF POZZOLAN: 15%
 SAMPLE DESIGNATION: F15
 DATE OF MIXING: 05/22/92
 TIME OF MIXING: 4.30 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
F25-1	11.58180	11.59120	11.59500	11.59605	11.59685	11.59860
F25-2	11.57745	11.58575	11.59245	11.59265	11.59280	11.59295
F25-3	11.58370	11.59260	11.59610	11.59735	11.59765	11.60000
F25-4	11.59030	11.60000	11.60345	11.60365	11.60400	11.60585

POZZOLAN SAMPLE: FLY ASH
 PERCENTAGE OF POZZOLAN: 25%
 SAMPLE DESIGNATION: F25
 DATE OF MIXING: 05/22/92
 TIME OF MIXING: 5 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
F20-1	11.63225	11.63905	11.64520	11.64730	11.64875	11.65080
F20-2	11.59530	11.60160	11.60625	11.61030	11.61085	11.61420
F20-3	11.58915	11.59540	11.60080	11.60310	11.60505	11.60830
F20-4	11.58940	11.59730	11.60090	11.60420	11.60540	11.60840

POZZOLAN SAMPLE: FLY ASH
 PERCENTAGE OF POZZOLAN: 20%
 SAMPLE DESIGNATION: F20
 DATE OF MIXING: 05/28/92
 TIME OF MIXING: 4 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
F30-1	11.57410	11.58460	11.58605	11.58790	11.58880	11.58995
F30-2	11.59695	11.60375	11.60880	11.61010	11.61110	11.61225
F30-3	11.53000	11.53480	11.54120	11.54170	11.54240	11.54345
F30-4	11.55350	11.56025	11.56340	11.56450	11.56520	11.56595

POZZOLAN SAMPLE: FLY ASH
 PERCENTAGE OF POZZOLAN: 30%
 SAMPLE DESIGNATION: F30
 DATE OF MIXING: 05/28/92
 TIME OF MIXING: 4 p.m.

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
F40-1	11.59260	11.60155	11.60550	11.60605	11.60615	11.60620
F40-2	11.63390	11.64080	11.64450	11.64470	11.64565	11.64595
F40-3	11.60325	11.61025	11.61560	11.61585	11.61640	11.61690
F40-4	11.63500	11.64190	11.64580	11.64595	11.64640	11.64655

POZZOLAN SAMPLE: FLY ASH
 PERCENTAGE OF POZZOLAN: 40%
 SAMPLE DESIGNATION: F40
 DATE OF MIXING: 05/28/92
 TIME OF MIXING: 4 p.m.

TABLE 11 CONTD.,

SPECIMEN #	LENGTH IN INCHES AT DAYS					
	INITIAL	0 DAY	3 DAY	7 DAY	11 DAY	14 DAY
RS-1	11.60185	11.60580	11.60955	11.61965	11.62700	11.62890
RS-2	11.56450	11.56800	11.57150	11.58050	11.58990	11.59105
RS-3	11.63180	11.63540	11.63760	11.64695	11.65525	11.65700
RS-4	11.59365	11.59765	11.59980	11.60800	11.61535	11.61865

POZZOLAN SAMPLE: NONE

PERCENTAGE OF POZZOLAN: NONE

SAMPLE DESIGNATION: REACTIVE SAND

DATE OF MIXING: 04/12/92

TIME OF MIXING: 4 p.m.

**TABLE 12 EXPANSIONS OF MORTAR BARS BY ASTM P214
TEST METHOD FOR POZZOLANS**

SPECIMEN #	PERCENTAGE EXPANSION			
	3 DAYS	7 DAYS	11 DAYS	14 DAYS
SM21-1	0.012	0.018	0.081	0.115
SM21-2	0.011	0.016	0.086	0.106
SM21-3	0.008	0.018	0.105	0.129
SM21-4	0.006*	0.014	0.122	0.130
MEAN	0.010	0.016	0.098	0.120
S.D.	0.002	0.001	0.018	0.011
% C.V.	20.1	9.9	19.2	9.4
SM22-1	0.011	0.018	0.027	0.036
SM22-2	0.011	0.020	0.028	0.039
SM22-3	0.013	0.018	0.023	0.041
SM22-4	0.012	0.017	0.035	0.049
MEAN	0.012	0.018	0.028	0.041
S.D.	0.001	0.001	0.004	0.005
% C.V.	9.0	6.8	16.8	13.0
SM23-1	0.022	0.034	0.043	0.043
SM23-2	0.023	0.027	0.046	0.046
SM23-3	0.016	0.024	0.030	0.041
SM23-4	0.022	0.046*	0.055*	0.055
MEAN	0.020	0.028	0.039	0.046
S.D.	0.003	0.005	0.008	0.006
% C.V.	15.9	18.1	21.4	13.3
CB11-1	0.013	0.071*	0.087	0.105
CB11-2	0.011	0.038	0.058	0.094
CB11-3	0.015	0.052*	0.092	0.124
CB11-4	0.014	0.031	0.071	0.115
MEAN	0.013	0.034	0.077	0.109
S.D.	0.001	0.004	0.015	0.013
% C.V.	13.4	14.3	20.2	11.8
CB12-1	0.020	0.053	0.063	0.119*
CB12-2	0.015	0.022	0.040	0.089
CB12-3	0.013	0.026	0.037	0.089
CB12-4	0.014	0.024	0.042	0.086
MEAN	0.014	0.024	0.039	0.088
S.D.	0.001	0.002	0.002	0.001
% C.V.	7.1	8.3	6.3	1.9

* - Omitted for the calculation of Mean, S.D. and %C.V.

TABLE 12 CONTD.,

SPECIMEN #	PERCENTAGE EXPANSION			
	3 DAYS	7 DAYS	11 DAYS	14 DAYS
CB13-1	0.006	0.014	0.028	0.051
CB13-2	0.007	0.012	0.024	0.052
CB13-3	0.006	0.014	0.037	0.060
CB13-4	0.008	0.016	0.034	0.062
MEAN	0.006	0.014	0.030	0.056
S.D.	0.001	0.001	0.006	0.005
% C.V.	14.1	11.6	19.5	9.9
CT11-1	0.042	0.065	0.082	0.119
CT11-2	0.038	0.060	0.105	0.115
CT11-3	0.040	0.062	0.111	0.146
CT11-4	0.030	0.036	0.090	0.105
MEAN	0.040	0.062	0.097	0.121
S.D.	0.002	0.002	0.013	0.017
% C.V.	5.0	4.0	13.6	14.4
CT12-1	0.021	0.030	0.050	0.051
CT12-2	0.024	0.027	0.053	0.073
CT12-3	0.020	0.020	0.052	0.065
CT12-4	0.022	0.040*	0.055	0.101*
MEAN	0.021	0.025	0.052	0.063
S.D.	0.001	0.005	0.002	0.011
% C.V.	7.8	19.9	3.9	17.6
CT13-1	0.060	0.075	0.084	0.090
CT13-2	0.058	0.078	0.083	0.093
CT13-3	0.061	0.070	0.080	0.095
CT13-4	0.061	0.072	0.086	0.090
MEAN	0.060	0.073	0.083	0.092
S.D.	0.001	0.003	0.002	0.002
% C.V.	2.3	4.7	3.0	2.6
US11-1	0.027	0.067	0.121	0.142
US11-2	0.027	0.056	0.122	0.123
US11-3	0.022	0.055	0.126	0.127
MEAN	0.025	0.059	0.123	0.131
S.D.	0.002	0.006	0.002	0.010
% C.V.	11.3	11.3	2.3	7.7
US12-1	0.027	0.031	0.088	0.102
US12-2	0.023	0.035	0.080	0.091
US12-3	0.024	0.019*	0.069	0.089
MEAN	0.024	0.033	0.079	0.094
S.D.	0.002	0.002	0.009	0.006
% C.V.	8.4	8.5	11.7	7.3

TABLE 12 CONTD.,

SPECIMEN #	PERCENTAGE EXPANSION			
	3 DAYS	7 DAYS	11 DAYS	14 DAYS
US13-1	0.008	0.015	0.017	0.023
US13-2	0.012	0.018	0.019	0.022
US13-3	0.013	0.013	0.016	0.020
US13-4	0.010	0.014	0.017	0.020
MEAN	0.010	0.015	0.017	0.021
S.D.	0.002	0.002	0.001	0.001
% C.V.	20.6	14.4	7.3	7.0
MW11-1	0.069	0.078	0.095	0.142
MW11-2	0.054	0.056	0.065	0.134
MW11-3	0.059	0.059	0.073	0.144
MW11-4	0.049	0.050	0.068	0.150
MEAN	0.057	0.061	0.075	0.142
S.D.	0.008	0.011	0.013	0.006
% C.V.	14.4	19.5	17.6	4.7
MW12-1	0.060	0.066	0.070	0.114
MW12-2	0.054	0.061	0.069	0.103
MW12-3	0.058	0.068	0.076	0.098
MW12-4	0.063	0.070	0.075	0.096
MEAN	0.058	0.066	0.072	0.102
S.D.	0.003	0.003	0.003	0.008
% C.V.	6.4	5.8	4.8	7.8
MW13-1	0.035	0.038	0.044	0.081
MW13-2	0.030	0.036	0.040	0.055
MW13-3	0.031	0.040	0.045	0.048
MW13-4	0.032	0.039	0.044	0.074
MEAN	0.032	0.038	0.043	0.064
S.D.	0.002	0.001	0.002	0.015
% C.V.	6.7	4.4	5.1	24.2
PRC11-1	0.036	0.131	0.167	0.258
PRC11-2	0.050*	0.103	0.171	0.211
PRC11-3	0.026	0.109	0.181	0.244
MEAN	0.031	0.114	0.173	0.238
S.D.	0.007	0.014	0.007	0.024
% C.V.	22.8	12.7	4.1	10.1
PRC12-1	0.017	0.043	0.091	0.168
PRC12-2	0.015	0.024*	0.094	0.161
PRC12-3	0.014	0.042	0.076	0.148
MEAN	0.015	0.042	0.087	0.159
S.D.	0.001	0.007	0.009	0.010
C.V.	9.9	1.6	11.0	6.3

TABLE 12 CONTD.,

SPECIMEN #	PERCENTAGE EXPANSION			
	3 DAYS	7 DAYS	11 DAYS	14 DAYS
PRC13-1	0.018	0.028	0.055	0.094
PRC13-2	0.014	0.055*	0.056	0.115
PRC13-3	0.016	0.027	0.045	0.077
PRC13-4	0.018	0.035	0.052	0.104
MEAN	0.016	0.030	0.052	0.097
S.D.	0.001	0.004	0.004	0.016
% C.V.	11.3	14.5	9.5	16.6
VA21-1	0.014*	0.113	0.209	0.242
VA21-2	0.027	0.165	0.235	0.275
VA21-3	0.030	0.164	0.240	0.262
MEAN	0.028	0.147	0.228	0.260
S.D.	0.002	0.029	0.016	0.016
% C.V.	7.4	20.0	7.2	6.3
VA22-1	0.032	0.177	0.280	0.332
VA22-2	0.032	0.172	0.263	0.304
VA22-3	0.014*	0.160	0.254	0.311
MEAN	0.032	0.170	0.266	0.316
S.D.	0.000	0.009	0.013	0.014
% C.V.	0.000	5.3	4.9	4.6
VA23-1	0.025	0.177	0.300	0.309
VA23-2	0.019	0.133	0.240	0.280
VA23-3	0.012*	0.127	0.233	0.280
VA23-3	0.029	0.163	0.273	0.317
MEAN	0.024	0.150	0.261	0.296
S.D.	0.005	0.024	0.030	0.019
% C.V.	20.6	15.9	11.8	6.5
F31-1	0.057	0.100	0.149	0.152
F31-2	0.081	0.104	0.191	0.203
F31-3	0.075	0.107	0.152	0.164
F31-4	0.204*	0.235*	0.281*	0.298*
MEAN	0.071	0.103	0.164	0.173
S.D.	0.012	0.003	0.023	0.026
% C.V.	17.5	3.3	14.2	15.4
F32-1	0.020	0.030	0.104*	0.110*
F32-2	0.019	0.027	0.079	0.084
F32-3	0.016	0.026	0.066	0.071
MEAN	0.018	0.026	0.072	0.077
S.D.	0.002	0.002	0.009	0.009
% C.V.	11.7	7.5	12.6	11.8

TABLE 12 CONTD.,

SPECIMEN #	PERCENTAGE EXPANSION			
	3 DAYS	7 DAYS	11 DAYS	14 DAYS
F33-1	0.039	0.040	0.089	0.091
F33-2	0.050	0.055	0.118	0.122
F33-3	0.038	0.040	0.084	0.087
F33-4	0.032	0.046	0.079	0.082
MEAN	0.040	0.045	0.092	0.095
S.D.	0.007	0.006	0.017	0.017
% C.V.	19.1	15.3	18.8	18.5
PS1E1-1	0.020	0.066	0.072	0.110
PS1E1-2	0.019	0.065	0.081	0.093
PS1E1-3	0.017	0.065	0.082	0.097
MEAN	0.019	0.065	0.078	0.100
S.D.	0.001	0.000	0.005	0.008
% C.V.	7.9	1.3	6.6	8.9
PS1E2-1	0.002	0.026 [*]	0.027 [*]	0.034 [*]
PS1E2-2	0.002	0.050	0.052	0.064
PS1E2-3	0.004	0.053	0.054	0.073
PS1E2-4	0.003	0.047	0.049	0.064
MEAN	0.002	0.050	0.051	0.067
S.D.	0.000	0.003	0.002	0.005
% C.V.	29.7	6.0	4.8	7.7
PS1E3-1	0.000	0.035	0.036	0.044
PS1E3-2	0.003	0.035	0.036	0.042
PS1E3-3	0.001	0.025	0.027	0.029
MEAN	0.001	0.031	0.033	0.038
S.D.	0.001	0.005	0.005	0.008
% C.V.	12.0	18.6	16.4	20.9
LK21-1	0.014	0.023	0.026	0.039
LK21-2	0.011	0.020	0.028	0.041
LK21-3	0.012	0.019	0.024	0.043
LK21-4	0.010	0.020	0.026	0.037
MEAN	0.011	0.020	0.026	0.040
S.D.	0.001	0.001	0.001	0.002
% C.V.	14.5	8.4	6.2	6.4
LK22-1	0.010	0.018	0.024	0.028
LK22-2	0.015	0.019	0.023	0.030
LK22-3	0.013	0.020	0.027	0.033
LK22-4	0.012	0.018	0.023	0.031
MEAN	0.012	0.018	0.024	0.030
S.D.	0.002	0.001	0.001	0.002
% C.V.	16.6	5.1	7.8	6.8

TABLE 12 CONTD.,

SPECIMEN #	PERCENTAGE EXPANSION			
	3 DAYS	7 DAYS	11 DAYS	14 DAYS
LK23-1	0.007	0.010	0.012	0.016
LK23-2	0.006	0.011	0.012	0.018
LK23-3	0.008	0.009	0.014	0.016
LK23-4	0.006	0.009	0.012	0.015
MEAN	0.006	0.009	0.012	0.016
S.D.	0.001	0.001	0.001	0.001
% C.V.	14.1	9.8	8.0	7.7
F10-1	0.057	0.077	0.122	0.164
F10-2	0.036	0.075	0.078	0.138
F10-3	0.059	0.069	0.109	0.144
F10-4	0.036	0.066	0.198*	0.215*
MEAN	0.047	0.071	0.103	0.148
S.D.	0.012	0.005	0.022	0.013
% C.V.	26.3	7.1	21.9	9.1
F15-1	0.044	0.044	0.044	0.111
F15-2	0.045	0.047	0.049	0.105
F15-3	0.036	0.044	0.056	0.108
F15-4	0.052	0.060	0.066	0.125
MEAN	0.044	0.049	0.054	0.112
S.D.	0.006	0.007	0.009	0.009
% C.V.	14.2	15.8	17.5	8.0
F25-1	0.038	0.048	0.056	0.074
F25-2	0.067*	0.069*	0.070*	0.072
F25-3	0.035	0.047	0.050	0.074
F25-4	0.034	0.036	0.040	0.058
MEAN	0.035	0.043	0.048	0.069
S.D.	0.002	0.006	0.008	0.007
% C.V.	5.8	15.2	16.6	10.7

TABLE 12 CONTD.,

SPECIMEN #	PERCENTAGE EXPANSION			
	3 DAYS	7 DAYS	11 DAYS	14 DAYS
F20-1	0.061	0.082	0.097	0.117
F20-2	0.046	0.087	0.092	0.126
F20-3	0.054	0.077	0.096	0.129
F20-4	0.036*	0.069	0.081	0.111
MEAN	0.053	0.078	0.091	0.120
S.D.	0.007	0.007	0.007	0.008
% C.V.	13.9	9.8	8.1	6.7
F30-1	0.014*	0.033*	0.042*	0.053*
F30-2	0.050	0.063	0.073	0.085
F30-3	0.064	0.069	0.076	0.086
F30-4	0.040	0.052	0.060	0.070
MEAN	0.051	0.061	0.069	0.080
S.D.	0.012	0.008	0.008	0.008
% C.V.	23.4	14.0	12.2	11.1
F40-1	0.039	0.045	0.046	0.046
F40-2	0.037	0.039	0.048	0.051
F40-3	0.053	0.056	0.061	0.066
F40-4	0.039	0.040	0.045	0.046
MEAN	0.042	0.045	0.050	0.052
S.D.	0.007	0.007	0.007	0.009
% C.V.	17.9	17.0	15.2	17.9
RS-1	0.037	0.138	0.210	0.231
RS-2	0.035	0.125	0.219	0.230
RS-3	0.022	0.110	0.179	0.216
RS-4	0.021	0.103	0.177	0.210
MEAN	0.028	0.119	0.199	0.221
S.D.	0.008	0.015	0.019	0.010
% C.V.	29.2	13.1	9.5	4.6

**TABLE 13 LENGTH MEASUREMENTS OF MORTAR BARS BY ASTM C227 METHOD
FOR POZZOLAN SAMPLES**

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
CB11-1	11.59140	11.59285	11.59345	11.59385	11.59395	11.59410	11.59420	11.59460
CB11-2	11.59165	11.59245	11.59330	11.59360	11.59375	11.59385	11.59415	11.59465
CB11-3	11.59255	11.59320	11.59410	11.59500	11.59525	11.59545	11.59585	11.59605
CB11-4	11.58790	11.58890	11.58960	11.58995	11.59015	11.59040	11.59060	11.59100

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
CB11-1	11.59140	11.59480	11.59520	11.59550	11.59575	11.59605	11.59630	11.59650
CB11-2	11.59165	11.59485	11.59515	11.59550	11.59570	11.59590	11.59620	11.59630
CB11-3	11.59255	11.59615	11.59635	11.59665	11.59690	11.59725	11.59750	11.59750
CB11-4	11.58790	11.59120	11.59155	11.59180	11.59210	11.59230	11.59250	11.59255

POZZOLAN SAMPLE NAME: CB1
MIX DESIGNATION : CB11
DATE OF MIXING : 5/18/92
TIME OF MIXING : 4 p.m
PERCENTAGE OF POZZOLAN : 10%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
CB11-1	11.59140	11.59660	11.59665	11.59665	11.59665	11.59665		
CB11-2	11.59165	11.59645	11.59645	11.59650	11.59655	11.59655		
CB11-3	11.59255	11.59760	11.59765	11.59770	11.59770	11.59770		
CB11-4	11.58790	11.59255	11.59255	11.59255	11.59255	11.59260		

POZZOLAN SAMPLE NAME: CB1
 MIX DESIGNATION : CB11
 DATE OF MIXING : 5/18/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 10%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
CB12-1	11.64790	11.64835	11.64895	11.64925	11.64935	11.64950	11.64960	11.64990
CB12-2	11.65200	11.65320	11.65400	11.65425	11.65435	11.65440	11.65440	11.65470
CB12-3	11.65020	11.65180	11.65240	11.65265	11.65285	11.65310	11.65330	11.65350
CB12-4	11.64860	11.64970	11.65040	11.65050	11.65080	11.65090	11.65110	11.65140

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
CB12-1	11.64790	11.65030	11.65080	11.65105	11.65130	11.65145	11.65160	11.65175
CB12-2	11.65200	11.65490	11.65535	11.65555	11.65575	11.65595	11.65600	11.65625
CB12-3	11.65020	11.65370	11.65410	11.65435	11.65450	11.65475	11.65495	11.65515
CB12-4	11.64860	11.65160	11.65195	11.65210	11.65230	11.65245	11.65270	11.65285

POZZOLAN SAMPLE NAME: CB1
 MIX DESIGNATION : CB12
 DATE OF MIXING : 5/18/92
 TIME OF MIXING : 4.30p.m
 PERCENTAGE OF POZZOLAN : 15%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
CB12-1	11.64790	11.65175	11.65180	11.65180	11.65185	11.65185		
CB12-2	11.65200	11.65630	11.65635	11.65635	11.65635	11.65640		
CB12-3	11.65020	11.65515	11.65515	11.65520	11.65525	11.65525		
CB12-4	11.64860	11.65285	11.65290	11.65290	11.65295	11.65300		

POZZOLAN SAMPLE NAME: CB1
MIX DESIGNATION : CB12
DATE OF MIXING : 5/18/92
TIME OF MIXING : 4.30 pm
PERCENTAGE OF POZZOLAN : 15%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
CB13-1	11.58555	11.58685	11.58725	11.58750	11.58760	11.58755	11.58795	11.58805
CB13-2	11.57715	11.57860	11.57915	11.57925	11.57925	11.57935	11.57945	11.59975
CB13-3	11.51300	11.51450	11.51505	11.51520	11.51530	11.51550	11.51560	11.51580
CB13-4	11.68240	11.68305	11.68385	11.68400	11.68405	11.68420	11.68450	11.68480

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
CB13-1	11.58555	11.58815	11.58835	11.58855	11.58860	11.58870	11.58885	11.58915
CB13-2	11.57715	11.57985	11.58000	11.58015	11.58025	11.58030	11.58040	11.58060
CB13-3	11.51300	11.51590	11.51610	11.51630	11.51645	11.51655	11.51660	11.51670
CB13-4	11.68240	11.68500	11.68525	11.68540	11.68555	11.68565	11.68575	11.68585

POZZOLAN SAMPLE NAME: CB1
 MIX DESIGNATION : CB13
 DATE OF MIXING : 5/18/92
 TIME OF MIXING : 5 p.m
 PERCENTAGE OF POZZOLAN : 25%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
CB13-1	11.58555	11.58920	11.58925	11.58925	11.58925	11.58925		
CB13-2	11.57715	11.58060	11.58060	11.58065	11.58065	11.58065		
CB13-3	11.51300	11.51675	11.51680	11.51680	11.51680	11.51680		
CB13-4	11.68240	11.68590	11.68595	11.68605	11.68605	11.68605		

POZZOLAN SAMPLE NAME: CB1
 MIX DESIGNATION : CB13
 DATE OF MIXING : 5/18/92
 TIME OF MIXING : 5 p.m
 PERCENTAGE OF POZZOLAN : 25%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
SM21-1	11.55795	11.55885	11.56000	11.56085	11.56110	11.56135	11.56175	11.56215
SM21-2	11.57730	11.57830	11.57955	11.58070	11.58130	11.58180	11.58200	11.58230
SM21-3	11.57815	11.57930	11.58030	11.58130	11.58185	11.58215	11.58245	11.58275
SM21-4	11.54870	11.54975	11.55125	11.55155	11.55205	11.55240	11.55270	11.55320

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
SM21-1	11.55795	11.56245	11.56295	11.56325	11.56340	11.56360	11.56380	11.56415
SM21-2	11.57730	11.58240	11.58295	11.58325	11.58350	11.58370	11.58385	11.58420
SM21-3	11.57815	11.58305	11.58350	11.58385	11.58405	11.58430	11.58450	11.58480
SM21-4	11.54870	11.55350	11.55395	11.55430	11.55450	11.55465	11.55480	11.55510

POZZOLAN SAMPLE NAME: SM2
 MIX DESIGNATION : SM21
 DATE OF MIXING : 5/20/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 10%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
SM21-1	11.55795	11.56420	11.56430	11.56435	11.56440	11.56445		
SM21-2	11.57730	11.58425	11.58430	11.58430	11.58435	11.58435		
SM21-3	11.57875	11.58480	11.58485	11.58490	11.58490	11.58490		
SM21-4	11.54870	11.55520	11.55520	11.55520	11.55520	11.55520		

POZZOLAN SAMPLE NAME: SM2
MIX DESIGNATION : SM21
DATE OF MIXING : 5/20/92
TIME OF MIXING : 4 p.m
PERCENTAGE OF POZZOLAN : 10%

TABLE 13 CONTD. ,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
SM22-2	11.65390	11.65475	11.65580	11.65700	11.65730	11.65750	11.65780	11.65810
SM22-3	11.65530	11.65615	11.65710	11.65805	11.65825	11.65875	11.65910	11.65940

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
SM22-2	11.65390	11.65840	11.65885	11.65905	11.65925	11.65950	11.65970	11.65980
SM22-3	11.65530	11.65960	11.66000	11.66025	11.66050	11.66070	11.66095	11.66095

POZZOLAN SAMPLE NAME: SM2
 MIX DESIGNATION : SM22
 DATE OF MIXING : 5/20/92
 TIME OF MIXING : 4.30 p.m
 PERCENTAGE OF POZZOLAN : 15%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
SM22-1								
SM22-2	11.65390	11.65990	11.65990	11.65995	11.65995	11.65995		
SM22-3	11.65530	11.66095	11.66095	11.66100	11.66105	11.66110		
SM22-4								

POZZOLAN SAMPLE NAME: SM2
MIX DESIGNATION : SM22
DATE OF MIXING : 5/20/92
TIME OF MIXING : 4,30 p m
PERCENTAGE OF POZZOLAN : 15%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
SM23-1	11.55500	11.55605	11.55680	11.55750	11.55765	11.55765	11.55790	11.55810
SM23-2	11.57385	11.57500	11.57570	11.57620	11.57620	11.57660	11.57665	11.57695
SM23-3	11.56585	11.56695	11.56780	11.56935	11.56935	11.56945	11.56955	11.56965
SM23-4	11.53325	11.53425	11.53515	11.53575	11.53585	11.53595	11.53625	11.53655

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
SM23-1	11.55500	11.55830	11.55860	11.55875	11.55885	11.55895	11.55900	11.55920
SM23-2	11.57385	11.57705	11.57740	11.57750	11.57760	11.57775	11.57780	11.57785
SM23-3	11.56585	11.56985	11.57015	11.57035	11.57045	11.57050	11.57060	11.57085
SM23-4	11.53325	11.53675	11.53705	11.53720	11.53735	11.53740	11.53750	11.53775

POZZOLAN SAMPLE NAME: SM222
MIX DESIGNATION : SM23
DATE OF MIXING : 5/20/92
TIME OF MIXING : 5 p.m
PERCENTAGE OF POZZOLAN : 25%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
SM23-1	11.55500	11.55920	11.59925	11.59925	11.59930	11.59930		
SM23-2	11.57385	11.57785	11.57785	11.57785	11.57785	11.57790		
SM23-3	11.56585	11.57090	11.57090	11.57095	11.57095	11.57095		
SM23-4	11.53325	11.53775	11.53775	11.53780	11.53785	11.53790		

POZZOLAN SAMPLE NAME: SM2
 MIX DESIGNATION : SM23
 DATE OF MIXING : 5/20/92
 TIME OF MIXING : 4.50 p.m
 PERCENTAGE OF POZZOLAN : 25%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
CT11-1	11.53390	11.53420	11.53470	11.53540	11.53570	11.53600	11.53640	11.53670
CT11-2	11.53890	11.53910	11.53950	11.54030	11.54060	11.54090	11.54120	11.54150
CT11-3	11.49380	11.49400	11.49470	11.49500	11.49540	11.49600	11.49580	11.49620
CT11-4	11.51985	11.52005	11.52055	11.52125	11.52165	11.52205	11.52205	11.52235

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
CT11-1	11.53390	11.53690	11.53715	11.53755	11.53770	11.53795	11.53805	11.53815
CT11-2	11.53890	11.54170	11.54195	11.54220	11.54240	11.54260	11.54275	11.54295
CT11-3	11.49380	11.49650	11.49680	11.49715	11.49730	11.49755	11.49780	11.49805
CT11-4	11.51985	11.52265	11.52300	11.52340	11.52360	11.52380	11.52400	11.52415

POZZOLAN SAMPLE NAME: CT1
 MIX DESIGNATION : CT11
 DATE OF MIXING : 5/23/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 10%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
CT11-1	11.53390	11.53815	11.53820	11.53825	11.53825	11.53825		
CT11-2	11.53890	11.54295	11.54300	11.54305	11.54305	11.54305		
CT11-3	11.49380	11.49810	11.49815	11.49815	11.49820	11.49820		
CT11-4	11.51985	11.52420	11.52425	11.52425	11.52425	11.52425		

POZZOLAN SAMPLE NAME: CT1
 MIX DESIGNATION : CT11
 DATE OF MIXING : 5/23/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 10%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
CT12-1	11.57585	11.57600	11.57625	11.57755	11.57765	11.57785	11.57815	11.57835
CT12-2	11.57795	11.57810	11.57835	11.57865	11.57895	11.57935	11.57955	11.57995
CT12-3	11.50935	11.50950	11.50975	11.51070	11.51100	11.51115	11.51155	11.51175

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
CT12-1	11.57585	11.57855	11.57880	11.57910	11.57930	11.57945	11.57960	11.57970
CT12-2	11.57795	11.58035	11.58060	11.58085	11.58095	11.58120	11.58140	11.58140
CT12-3	11.50935	11.51185	11.51205	11.51230	11.51250	11.51275	11.51295	11.51310

POZZOLAN SAMPLE NAME: CT1
 MIX DESIGNATION : CT12
 DATE OF MIXING : 5/23/92
 TIME OF MIXING : 4.30 p.m
 PERCENTAGE OF POZZOLAN : 15%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
CT12-1	11.57585	11.57975	11.57980	11.57985	11.57985	11.57985		
CT12-2	11.57795	11.58145	11.58145	11.58150	11.58150	11.58150		
CT12-3	11.50935	11.51315	11.51320	11.51325	11.51325	11.51325		
CT12-4								

POZZOLAN SAMPLE NAME: CT1
MIX DESIGNATION : CT12
DATE OF MIXING : 5/23/92
TIME OF MIXING : 4.40 p.m
PERCENTAGE OF POZZOLAN : 15%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
CT13-1	11.63645	11.63665	11.63685	11.63735	11.63745	11.63785	11.63805	11.63835
CT13-2	11.65220	11.65230	11.65250	11.65300	11.65350	11.65380	11.65400	11.65420
CT13-3	11.64420	11.64440	11.64460	11.64510	11.65530	11.64580	11.64600	11.64620

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
CT13-1	11.63645	11.63865	11.63885	11.63900	11.63910	11.63925	11.63930	11.63955
CT13-2	11.65220	11.65440	11.65470	11.65490	11.65945	11.65505	11.65515	11.65545
CT13-3	11.64420	11.64640	11.64660	11.64690	11.64700	11.64720	11.64730	11.64750

POZZOLAN SAMPLE NAME: CT1
 MIX DESIGNATION : CT13
 DATE OF MIXING : 5/23/92
 TIME OF MIXING : 5 p.m
 PERCENTAGE OF POZZOLAN : 25%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
CT13-1	11.63645	11.63960	11.63965	11.63965	11.63965	11.63970		
CT13-2	11.65220	11.65545	11.65545	11.65550	11.65550	11.65550		
CT13-3	11.64420	11.64755	11.64760	11.64760	11.64765	11.64765		
CT13-4								

POZZOLAN SAMPLE NAME: CT1
 MIX DESIGNATION : CT13
 DATE OF MIXING : 5/23/92
 TIME OF MIXING : 5 p.m
 PERCENTAGE OF POZZOLAN : 25%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
US11-1	11.50500	11.50550	11.50570	11.50580	11.50585	11.50610	11.50650	11.50680
US11-2	11.55610	11.55640	11.55680	11.55750	11.55795	11.55820	11.55850	11.55900
US11-3	11.56895	11.56930	11.56965	11.57005	11.57035	11.57075	11.57085	11.57135
US11-4	11.57245	11.57275	11.57300	11.57370	11.57395	11.57415	11.57435	11.57495

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
US11-1	11.50500	11.50700	11.50750	11.50780	11.50800	11.50380	11.50850	11.50875
US11-2	11.55610	11.55900	11.55940	11.55970	11.55990	11.56015	11.56025	11.56045
US11-3	11.56895	11.57105	11.57200	11.57220	11.57240	11.57260	11.57275	11.57285
US11-4	11.57245	11.57515	11.57545	11.57575	11.57595	11.57605	11.57625	11.57655

POZZOLAN SAMPLE NAME: US1
 MIX DESIGNATION : US11
 DATE OF MIXING : 5/26/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 10%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
US11-1	11.50500	11.50885	11.50890	11.50895	11.50895	11.50895		
US11-2	11.55610	11.56050	11.56055	11.56065	11.56065	11.56065		
US11-3	11.56985	11.57290	11.57290	11.57300	11.57300	11.57300		
US11-4	11.57245	11.57660	11.57670	11.57675	11.57675	11.57675		

POZZOLAN SAMPLE NAME: US1
MIX DESIGNATION : US11
DATE OF MIXING : 5/26/92
TIME OF MIXING : 4.30 p.m
PERCENTAGE OF POZZOLAN : 10%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
US12-1	11.64835	11.64865	11.64885	11.64955	11.64975	11.64985	11.65015	11.65045
US12-2	11.65170	11.65200	11.65230	11.65290	11.65300	11.65320	11.65360	11.65390
US12-3	11.64595	11.64635	11.64655	11.64705	11.64735	11.64755	11.64795	11.64815
US12-4	11.64535	11.64565	11.64605	11.64635	11.64655	11.64675	11.64725	11.64765

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
US12-1	11.64835	11.65075	11.65110	11.65130	11.65150	11.65170	11.65190	11.65205
US12-2	11.65170	11.65420	11.65460	11.65475	11.65485	11.65500	11.65515	11.65525
US12-3	11.64595	11.64835	11.64870	11.64890	11.64905	11.64920	11.64930	11.64940
US12-4	11.64535	11.64785	11.64825	11.64850	11.64870	11.64885	11.64890	11.64900

POZZOLAN SAMPLE NAME: US1
 MIX DESIGNATION : US12
 DATE OF MIXING : 5/26/92
 TIME OF MIXING : 4.30 p.m
 PERCENTAGE OF POZZOLAN : 15%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
US12-1	11.64835	11.65210	11.65215	11.65220	11.65220	11.65220		
US12-2	11.65170	11.65530	11.65540	11.65540	11.65545	11.65550		
US12-3	11.64595	11.64940	11.64945	11.64955	11.64960	11.64960		
US12-4	11.64535	11.64910	11.64910	11.64915	11.64915	11.64915		

POZZOLAN SAMPLE NAME: US1
MIX DESIGNATION : US12
DATE OF MIXING : 5/26/92
TIME OF MIXING : 4.30 pm
PERCENTAGE OF POZZOLAN : 15%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
US13-1	11.57015	11.57045	11.57075	11.57115	11.57125	11.57135	11.57135	11.57155
US13-2	11.61990	11.62000	11.62010	11.62010	11.62030	11.62070	11.62110	11.62130
US13-4	11.55265	11.55280	11.55290	11.55380	11.55385	11.55395	11.55415	11.55425

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
US13-1	11.57015	11.57185	11.57205	11.57215	11.57230	11.57240	11.57245	11.57255
US13-2	11.61990	11.62150	11.62185	11.62195	11.62205	11.62220	11.62230	11.62235
US13-4	11.55265	11.55445	11.55480	11.55495	11.55500	11.55510	11.55520	11.55530

POZZOLAN SAMPLE NAME: US1
 MIX DESIGNATION : US13
 DATE OF MIXING : 5/26/92
 TIME OF MIXING : 5 p.m
 PERCENTAGE OF POZZOLAN : 25%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
US13-1	11.57015	11.57255	11.57260	11.57265	11.57265	11.57265		
US13-2	11.61990	11.62240	11.62245	11.62250	11.62250	11.62250		
US13-3								
US13-4	11.55265	11.55535	11.55540	11.55540	11.55540	11.55540		

POZZOLAN SAMPLE NAME: US1
MIX DESIGNATION : US13
DATE OF MIXING : 5/26/92
TIME OF MIXING : 4.50 pm
PERCENTAGE OF POZZOLAN : 25%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
PRC11-1	11.50550	11.50605	11.50880	11.51000	11.51030	11.51050	11.51060	11.51090
PRC11-2	11.49065	11.49175	11.49295	11.49455	11.49495	11.49505	11.49545	11.49595
PRC11-3	11.51195	11.51275	11.51435	11.51475	11.51485	11.51525	11.51585	11.51635

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
PRC11-1	11.50550	11.51130	11.51165	11.51190	11.51210	11.51240	11.51255	11.51290
PRC11-2	11.49065	11.49635	11.49675	11.49700	11.49730	11.49750	11.49770	11.49805
PRC11-3	11.51195	11.51675	11.51710	11.51730	11.51750	11.51785	11.51800	11.51835

POZZOLAN SAMPLE NAME: PRC1
 MIX DESIGNATION : PRC11
 DATE OF MIXING : 5/27/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 10%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
PRC11-1	11.50550	11.51300	11.51300	11.51305	11.51305	11.51305		
PRC11-2	11.49065	11.49820	11.49825	11.49825	11.49825	11.49830		
PRC11-3	11.51195	11.51840	11.51845	11.51850	11.51850	11.51850		
PRC11-4								

POZZOLAN SAMPLE NAME: PRC1
MIX DESIGNATION : PRC11
DATE OF MIXING : 5/27/92
TIME OF MIXING : 4 p.m
PERCENTAGE OF POZZOLAN : 10%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
PRC12-1	11.65480	11.65520	11.65695	11.65755	11.65810	11.65840	11.65875	11.65905
PRC12-2	11.65485	11.65530	11.65715	11.65785	11.65815	11.65845	11.65890	11.65930
PRC12-3	11.63180	11.63220	11.63425	11.63480	11.63505	11.63515	11.63545	11.63595
PRC12-4	11.59370	11.59405	11.59585	11.59650	11.59690	11.59720	11.59745	11.59795

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
PRC12-1	11.65480	11.65935	11.65950	11.65965	11.65980	11.65995	11.66010	11.66015
PRC12-2	11.65485	11.65980	11.66000	11.66020	11.66040	11.66055	11.66070	11.66080
PRC12-3	11.63180	11.63625	11.63650	11.63665	11.63685	11.63695	11.63710	11.63715
PRC12-4	11.59370	11.59815	11.59840	11.59845	11.59860	11.59880	11.59895	11.59900

POZZOLAN SAMPLE NAME: PRC1
 MIX DESIGNATION : PRC12
 DATE OF MIXING : 5/27/92
 TIME OF MIXING : 4.30 p.m
 PERCENTAGE OF POZZOLAN : 15%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
PRC12-1	11.65480	11.66020	11.66020	11.66025	11.66025	11.66030		
PRC12-2	11.65485	11.66085	11.66090	11.66095	11.66095	11.66100		
PRC12-3	11.63180	11.63720	11.63720	11.63720	11.63725	11.63725		
PRC12-4	11.59370	11.59900	11.59900	11.59905	11.59905	11.59905		

POZZOLAN SAMPLE NAME: PRC1
 MIX DESIGNATION : PRC12
 DATE OF MIXING : 5/27/92
 TIME OF MIXING : 4.30 pm
 PERCENTAGE OF POZZOLAN : 15%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
PRC13-1	11.54505	11.54560	11.54615	11.54710	11.54730	11.54755	11.54785	11.54805
PRC13-2	11.57270	11.57320	11.57360	11.57425	11.57435	11.57440	11.57470	11.57500
PRC13-3	11.57635	11.57690	11.57745	11.57840	11.57855	11.57885	11.57865	11.57885
PRC13-4	11.57970	11.58020	11.58035	11.58130	11.58145	11.58170	11.58180	11.58210

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
PRC13-1	11.54505	11.54835	11.54850	11.54860	11.54875	11.54890	11.54905	11.54920
PRC13-2	11.57270	11.57530	11.57555	11.57570	11.57590	11.57600	11.57605	11.57615
PRC13-3	11.57635	11.57915	11.57935	11.57950	11.57965	11.57975	11.57995	11.58005
PRC13-4	11.57970	11.58240	11.58260	11.58270	11.58285	11.58295	11.58310	11.58330

POZZOLAN SAMPLE NAME: PRC1
 MIX DESIGNATION : PRC13
 DATE OF MIXING : 5/27/92
 TIME OF MIXING : 5 p.m
 PERCENTAGE OF POZZOLAN : 25%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
PRC13-1	11.54505	11.54920	11.54925	11.54930	11.54930	11.54930		
PRC13-2	11.57270	11.57620	11.57620	11.57620	11.57620	11.57620		
PRC13-3	11.57635	11.58015	11.58015	11.58020	11.58020	11.58020		
PRC13-4	11.57970	11.58330	11.58330	11.58335	11.58335	11.58335		

POZZOLAN SAMPLE NAME: PRC1
 MIX DESIGNATION : PRC13
 DATE OF MIXING : 5/27/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 25%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
LK21-1	11.49030	11.49080	11.49200	11.49235	11.49245	11.49270	11.49280	11.49310
LK21-2	11.55180	11.55230	11.55400	11.55460	11.55500	11.55510	11.55540	11.55560
LK21-3	11.49795	11.49835	11.49945	11.50010	11.50035	11.50035	11.50055	11.50095
LK21-4	11.50860	11.50915	11.50975	11.51045	11.51090	11.51120	11.51130	11.51160

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
LK21-1	11.49030	11.49340	11.49375	11.49395	11.49410	11.49430	11.49455	11.49465
LK21-2	11.55180	11.55570	11.55600	11.55625	11.55650	11.55670	11.55690	11.55700
LK21-3	11.49795	11.50135	11.50160	11.50175	11.50195	11.50205	11.50225	11.50235
LK21-4	11.50860	11.51190	11.51230	11.51255	11.51275	11.51290	11.51305	11.51310

POZZOLAN SAMPLE NAME: LK2
 MIX DESIGNATION : LK21
 DATE OF MIXING : 5/28/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 10%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
LK21-1	11.49030	11.49470	11.49470	11.49475	11.49475	11.49475		
LK21-2	11.55180	11.55710	11.55710	11.55720	11.55720	11.55720		
LK21-3	11.49795	11.50240	11.50240	11.50245	11.50245	11.50245		
LK21-4	11.50860	11.51310	11.51315	11.51320	11.51320	11.51320		

POZZOLAN SAMPLE NAME: LK2
 MIX DESIGNATION : LK21
 DATE OF MIXING : 5/28/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 10%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
LK22-1	11.59200	11.59240	11.59360	11.59400	11.59415	11.59420	11.59440	11.59470
LK22-2	11.53180	11.53380	11.53500	11.53515	11.53535	11.53535	11.53550	11.53580
LK22-3	11.49765	11.49870	11.49975	11.49995	11.50015	11.50015	11.50015	11.50045
LK22-4	11.57310	11.57425	11.57470	11.57490	11.57510	11.57520	11.57530	11.57580

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
LK22-1	11.59200	11.59500	11.59525	11.59555	11.59575	11.59590	11.59610	11.59620
LK22-2	11.53180	11.53600	11.53630	11.53650	11.53680	11.53705	11.53725	11.53735
LK22-3	11.49765	11.50065	11.50090	11.50110	11.50130	11.50155	11.50170	11.50180
LK22-4	11.57310	11.57610	11.57635	11.57655	11.57670	11.57690	11.57705	11.57710

POZZOLAN SAMPLE NAME: LK2
 MIX DESIGNATION : LK22
 DATE OF MIXING : 5/28/92
 TIME OF MIXING : 4.30 p.m
 PERCENTAGE OF POZZOLAN : 15%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
LK22-1	11.59200	11.59620	11.59620	11.59620	11.59620	11.59625		
LK22-2	11.53180	11.53740	11.53745	11.53750	11.53750	11.53750		
LK22-3	11.49765	11.50180	11.50180	11.50185	11.50185	11.50185		
LK22-4	11.57310	11.57710	11.57710	11.57715	11.57715	11.57715		

POZZOLAN SAMPLE NAME: LK2
 MIX DESIGNATION : LK22
 DATE OF MIXING : 5/28/92
 TIME OF MIXING : 4.30 pm
 PERCENTAGE OF POZZOLAN : 15%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
LK23-1	11.50050	11.50095	11.50195	11.50235	11.50245	11.50260	11.50280	11.50310
LK23-2	11.56090	11.56135	11.56245	11.56290	11.56300	11.56300	11.56330	11.56350
LK23-3	11.55985	11.56025	11.56150	11.56165	11.56165	11.56205	11.56215	11.56235
LK23-4	11.51680	11.51720	11.51835	11.51875	11.51880	11.51900	11.51920	11.51950

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
LK23-1	11.50050	11.50340	11.50375	11.50390	11.50405	11.50420	11.50440	11.50450
LK23-2	11.56090	11.56360	11.56390	11.56410	11.56415	11.56430	11.56445	11.56450
LK23-3	11.55985	11.56255	11.56280	11.56305	11.56320	11.56340	11.56355	11.56365
LK23-4	11.51680	11.51960	11.51985	11.51995	11.52005	11.52020	11.52030	11.52040

POZZOLAN SAMPLE NAME: LK2
 MIX DESIGNATION : LK23
 DATE OF MIXING : 5/28/92
 TIME OF MIXING : 5 p.m
 PERCENTAGE OF POZZOLAN : 25%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
LK23-1	11.50050	11.50460	11.50465	11.50470	11.50470	11.50470		
LK23-2	11.56090	11.56450	11.56450	11.56460	11.56460	11.56460		
LK23-3	11.55985	11.56370	11.56375	11.56375	11.56375	11.56375		
LK23-4	11.51680	11.52040	11.52040	11.52040	11.52040	11.52040		

POZZOLAN SAMPLE NAME: LK2
MIX DESIGNATION : LK23
DATE OF MIXING : 5/28/92
TIME OF MIXING : 5 p.m
PERCENTAGE OF POZZOLAN : 25%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
VA21-1	11.62850	11.62955	11.63125	11.63150	11.63175	11.63180	11.63200	11.63230
VA21-2	11.54160	11.54220	11.54305	11.54355	11.54380	11.54410	11.54440	11.54490
VA21-3	11.55895	11.55980	11.56065	11.56115	11.56140	11.56175	11.56195	11.56245

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
VA21-1	11.62850	11.63250	11.63275	11.63295	11.63310	11.63335	11.63350	11.63360
VA21-2	11.54160	11.54510	11.54525	11.54540	11.54560	11.54575	11.54595	11.54620
VA21-3	11.55895	11.56265	11.56285	11.56305	11.56325	11.56350	11.56370	11.56395

POZZOLAN SAMPLE NAME: VA2
 MIX DESIGNATION : VA21
 DATE OF MIXING : 5/30/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 10%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
VA21-1	11.62850	11.63365	11.63375	11.63380	11.63380	11.63380		
VA21-2	11.54160	11.54625	11.54625	11.54625	11.54625	11.54625		
VA21-3	11.55895	11.56395	11.56395	11.56400	11.56400	11.56400		
VA21-4								

POZZOLAN SAMPLE NAME: VA2
MIX DESIGNATION : VA21
DATE OF MIXING : 5/30/92
TIME OF MIXING : 4 p.m
PERCENTAGE OF POZZOLAN : 10%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
VA22-1	11.58300	11.58370	11.58440	11.58600	11.58630	11.58670	11.58690	11.58730
VA22-3	11.57890	11.57965	11.58105	11.58300	11.58335	11.58350	11.58390	11.58430
VA22-4	11.55435	11.55520	11.55620	11.55760	11.55760	11.55795	11.55825	11.55875

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
VA22-1	11.58300	11.58750	11.58780	11.58795	11.58820	11.58835	11.58855	11.58885
VA22-3	11.57890	11.58460	11.58485	11.58505	11.58525	11.58540	11.58555	11.58565
VA22-4	11.55435	11.55915	11.55935	11.55950	11.55970	11.55985	11.55995	11.56005

POZZOLAN SAMPLE NAME: VA2
 MIX DESIGNATION : VA22
 DATE OF MIXING : 5/30/92
 TIME OF MIXING : 4.30 p.m
 PERCENTAGE OF POZZOLAN : 15%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
VA22-1	11.58300	11.58895	11.58895	11.58900	11.58900	11.58900		
VA22-2								
VA22-3	11.57890	11.58570	11.58570	11.58575	11.58575	11.58575		
VA22-4	11.55435	11.56010	11.56010	11.56015	11.56020	11.56025		

POZZOLAN SAMPLE NAME: VA2
MIX DESIGNATION : VA22
DATE OF MIXING : 5/30/92
TIME OF MIXING : 4 p.m
PERCENTAGE OF POZZOLAN : 15%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
VA23-1	11.50240	11.50315	11.50400	11.50600	11.50635	11.50670	11.50700	11.50740
VA23-2	11.50815	11.50835	11.50965	11.51150	11.51185	11.51215	11.51255	11.51295
VA23-3	11.65050	11.65120	11.65200	11.65390	11.65415	11.65450	11.65500	11.65530
VA23-4	11.65205	11.65295	11.65385	11.65620	11.65660	11.65685	11.65705	11.65735

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
VA23-1	11.50240	11.50760	11.50785	11.50795	11.50810	11.50825	11.50850	11.50870
VA23-2	11.50815	11.51315	11.51338	11.51345	11.51355	11.51370	11.51375	11.51395
VA23-3	11.65050	11.65570	11.65590	11.65605	11.65620	11.65630	11.65645	11.65665
VA23-4	11.65205	11.65755	11.65780	11.65795	11.65805	11.65810	11.65830	11.65855

POZZOLAN SAMPLE NAME: VA2
MIX DESIGNATION : VA23
DATE OF MIXING : 5/30/92
TIME OF MIXING : 5 p.m
PERCENTAGE OF POZZOLAN : 25%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
VA23-1	11.50240	11.50880	11.50880	11.50880	11.50885	11.50885		
VA23-2	11.50875	11.51395	11.51400	11.51400	11.51405	11.51410		
VA23-3	11.65050	11.65670	11.65670	11.65675	11.65675	11.65675		
VA23-4	11.65205	11.65855	11.65860	11.65865	11.65865	11.65865		

POZZOLAN SAMPLE NAME: VA2
MIX DESIGNATION : VA23
DATE OF MIXING : 5/30/92
TIME OF MIXING : 5 p.m
PERCENTAGE OF POZZOLAN : 25%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
PS1E1-1	11.60230	11.60300	11.60515	11.60525	11.60535	11.60540	11.60560	11.60590
PS1E1-2	11.56565	11.56610	11.56820	11.56850	11.56880	11.56895	11.56915	11.56955
PS1E1-3	11.53555	11.53600	11.53750	11.53790	11.53810	11.53825	11.53845	11.53885
PS1E1-4	11.56000	11.56065	11.56115	11.56160	11.56200	11.56240	11.56260	11.56310

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
PS1E1-1	11.60230	11.60630	11.60665	11.60685	11.60705	11.60725	11.60750	11.60760
PS1E1-2	11.56565	11.56985	11.57010	11.57030	11.57045	11.57060	11.57080	11.57110
PS1E1-3	11.53555	11.53945	11.53995	11.54010	11.54025	11.54045	11.54060	11.54080
PS1E1-4	11.56000	11.56350	11.56390	11.56405	11.56420	11.56440	11.56450	11.56490

POZZOLAN SAMPLE NAME: PS1E
 MIX DESIGNATION : PS1E1
 DATE OF MIXING : 5/31/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 10%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
PS1E1-1	11.60230	11.60760	11.60760	11.60760	11.60760	11.60760		
PS1E1-2	11.56565	11.57110	11.57115	11.57125	11.57125	11.57125		
PS1E1-3	11.53555	11.54080	11.54085	11.54085	11.54090	11.54095		
PS1E1-4	11.56000	11.56490	11.56490	11.56500	11.56500	11.56500		

POZZOLAN SAMPLE NAME: PS1E
 MIX DESIGNATION : PS1E1
 DATE OF MIXING : 5/31/92
 TIME OF MIXING : 4 p.m
 PERCENTAGE OF POZZOLAN : 10%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
PS1E2-1	11.53550	11.53600	11.53620	11.53700	11.53730	11.53780	11.53810	11.53850
PS1E2-2	11.52790	11.52830	11.52895	11.53050	11.53085	11.53120	11.53150	11.53190
PS1E2-3	11.50080	11.50125	11.50170	11.50220	11.50230	11.50260	11.50320	11.50360

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
PS1E2-1	11.53550	11.53870	11.53890	11.53910	11.53925	11.53940	11.53955	11.53980
PS1E2-2	11.52790	11.53200	11.53230	11.53240	11.53255	11.53275	11.53290	11.53310
PS1E2-3	11.50080	11.50380	11.50405	11.50415	11.50430	11.50445	11.50460	11.50475

POZZOLAN SAMPLE NAME: PS1E
 MIX DESIGNATION : PS1E2
 DATE OF MIXING : 5/31/92
 TIME OF MIXING : 4.30 p.m
 PERCENTAGE OF POZZOLAN : 15%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
PS1E2-1	11.53550	11.53980	11.53985	11.53985	11.53985	11.53985		
PS1E2-2	11.52790	11.53320	11.53320	11.53325	11.53325	11.53325		
PS1E2-3	11.50080	11.50480	11.50485	11.50495	11.50495	11.50495		
PS1E2-4								

POZZOLAN SAMPLE NAME: PS1E
 MIX DESIGNATION : PS1E2
 DATE OF MIXING : 5/31/92
 TIME OF MIXING : 4.30 pm
 PERCENTAGE OF POZZOLAN : 15%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
PS1E3-2	11.65495	11.65530	11.65610	11.65625	11.65635	11.65655	11.65665	11.65705
PS1E3-3	11.64705	11.64750	11.64785	11.64800	11.64805	11.64835	11.64855	11.64885
PS1E3-4	11.65900	11.65935	11.65985	11.65995	11.66010	11.66050	11.66060	11.66100

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
PS1E3-2	11.65495	11.65715	11.65730	11.65750	11.65765	11.65785	11.65795	11.65805
PS1E3-3	11.64705	11.64915	11.64935	11.64950	11.64965	11.64975	11.64995	11.65005
PSIE3-4	11.65900	11.66100	11.66125	11.66140	11.66150	11.66165	11.66180	11.66195

POZZOLAN SAMPLE NAME: PS1E
 MIX DESIGNATION : PS1E3
 DATE OF MIXING : 5/31/92
 TIME OF MIXING : 5 p.m
 PERCENTAGE OF POZZOLAN : 25%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
MW12-1	11.53830	11.54370	11.54375	11.54380	11.54380	11.54385		
MW12-2	11.54230	11.54730	11.54735	11.54740	11.54745	11.54745		
MW12-3	11.53110	11.53625	11.53625	11.53630	11.53635	11.53635		
MW12-4	11.59955	11.60505	11.60510	11.60515	11.60520	11.60520		

POZZOLAN SAMPLE NAME: MW1
MIX DESIGNATION : MW12
DATE OF MIXING : 6/02/92
TIME OF MIXING : 4.30 pm
PERCENTAGE OF POZZOLAN : 15%

TABLE 13 CONTD.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		14	30	60	90	120	150	180
MW13-1	11.62855	11.62950	11.63000	11.63030	11.63045	11.63075	11.63115	11.63155
MW13-2	11.66720	11.66855	11.66915	11.66925	11.66940	11.66940	11.66990	11.67010
MW13-3	11.49790	11.49930	11.50000	11.50020	11.50020	11.50060	11.50080	11.50100
MW13-4	11.55495	11.55630	11.55690	11.55705	11.55715	11.55745	11.55775	11.55805

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		210	240	270	300	330	360	390
MW13-1	11.62855	11.63185	11.63200	11.63225	11.63235	11.63260	11.63270	11.63275
MW13-2	11.66720	11.67030	11.67045	11.67060	11.67075	11.67105	11.67125	11.67155
MW13-3	11.49790	11.50140	11.50155	11.50170	11.50185	11.50190	11.50215	11.50225
MW13-4	11.55495	11.55835	11.55855	11.55875	11.55885	11.55890	11.55900	11.55910

POZZOLAN SAMPLE NAME: MW1
 MIX DESIGNATION : MW13
 DATE OF MIXING : 6/02/92
 TIME OF MIXING : 5 p.m
 PERCENTAGE OF POZZOLAN : 25%

TABLE 13 COND.,

SPEC #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT (DAYS)						
		420	450	480	510	540		
MW13-1	11.62855	11.63290	11.63300	11.63305	11.63310	11.63310		
MW13-2	11.66720	11.67165	11.67170	11.67175	11.67175	11.67175		
MW13-3	11.49790	11.50225	11.50230	11.50235	11.50235	11.50235		
MW13-4	11.55495	11.55915	11.55920	11.55925	11.55925	11.55925		

POZZOLAN SAMPLE NAME: MW1
MIX DESIGNATION : MW13
DATE OF MIXING : 6/02/92
TIME OF MIXING : 5 p.m
PERCENTAGE OF POZZOLAN : 25%

TABLE 14 EXPANSIONS OF MORTAR BARS BY ASTM C227 TEST METHOD FOR POZZOLAN SAMPLES

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	14	30	60	90	120	150	180	210	240	270	300	330	360
CB11-1	.010	.020	.024	.025	.027	.028	.032	.034	.038	.041	.044	.046	.049
CB11-2	.008	.016	.019	.021	.022	.025	.030	.032	.035	.039	.040	.042	.046
CB11-3	.006	.015	.024	.027	.029	.033	.035	.036	.038	.041	.044	.047	.049
CB11-4	.010	.017	.020	.022	.025	.027	.031	.033	.037	.039	.042	.044	.046
MEAN	.008	.017	.022	.023	.025	.028	.032	.034	.037	.040	.042	.045	.047
S.D.	.002	.002	.002	.002	.001	.003	.002	.002	.001	.001	.002	.002	.017
% C.V.	22.5	12.7	12.1	11.6	11.5	12.0	6.7	5.06	3.89	2.88	4.51	4.95	3.64
CB12-1	.004*	.010*	.013*	.014*	.016*	.017*	.020*	.024*	.029*	.031*	.034*	.035*	.037*
CB12-2	.010	.018	.022	.023	.024	.024	.027	.029	.034	.035	.037	.040	.040
CB12-3	.016	.022	.024	.026	.029	.031	.033	.035	.039	.041	.043	.045	.047
CB12-4	.011	.018	.019	.022	.023	.025	.028	.030	.033	.035	.037	.038	.041
MEAN	.012	.019	.021	.023	.025	.026	.029	.031	.035	.037	.039	.041	.043
S.D.	.003	.002	.002	.002	.003	.003	.003	.003	.003	.003	.003	.003	.003
% C.V.	20.0	11.9	11.6	8.7	12.6	14.1	10.9	10.2	8.89	9.36	8.88	8.79	8.87
CB13-1	.013	.017	.019	.020	.022	.024	.025	.026	.028	.030	.030	.031	.033
CB13-2	.014	.020	.021	.021	.022	.023	.026	.027	.028	.030	.031	.031	.032
CB13-3	.015	.020	.022	.023	.025	.026	.028	.029	.031	.033	.034	.035	.036
CB13-4	.006*	.014*	.016	.016	.018	.021	.024	.026	.029	.030	.031	.032	.034
MEAN	.014	.019	.019	.020	.021	.023	.025	.027	.029	.031	.031	.032	.034
S.D.	.001	.001	.002	.002	.002	.002	.001	.001	.001	.001	.001	.002	.002
% C.V.	7.1	9.1	13.5	14.7	13.2	8.8	6.6	5.23	4.97	4.87	5.49	5.86	5.06

* - Omitted for the calculation of Mean, S.D. and %C.V.

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	390	420	450	480	510	540							
CB11-1	.0510	.0520	.0525	.0525	.0525	.0525							
CB11-2	.0465	.0480	.0480	.0485	.0490	.0490							
CB11-3	.0495	.0505	.0510	.0515	.0515	.0515							
CB11-4	.0465	.0465	.0465	.0465	.0465	.0470							
MEAN	.0484	.0493	.0495	.0497	.0498	.0500							
S.D.	.0023	.0025	.0027	.0027	.0027	.0025							
% C.V.	.0465	.0500	.0553	.0053	.0539	.0496							
CB12-1	.0385	.0385	.0390	.0390	.0395	.0395							
CB12-2	.0425	.0430	.0435	.0435	.0435	.0440							
CB12-3	.0495	.0495	.0495	.0500	.0505	.0505							
CB12-4	.0425	.0425	.0430	.0430	.0435	.0440							
MEAN	.0432	.0434	.0437	.0439	.0442	.0445							
S.D.	.0046	.0045	.0043	.0045	.0046	.0045							
% C.V.	.1057	.1049	.0989	.1037	.1033	.1017							
CB13-1	.0360	.0365	.0370	.0370	.0370	.0370							
CB13-2	.0345	.0345	.0345	.0350	.0350	.0350							
CB13-3	.0370	.0375	.0380	.0380	.0380	.0380							
CB13-4	.0345	.0350	.0355	.0365	.0365	.0365							
MEAN	.0355	.0359	.0362	.0366	.0366	.0366							
S.D.	.0012	.0014	.0015	.0012	.0012	.0012							
% C.V.	.0345	.0383	.0429	.0341	.0341	.0341							

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	14	30	60	90	120	150	180	210	240	270	300	330	360
SM21-1	.009	.020	.029	.031	.034	.038	.042	.045	.050	.053	.054	.056	.058
SM21-2	.010	.022	.034	.040	.045	.047	.050	.051	.056	.059	.062	.064	.065
SM21-3	.011	.021	.031	.037	.040	.043	.046	.049	.054	.057	.059	.061	.063
SM21-4	.010	.025	.028	.033	.037	.040	.045	.048	.053	.056	.058	.059	.061
MEAN	.010	.022	.030	.035	.039	.042	.045	.048	.053	.056	.058	.060	.062
S.D.	.001	.002	.002	.004	.004	.004	.003	.002	.002	.002	.003	.003	.003
% C.V.	10.0	9.8	8.6	11.4	12.0	9.3	7.2	5.2	4.7	4.4	5.67	5.61	4.83
SM22-2	.008	.018	.031	.034	.036	.039	.042	.045	.049	.050	.053	.056	.058
SM22-3	.008	.018	.027	.029	.034	.038	.041	.043	.047	.049	.052	.054	.057
MEAN	.008	.018	.029	.031	.035	.038	.041	.044	.048	.049	.052	.055	.057
S.D.	.000	.000	.002	.003	.001	.001	.001	.001	.001	0.0	0.0	.001	.000
% C.V.	0.00	0.00	9.7	11.2	4.0	1.8	1.7	3.2	2.9	0.0	0.0	2.57	0.00
SM23-1	.010	.018	.025	.026	.026	0.29	.031	.033	.036	.038	.038	.039	.040
SM23-2	.011	.018	.023	.023	.027	.028	.031	.032	.035	.036	.037	.039	.039
SM23-3	.011	.019	.035	.035	.036	.037	.038	.040	.043	.045	.046	.046	.047
SM23-4	.010	.019	.025	.026	.027	.030	.033	.035	.038	.039	.041	.042	.043
MEAN	.010	.018	.027	.027	.029	.031	.033	.035	.038	.039	.040	.041	.042
S.D.	.000	.000	.005	.005	.004	.004	.003	.004	.003	.004	.004	.003	.003
% C.V.	0.00	0.00	20.0	18.8	16.1	13.1	9.9	1.02	9.4	9.8	9.9	7.9	8.51

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES											
	390	420	450	480	510	540						
SM21-1	.0620	.0625	.0635	.0640	.0645	.0650						
SM21-2	.0690	.0695	.0700	.0700	.0705	.0705						
SM21-3	.0665	.0665	.0670	.0675	.0675	.0675						
SM21-4	.0640	.0650	.0650	.0650	.0650	.0650						
MEAN	.0654	.0658	.0664	.0666	.0668	.0670						
S.D.	.0030	.0030	.0028	.0027	.0027	.0026						
% C.V.	.0465	.0444	.0423	.0403	.0411	.0390						
SM22-2	.0590	.0600	.0600	.0605	.0605	.0605						
SM22-3	.0565	.0565	.0565	.0570	.0575	.0580						
MEAN	.0577	.0583	.0583	.0587	.0590	.0592						
S.D.	.0017	.0024	.0024	.0025	.0021	.0017						
% C.V.	.0306	.0425	.0425	.0421	.0359	.0298						
SM23-1	.0420	.0420	.0425	.0425	.0430	.0430						
SM23-2	.0400	.0400	.0400	.0400	.0400	.0405						
SM23-3	.0500	.0505	.0505	.0510	.0510	.0510						
SM23-4	.0450	.0450	.0450	.0455	.0460	.0465						
MEAN	.0442	.0444	.0445	.0447	.0450	.0453						
S.D.	.0043	.0046	.0045	.0047	.0469	.0455						
% C.V.	.0983	.1030	.1009	.1060	.1042	.1006						

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	14	30	60	90	120	150	180	210	240	270	300	330	360
CT11-1	.003	.008	.015	.018	.021	.025	.028	.030	.032	.036	.038	.040	.041
CT11-2	.002	.006	.014	.017	.020	.023	.026	.028	.031	.033	.035	.037	.038
CT11-3	.002	.009	.012	.016	.022	.020	.024	.027	.030	.034	.035	.037	.040
CT11-4	.002	.007	.014	.018	.022	.022	.025	.028	.032	.035	.037	.039	.041
MEAN	.002	.007	.013	.017	.021	.022	.022	.028	.031	.034	.036	.038	.040
S.D.	.001	.001	.001	.001	.001	.002	.002	.001	.001	.001	.001	.001	.001
% C.V.	22.2	17.2	9.1	5.5	4.5	9.2	9.2	4.5	3.1	3.7	4.1	3.9	3.5
CT12-1	.001	.004	.017	.018*	.020*	.023*	.025*	.027	.030	.030	.034	.036	.037
CT12-2	.001	.004	.007*	.010*	.014*	.016*	.020*	.024	.026	.029	.030	.032	.034
CT12-3	.001	.004	.013	.016	.018	.022	.024	.025	.027	.030	.031	.034	.036
MEAN	.001	.004	.015	.017	.019	.022	.024	.025	.028	.030	.032	.034	.036
S.D.	0.00	0.00	.002	.001	.001	.001	.001	.001	.002	.001	.002	.002	.001
% C.V.	0.00	0.00	18.8	8.3	7.4	3.1	2.8	4.5	7.4	1.9	6.5	5.8	4.28
CT13-1	.002	.004	.009	.010	.014	.016	.019	.022	.024	.025	.026	.028	.029
CT13-2	.001	.003	.008	.013	.016	.018	.020	.022	.025	.027	.027	.028	.029
CT13-3	.002	.004	.009	.011	.016	.018	.020	.022	.024	.027	.028	.030	.031
MEAN	.002	.003	.008	.011	.015	.017	.019	.022	.024	.026	.027	.029	.030
S.D.	.001	.001	.001	.001	.001	.001	.001	0	.001	.001	.001	.001	.001
% C.V.	34.6	15.7	6.6	13.4	7.5	6.6	2.9	0	2.4	4.4	3.7	4.0	3.89

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	390	420	450	480	510	540							
CT11-1	.0425	.0425	.0430	.0435	.0435	.0435							
CT11-2	.0405	.0405	.0410	.0415	.0415	.0415							
CT11-3	.0425	.0430	.0435	.0435	.0440	.0440							
CT11-4	.0430	.0435	.0440	.0440	.0440	.0440							
MEAN	.0421	.0424	.0429	.0431	.0432	.0432							
S.D.	.0011	.0013	.0013	.0011	.0012	.0012							
% C.V.	.0263	.0310	.0307	.0257	.0275	.0275							
CT12-1	.0385	.0390	.0395	.0400	.0400	.0400							
CT12-2	.0345	.0350	.0350	.0355	.0355	.0355							
CT12-3	.0375	.0380	.0385	.0390	.0390	.0390							
CT12-4													
MEAN	.0368	.0373	.0376	.0382	.0382	.0382							
S.D.	.0021	.0021	.0024	.0024	.0024	.0024							
% C.V.	.0565	.0557	.0627	.0619	.0619	.0619							
CT13-1	.0310	.0315	.0320	.0320	.0320	.0325							
CT13-2	.0325	.0325	.0325	.0330	.0330	.0330							
CT13-3	.0330	.0335	.0340	.0340	.0345	.0345							
CT13-4													
MEAN	.0322	.0325	.0328	.0330	.0332	.0333							
S.D.	.0010	.0010	.0010	.0010	.0012	.0010							
% C.V.	.0323	.0307	.0317	.0303	.0379	.0312							

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	14	30	60	90	120	150	180	210	240	270	300	330	360
US11-1	.005*	.007	.008*	.008*	.011*	.015*	.018*	.020*	.025*	.028*	.030*	.033*	.035*
US11-2	.003	.007	.014	.018	.021	.024	.029	.029	.033	.036	.038	.040	.041
US11-3	.003	.007	.011	.014	.018	.019	.024	.027	.031	.032	.034	.036	.038
US11-4	.003	.005	.012	.015	.017	.019	.025	.027	.030	.033	.035	.036	.038
MEAN	.003	.006	.012	.015	.018	.020	.026	.027	.031	.032	.034	.036	.038
S.D.	.000	.001	.001	.002	.002	.002	.002	.001	.001	.003	.003	.003	.002
% C.V.	0.00	15.3	12.3	13.2	11.1	13.9	10.1	4.2	4.9	10.2	9.6	7.9	4.44
US12-1	.003	.005	.012	.014	.015	.018	.021	.024	.028	.029	.031	.033	.035
US12-2	.003	.006	.012	.013	.015	.019	.022	.025	.029	.030	.031	.033	.034
US12-3	.004	.006	.011	.014	.016	.020	.022	.024	.028	.029	.031	.032	.033
US12-4	.003	.007	.010	.012	.014	.019	.023	.025	.029	.031	.033	.035	.035
MEAN	.003	.006	.011	.013	.015	.019	.022	.025	.029	.030	.031	.033	.034
S.D.	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001
% C.V.	15.3	13.6	8.5	7.2	5.4	4.3	3.7	2.3	2.0	3.2	3.2	3.8	2.79
US13-1	.003*	.006*	.010	.011	.012	.012	.014	.017	.019	.020	.021	.022	.023
US13-2	.001	.002	.002*	.004*	.008*	.012	.014	.016	.020	.020	.021	.023	.024
US13-3	.001	.002	.011	.012	.013	.015	.016	.018	.022	.023	.023	.024	.025
MEAN	.001	.002	.010	.011	.012	.013	.014	.017	.020	.021	.022	.023	.024
S.D.	.000	.000	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001
% C.V.	0.00	0.00	6.7	6.1	5.6	13.3	7.8	5.9	7.5	8.2	5.3	4.3	4.16

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	390	420	450	480	510	540							
US11-1	.0375	.0385	.0390	.0395	.0395	.0395							
US11-2	.0435	.0440	.0445	.0455	.0455	.0455							
US11-3	.0390	.0395	.0395	.0400	.0400	.0400							
US11-4	.0410	.0415	.0425	.0430	.0430	.0430							
MEAN	.0402	.0409	.0412	.0420	.0420	.0420							
S.D.	.0026	.0024	.0027	.0028	.0028	.0028							
% C.V.	.0645	.0594	.0660	.0666	.0666	.0666							
US12-1	.0370	.0375	.0380	.0385	.0385	.0385							
US12-2	.0355	.0360	.0370	.0370	.0375	.0380							
US12-3	.0345	.0345	.0350	.0360	.0365	.0365							
US12-4	.0365	.0375	.0375	.0380	.0380	.0380							
MEAN	.0358	.0364	.0369	.0374	.0376	.0377							
S.D.	.0011	.0014	.0013	.0013	.0085	.0087							
% C.V.	.0309	.0363	.0356	.0297	.0227	.0229							
US13-1	.0240	.0240	.0245	.0250	.0250	.0250							
US13-2	.0245	.0250	.0255	.0260	.0260	.0260							
US13-3													
US13-4	.0265	.0270	.0275	.0275	.0275	.0275							
MEAN	.0250	.0253	.0256	.0262	.0262	.0262							
S.D.	.0013	.0015	.0014	.0013	.0013	.0013							
% C.V.	.0529	.0603	.0544	.0480	.0480	.0480							

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	14	30	60	90	120	150	180	210	240	270	300	330	360
PRC11-1	.005	.030	.045	.048	.050	.051	.054	.058	.061	.064	.066	.069	.070
PRC11-2	.010*	.023	.039	.043	.044	.048	.053	.057	.061	.063	.066	.068	.070
PRC11-3	.008	.024	.028*	.029*	.033*	.039	.044*	.048*	.052*	.053*	.055*	.059*	.061*
MEAN	.006	.025	.042	.045	.047	.046	.053	.058	.061	.063	.066	.068	.070
S.D.	.002	.003	.004	.003	.004	.006	.001	.001	0.0	0.0	0.0	0.0	.000
% C.V.	22.6	13.1	10.1	7.7	9.0	13.5	1.3	1.23	0.0	0.0	0.0	0.0	.000
PRC12-1	.005	.022	.028	.033	.036	.039	.042	.045	.047	.048	.050	.051	.053
PRC12-2	.004	.023	.030	.033	.036	.040	.044	.049	.051	.053	.055	.057	.058
PRC12-3	.005	.025	.031	.032	.033	.036	.041	.044	.047	.048	.050	.051	.053
PRC12-4	.003*	.021	.028	.032	.035	.037	.042	.044	.047	.047	.049	.051	.052
MEAN	.004	.022	.029	.032	.035	.038	.042	.046	.048	.049	.051	.052	.054
S.D.	.001	.001	.001	.001	.001	.002	.001	.002	.002	.003	.003	.003	.003
% C.V.	12.3	7.5	5.1	1.7	4.0	4.8	2.9	5.2	4.2	5.5	5.3	5.7	5.01
PRC13-1	.005	.011	.020	.022	.025	.028	.030	.033	.035	.035	.037	.038	.040
PRC13-2	.005	.009	.015	.016	.017	.020	.023	.026	.028	.030	.032	.033	.033
PRC13-3	.005	.011	.020	.022	.022	.023	.025	.027	.029	.031	.033	.034	.036
PRC13-4	.005	.006*	.016	.017	.020	.021	.024	.028	.030	.030	.031	.032	.034
MEAN	.005	.010	.017	.019	.021	.023	.025	.028	.030	.031	.033	.034	.036
S.D.	.000	.001	.002	.003	.003	.003	.001	.003	.003	.002	.002	.003	.003
% C.V.	0.00	11.1	14.8	16.6	16.0	15.4	12.2	10.9	10.2	7.5	6.9	7.6	8.66

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	390	420	450	480	510	540							
PRC11-1	.0740	.0750	.0750	.0755	.0755	.0755							
PRC11-2	.0740	.0755	.0760	.0760	.0760	.0765							
PRC11-3*	.0640	.0645	.0650	.0655	.0655	.0655							
PRC11-4													
MEAN	.0740	.0753	.0755	.0758	.0758	.0760							
S.D.	.0000	.0003	.0007	.0003	.0003	.0007							
% C.V.	.0000	.0047	.0094	.0047	.0047	.0093							
PRC12-1	.0535	.0540	.0540	.0545	.0545	.0550							
PRC12-2	.0595	.0600	.0605	.0610	.0610	.0610							
PRC12-3	.0535	.0540	.0540	.0540	.0545	.0545							
PRC12-4	.0530	.0530	.0530	.0535	.0535	.0535							
MEAN	.0549	.0552	.0553	.0557	.0559	.0560							
S.D.	.0031	.0032	.0034	.0035	.0034	.0034							
% C.V.	.0563	.0579	.0623	.0632	.0620	.0605							
PRC13-1	.0415	.0415	.0420	.0425	.0425	.0425							
PRC13-2	.0345	.0350	.0350	.0350	.0350	.0350							
PRC13-3	.0370	.0380	.0380	.0385	.0385	.0385							
PRC13-4	.0360	.0360	.0360	.0365	.0365	.0365							
MEAN	.0372	.0376	.0377	.0381	.0381	.0381							
S.D.	.0030	.0028	.0031	.0032	.0032	.0032							
% C.V.	.0810	.0762	.0820	.0852	.0852	.0852							

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	14	30	60	90	120	150	180	210	240	270	300	330	360
LK21-1	.005	.017	.020	.021	.024	.025	.028	.031	.034	.036	.038	.040	.042
LK21-2	.005	.022	.028*	.032*	.033*	.036*	.038*	.039*	.042*	.044*	.047*	.049*	.051*
LK21-3	.004	.015	.021	.024	.024	.026	.030	.034	.037	.038	.040	.041	.043
LK21-4	.005	.011*	.018	.023	.026	.027	.030	.033	.037	.039	.041	.043	.044
MEAN	.004	.018	.019	.022	.024	.026	.026	.033	.036	.037	.040	.041	.043
S.D.	.001	.003	.001	.001	.001	.001	.001	.001	.002	.001	.001	.001	.001
% C.V.	10.5	20.0	7.7	6.7	4.6	3.8	3.8	4.7	4.8	4.05	3.85	3.69	2.32
LK22-1	.004*	.016	.020	.021	.022	.024	.027	.030	.032	.035	.037	.039	.041
LK22-2	.020	.032*	.033*	.035*	.035*	.037*	.040*	.042*	.045*	.047*	.050*	.052*	.054*
LK22-3	.010	.021	.023	.025	.025	.025	.028	.030	.033	.034	.036	.039	.040
LK22-4	.011	.016	.018	.020	.021	.022	.025	.028	.032	.034	.036	.038	.039
MEAN	.013	.017	.020	.022	.022	.023	.023	.029	.033	.034	.036	.039	.040
S.D.	.005	.002	.002	.002	.002	.001	.001	.001	.002	0.0	0.0	0.0	.001
% C.V.	20.0	16.3	12.3	12.0	9.1	6.4	6.4	4.0	5.2	0.0	0.0	0.0	2.50
LK23-1	.004	.014	.018	.019	.021	.023	.026	.029	.033	.034	.035	.037	.039
LK23-2	.004	.015	.020	.021	.021	.024	.026	.027	.030	.032	.032	.034	.035
LK23-3	.004	.016	.018	.018	.022	.023	.025	.027	.029	.032	.033	.035	.037
LK23-4	.004	.015	.019	.020	.022	.024	.027	.028	.031	.031	.032	.034	.035
MEAN	.004	.015	.018	.019	.021	.023	.026	.028	.031	.032	.033	.035	.036
S.D.	0.00	.001	.001	.001	.001	.001	.001	.001	.002	.001	.001	.001	.002
% C.V.	0.00	5.4	5.1	6.6	2.6	2.4	3.1	3.5	3.5	3.9	4.28	4.04	5.24

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	390	420	450	480	510	540							
LK21-1	.0435	.0440	.0440	.0445	.0445	.0445							
LK21-2*	.0520	.0530	.0530	.0540	.0540	.0540							
LK21-3	.0440	.0445	.0445	.0450	.0450	.0450							
LK21-4	.0450	.0450	.0455	.0460	.0460	.0460							
MEAN	.0442	.0445	.0447	.0451	.0451	.0451							
S.D.	.0007	.0005	.0007	.0004	.0004	.0004							
% C.V.	.0173	.0112	.0171	.0941	.0941	.0941							
LK22-1	.0420	.0420	.0420	.0420	.0420	.0425							
LK22-2*	.0555	.0560	.0565	.0570	.0570	.0570							
LK22-3	.0415	.0415	.0415	.0420	.0420	.0420							
LK22-4	.0400	.0400	.0400	.0405	.0405	.0405							
MEAN	.0412	.0412	.0412	.0415	.0415	.0417							
S.D.	.0010	.0010	.0010	.0008	.0008	.0001							
% C.V.	.0253	.0253	.0253	.0208	.0208	.0249							
LK23-1	.0400	.0410	.0415	.0420	.0420	.0420							
LK23-2	.0360	.0360	.0360	.0370	.0730	.0370							
LK23-3	.0380	.0385	.0390	.0390	.0390	.0390							
LK23-4	.0360	.0360	.0360	.0360	.0360	.0360							
MEAN	.0375	.0379	.0381	.0385	.0385	.0385							
S.D.	.0019	.0024	.0026	.0026	.0026	.0026							
% C.V.	.0511	.0632	.0682	.0687	.0687	.0687							

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	14	30	60	90	120	150	180	210	240	270	300	330	360
VA21-1	.010	.027	.030	.032	.033	.035	.038	.040	.042	.044	.046	.048	.050
VA21-2	.006	.014	.019	.022	.025	.028	.033	.035	.037	.038	.040*	.041*	.043*
VA21-3	.008	.017	.022	.024	.028	.030	.035	.037	.039	.041	.043	.045	.047
MEAN	.008	.019	.023	.026	.028	.031	.035	.036	.039	.040	.044	.046	.049
S.D.	.002	.006	.005	.005	.004	.004	.002	.002	.002	.002	.002	.002	.002
% C.V.	25.0	35.2	24.0	20.3	14.0	11.6	7.1	6.7	6.3	4.9	4.7	4.5	4.3
VA22-1	.007	.014	.030	.033	.037	.039	.043	.045	.048	.049	.052	.053	.055
VA22-3	.007	.021	.041	.044	.046	.050	.054	.057	.060	.061	.063	.065	.066
VA22-4	.008	.018	.032	.032	.036	.039	.044	.048	.050	.051	.053	.055	.056
MEAN	.007	.017	.034	.036	.039	.042	.047	.050	.053	.054	.056	.057	.059
S.D.	.001	.003	.005	.006	.005	.006	.006	.006	.006	.006	.006	.006	.006
% C.V.	7.8	19.8	17.0	18.3	13.8	14.8	12.9	12.5	12.2	11.9	10.8	11.1	10.3
VA23-1	.007	.016	.036	.039	.043	.046	.050	.052	.055	.055	.057	.058	.061
VA23-2	.002*	.015	.033	.037	.040	.044	.048	.050	.052	.053	.054	.055	.056
VA23-3	.005	.015	.034	.036	.040	.045	.048	.052	.054	.055	.057	.058	.059
VA23-4	.008	.018	.041	.047	.048	.050	.053	.055	.057	.059	.060	.060	.062
MEAN	.006	.016	.036	.039	.042	.046	.049	.052	.055	.055	.056	.058	.059
S.D.	.001	.001	.003	.005	.003	.002	.002	.002	.002	.002	.002	.002	.003
% C.V.	22.9	8.8	9.8	12.5	8.8	5.6	4.7	3.9	5.5	4.5	4.3	3.56	4.44

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	390	420	450	480	510	540							
VA21-1	.0510	.0515	.0525	.0530	.0530	.0530							
VA21-2*	.0460	.0465	.0465	.0465	.0465	.0465							
VA21-3	.0500	.0500	.0500	.0505	.0505	.0505							
VA21-4													
MEAN	.0505	.0507	.0513	.0518	.0518	.0518							
S.D.	.0007	.0011	.0017	.0017	.0017	.0017							
% C.V.	.0014	.0021	.0034	.0341	.0341	.0341							
VA22-1	.0550	.0560	.0560	.0565	.0565	.0565							
VA22-2													
VA22-3	.0675	.0680	.0680	.0685	.0685	.0685							
VA22-4	.0570	.0575	.0575	.0580	.0580	.0585							
MEAN	.0589	.0605	.0605	.0610	.0610	.0611							
S.D.	.0067	.0065	.0065	.0064	.0064	.0064							
% C.V.	.0112	.1081	.1081	.1072	.1072	.1051							
VA23-1	.0630	.0640	.0640	.0640	.0640	.0640							
VA23-2	.0580	.0580	.0585	.0585	.0590	.0595							
VA23-3	.0615	.0620	.0620	.0625	.0625	.0625							
VA23-4	.0650	.0650	.0655	.0660	.0660	.0660							
MEAN	.0619	.0620	.0625	.0627	.0628	.0630							
S.D.	.0029	.0028	.0030	.0030	.0029	.0027							
% C.V.	.0477	.0452	.0484	.0506	.0469	.0434							

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	14	30	60	90	120	150	180	210	240	270	300	330	360
PS1E1-1	.007*	.028	.029	.030	.031	.033	.036	.040	.043	.045	.047	.049	.052
PS1E1-2	.004	.025	.028	.031	.033	.035	.039	.042	.045	.046	.048	.049	.051
PS1E1-3	.004	.019	.023	.025	.027	.029	.033	.039	.044	.045	.047	.049	.050
PS1E1-4	.006	.011*	.016*	.020*	.024*	.026	.031	.035	.039	.040	.042	.044	.045
MEAN	.004	.024	.026	.028	.030	.030	.034	.039	.043	.044	.046	.048	.049
S.D.	.001	.004	.003	.003	.003	.004	.003	.003	.003	.003	.003	.002	.003
% C.V.	24.7	19.0	12.0	11.2	10.0	13.1	10.0	7.55	6.2	6.15	5.88	5.23	6.28
PS1E2-1	.005	.007	.015	.018*	.023*	.026*	.030*	.032*	.034*	.036*	.037*	.039*	.040*
PS1E2-2	.004	.010	.026*	.029*	.033*	.036*	.040*	.041*	.044*	.045*	.046*	.048*	.050*
PS1E2-3	.004	.009	.014	.015	.018	.024	.028	.030	.033	.033	.035	.036	.038
MEAN	.004	.008	.014	.016	.020	.025	.029	.031	.034	.034	.036	.037	.039
S.D.	.001	.001	.001	.002	.003	.001	.001	.001	.001	.002	.001	.002	.001
% C.V.	13.3	17.6	4.8	12.8	17.2	5.6	4.1	4.5	2.1	6.14	3.92	5.65	3.62
PS1E3-2	.003	.011	.013	.013	.016	.017	.021	.022	.023	.025	.027	.029	.030
PS1E3-3	.004	.008	.009	.010	.013	.015	.018	.021	.023	.024	.026	.027	.029
PS1E3-4	.003	.008	.009	.011	.015	.016	.020	.020	.023	.024	.025	.026	.028
MEAN	.003	.009	.010	.011	.014	.016	.019	.021	.023	.024	.026	.027	.029
S.D.	.001	.001	.002	.002	.001	.001	.001	.001	0.0	0.0	.001	.001	.001
% C.V.	17.3	19.2	22.3	17.8	10.4	6.2	7.7	4.7	0.0	0.0	3.84	5.58	3.44

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES											
	390	420	450	480	510	540						
PS1E1-1	.0530	.0530	.0530	.0530	.0530	.0530						
PS1E1-2	.0535	.0545	.0550	.0560	.0560	.0560						
PS1E1-3	.0520	.0525	.0530	.0530	.0535	.0535						
PS1E1-4	.0485	.0490	.0490	.0500	.0500	.0500						
MEAN	.0512	.0523	.0525	.0530	.0531	.0531						
S.D.	.0022	.0023	.0025	.0025	.0024	.0024						
% C.V.	.0435	.0445	.0479	.0462	.0463	.0463						
PS1E2-1	.0430	.0430	.0435	.0435	.0435	.0435						
PS1E2-2*	.0520	.0530	.0530	.0535	.0535	.0535						
PS1E2-3	.0395	.0400	.0405	.0415	.0415	.0415						
PS1E2-4												
MEAN	.0412	.0415	.0420	.0425	.0425	.0425						
S.D.	.0025	.0021	.0021	.0014	.0014	.0014						
% C.V.	.0599	.0511	.0505	.0332	.0332	.0332						
PS1E3-1												
PS1E3-2	.0310	.0315	.0315	.0325	.0325	.0325						
PS1E3-3	.0300	.0315	.0325	.0325	.0325	.0325						
PS1E3-4	.0295	.0305	.0305	.0310	.0310	.0310						
MEAN	.0302	.0312	.0315	.0320	.0320	.0320						
S.D.	.0007	.0006	.0010	.0009	.0009	.0009						
% C.V.	.0253	.0185	.0317	.0281	.0281	.0281						

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	14	30	60	90	120	150	180	210	240	270	300	330	360
F31-1	.019	.026	.031	.035	.037	.040	.044	.045	.046	.048	.051	.052	.053
F31-2	.013	.019	.022	.026	.030	.035	.040	.042	.044	.047	.049	.051	.053
F31-3	.015	.022	.025	.028	.032	.036	.041	.043	.044	.046	.046	.048	.049
F31-4	.020	.031	.034	.036	.036	.040	.043	.043	.044	.046	.049	.051	.052
MEAN	.016	.024	.028	.031	.033	.037	.042	.043	.044	.047	.048	.050	.051
S.D.	.003	.005	.005	.005	.003	.002	.001	.001	.001	.001	.002	.002	.002
% C.V.	19.7	21.2	19.5	15.9	9.7	6.9	4.3	2.9	2.2	2.0	4.2	3.4	3.65
F32-3	.014	.023	.027	.029	.033	.036	.040	.042	.043	.043	.045	.045	.046
F32-4	.012	.019	.023	.026	.027	.030	.035	.038	.040	.042	.044	.045	.046
MEAN	.013	.021	.025	.027	.030	.033	.037	.040	.041	.042	.044	.045	.046
S.D.	.001	.003	.003	.002	.004	.004	.003	.003	.002	0.0	0.0	0.0	.000
% C.V.	10.8	13.4	11.3	7.7	14.1	12.8	9.4	7.1	5.1	0.0	0.0	0.0	.000
F33-2	.009	.017	.019	.021	.023	.026	.030	.032	.033	.033	.034	.035	.035
F33-3	.013	.018	.021	.022	.025	.028	.031	.033	.035	.036	.037	.038	.039
F33-4	.012	.021	.023	.025	.026	.028	.030	.032	.033	.034	.034	.035	.036
MEAN	.014	.019	.021	.022	.024	.027	.030	.032	.034	.034	.035	.036	.037
S.D.	.002	.002	.002	.002	.001	.001	.001	0.0	.001	.001	.001	.001	.002
% C.V.	18.3	11.1	9.5	9.1	6.1	4.2	1.9	0.0	3.4	4.4	4.9	4.8	5.6
MW11-1	.013	.016	.021	.024	.028	.032	.035	.036	.038	.040	.042	.045	.047
MW11-2	.013	.017	.019	.021	.025	.029	.031	.033	.034	.036	.039	.040	.041
MW11-3	.015	.021	.028	.031	.033	.036	.037	.037	.039	.041	.042	.044	.047
MW11-4	.017	.022	.026	.028	.032	.034	.037	.038	.039	.041	.042	.044	.046
MEAN	.014	.019	.023	.026	.029	.032	.035	.036	.037	.039	.041	.043	.045
S.D.	.002	.003	.004	.004	.006	.003	.002	.002	.002	.002	.001	.002	.003
% C.V.	13.2	15.5	17.8	17.0	12.5	9.1	8.0	6.0	6.3	6.1	3.6	5.1	6.34

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES												
	390	420	450	480	510	540							
F31-1	.0550	.0565	.0570	.0575	.0580	.0580							
F31-2	.0545	.0545	.0550	.0555	.0555	.0560							
F31-3	.0505	.0515	.0515	.0520	.0520	.0520							
F31-4	.0540	.0540	.0545	.0550	.0555	.0560							
MEAN	.0535	.0541	.0544	.0550	.0552	.0555							
S.D.	.0020	.0020	.0025	.0023	.0025	.0025							
% C.V.	.0381	.0378	.0459	.0413	.0446	.0453							
F32-1													
F32-2													
F32-3	.0480	.0485	.0490	.0495	.0495	.0495							
F32-4	.0475	.0480	.0480	.0485	.0485	.0485							
MEAN	.0477	.0483	.0485	.0490	.0490	.0490							
S.D.	.0003	.0003	.0007	.0007	.0007	.0007							
% C.V.	.0074	.0073	.0146	.0144	.0144	.0144							
F33-1	.0365	.0370	.0370	.0370	.0370	.0370							
F33-2	.0400	.0405	.0405	.0410	.0410	.0415							
F33-3	.0370	.0380	.0380	.0380	.0380	.0380							
F33-4													
MEAN	.0378	.0385	.0385	.0387	.0387	.0388							
S.D.	.0019	.0018	.0018	.0021	.0021	.0024							
% C.V.	.0500	.0468	.0468	.0538	.0538	.0608							

TABLE 14 CONTD.,

SPECIMEN	MEAN PERCENTAGE EXPANSION AT AGES												
	14	30	60	90	120	150	180	210	240	270	300	330	360
MW12-1	.014	.022	.027	.028	.033	.036	.040	.043	.045	.047	.049	.050	.052
MW12-2	.016	.019	.022	.024	.027	.030	.033	.037	.038	.041	.043	.046	.048
MW12-3	.014	.020	.024	.027	.032	.034	.037	.039	.041	.043	.045	.047	.049
MW12-4	.018	.024	.027	.029	.034	.036	.040	.044	.047	.048	.051	.052	.053
MEAN	.015	.021	.025	.027	.031	.034	.037	.041	.043	.045	.047	.048	.051
S.D.	.002	.002	.002	.002	.003	.002	.003	.003	.004	.003	.004	.003	.002
% C.V.	12.3	10.4	9.8	8.0	9.8	8.3	8.8	8.1	9.4	7.3	7.8	5.6	4.71
MW13-1	.009	.014	.017	.019	.022	.026	.030	.033	.034	.037	.038	.040	.041
MW13-2	.013	.019	.020	.022	.022	.027	.029	.031	.032	.034	.035	.038	.040
MW13-3	.014	.021	.023	.023	.027	.029	.031	.035	.036	.038	.039	.040	.042
MW13-4	.013	.019	.021	.022	.025	.028	.031	.034	.036	.038	.039	.039	.040
MEAN	.012	.018	.020	.021	.024	.027	.030	.033	.034	.037	.038	.039	.041
S.D.	.002	.003	.002	.001	.002	.001	.001	.001	.002	.002	.002	0.0	.009
% C.V.	18.1	16.3	12.3	8.0	10.2	4.6	3.1	5.1	5.5	5.1	5.0	0.0	2.34

TABLE 14 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT AGES											
	390	420	450	480	510	540						
MW11-1	.0485	.0490	.0495	.0500	.0500	.0500						
MW11-2	.0430	.0435	.0440	.0445	.0445	.0445						
MW11-3	.0490	.0500	.0505	.0510	.0510	.0510						
MW11-4	.0475	.0480	.0480	.0480	.0480	.0480						
MEAN	.0470	.0476	.0480	.0484	.0484	.0484						
S.D.	.0027	.0029	.0028	.0028	.0028	.0028						
% C.V.	.0582	.0602	.0595	.0593	.0593	.0593						
MW12-1	.0535	.0540	.0545	.0550	.0550	.0555						
MW12-2	.0495	.0500	.0505	.0510	.0515	.0515						
MW12-3	.0515	.0515	.0515	.0520	.0525	.0525						
MW12-4	.0545	.0550	.0555	.0560	.0565	.0565						
MEAN	.0522	.0526	.0530	.0535	.0539	.0540						
S.D.	.0022	.0023	.0024	.0024	.0228	.0238						
% C.V.	.0424	.0434	.0449	.0444	.0424	.0441						
MW13-1	.0420	.0435	.0445	.0450	.0450	.0450						
MW13-2	.0435	.0445	.0450	.0455	.0455	.0455						
MW13-3	.0435	.0435	.0440	.0445	.0445	.0445						
MW13-4	.0415	.0420	.0425	.0430	.0430	.0430						
MEAN	.0426	.4034	.0440	.0445	.0445	.0445						
S.D.	.0010	.0010	.0011	.0011	.0011	.0011						
% C.V.	.0242	.0238	.0245	.0242	.0242	.0242						

TABLE 14a COMPARISON OF PERCENTAGE REDUCTION OF EXPANSIONS
OBTAINED FROM ASTM P214 AND ASTM C227
TEST METHODS

POZZOLAN	PERCENTAGE REDUCTION					
	10%		15%		25%	
	P214	C227	P214	C227	P214	C227
SM2	45.70	1.58	81.44	9.52	79.18	33.33
CB1	50.67	25.39	60.18	31.74	74.66	46.03
CT1	45.24	36.50	71.15	42.85	58.37	52.24
US1	40.72	39.68	57.46	46.03	90.50	61.90
MW1	35.75	28.57	53.85	19.00	71.04	34.92
PRC1	-7.69	-11.11	28.05	14.28	56.10	42.85
F3	21.72	19.04	65.16	26.98	57.01	41.26
PS1E	54.75	22.22	69.68	38.09	82.80	53.96
LK2	81.90	31.75	86.42	36.50	92.76	42.85
VA2	-17.64	22.22	-42.98	6.35	-33.94	6.35

Note: Negative sign denotes percentage increase in the expansion.

TABLE 15 LENGTH MEASUREMENTS OF MORTAR BARS BY ASTM C227 METHOD WITH FLY ASH

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
MA1-1	11.73750	11.73810	11.73960	11.73990	11.74240	11.74275	11.74410	11.74435
MA1-2	11.68975	11.69055	11.69185	11.69225	11.69445	11.69495	11.69605	11.69640
MA1-3	11.64925	11.65005	11.65140	11.65190	11.65480	11.65530	11.65675	11.65695
MA1-4	11.73285	11.73340	11.73490	11.73525	11.73775	11.73845	11.74010	11.74040

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
MA1-1		11.74450	11.74460	11.74470	11.74480	11.74480	11.74485
MA1-2		11.69650	11.69665	11.69675	11.69675	11.69675	11.69685
MA1-3		11.65715	11.65730	11.65740	11.65755	11.65745	11.65750
MA1-4		11.74060	11.74080	11.74090	11.74100	11.74100	11.74105

SAND SAMPLE NAME: EVERIST HAWARDEN
 MIX DESIGNATION : MA1
 DATE OF MIXING : 04/27/91
 TIME OF MIXING : 4 p.m.
 FLYASH PERCENT : 10 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
MA3-1	11.72890	11.72905	11.72905	11.72920	11.72940	11.72950	11.72965	11.72970
MA3-2	11.75685	11.75695	11.75710	11.75735	11.75750	11.75760	11.75760	11.75790
MA3-3	11.68150	11.68165	11.68175	11.68200	11.68205	11.68220	11.68235	11.68235
MA3-4	11.66250	11.66265	11.66265	11.66280	11.66295	11.66320	11.66320	11.66330

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
MA3-1		11.72970	11.72975	11.72980	11.72985	11.72990	11.72995
MA3-2		11.75790	11.75805	11.75810	11.75810	11.75820	11.75830
MA3-3		11.68235	11.68240	11.68240	11.68250	11.68250	11.68255
MA3-4		11.66345	11.66350	11.63555	11.66355	11.66355	11.66360

SAND SAMPLE NAME: EVERIST HAWARDEN
 MIX DESIGNATION : MA3
 DATE OF MIXING : 04/28/91
 TIME OF MIXING : 4 p.m.
 FLYASH PERCENT : 30 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
MB1-1	11.78230	11.78295	11.78410	11.78450	11.78550	11.78575	11.78785	11.78950
MB1-2	11.71070	11.71130	11.71235	11.71275	11.71350	11.71390	11.71580	11.71765
MB1-3	11.63800	11.63900	11.64035	11.64085	11.64200	11.64260	11.64050	11.64195
MB1-4	11.69705	11.69815	11.69965	11.69995	11.70145	11.70200	11.70350	11.70535

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
MB1-1		11.79000	11.79015	11.79085	11.79025	11.79030	11.79035
MB1-2		11.71765	11.71780	11.71000	11.71785	11.71790	11.71795
MB1-3		11.64225	11.64255	11.64285	11.64290	11.64300	11.64035
MB1-4		11.70580	11.70600	11.70610	11.70615	11.70625	11.70625

SAND SAMPLE NAME: HARRY PERRY PIT
 MIX DESIGNATION : MB1
 DATE OF MIXING : 05/08/91
 TIME OF MIXING : 4 p.m.
 FLYASH PERCENT : 10 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
MB2-1	11.63150	11.63215	11.63315	11.63350	11.63395	11.63435	11.63650	11.63700
MB2-2	11.64915	11.65010	11.65110	11.65160	11.65190	11.65240	11.65480	11.65540
MB2-3	11.65840	11.65915	11.65995	11.66070	11.66095	11.66185	11.66440	11.66485
MB2-4	11.67300	11.67380	11.67495	11.67555	11.67595	11.67625	11.67820	11.67865

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
MB2-1		11.63765	11.63800	11.63825	11.63825	11.63830	11.63840
MB2-2		11.65600	11.65620	11.65635	11.65635	11.65655	11.65655
MB2-3		11.66540	11.66545	11.66560	11.66560	11.66565	11.66570
MB2-4		11.67895	11.67910	11.67945	11.67945	11.67955	11.67960

SAND SAMPLE NAME: HARRY PERRY PIT
 MIX DESIGNATION : MB2
 DATE OF MIXING : 05/08/91
 TIME OF MIXING : 6 p.m
 FLYASH PERCENT : 20 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
MB3-1	11.75500	11.75520	11.75545	11.75550	11.75565	11.75575	11.75595	11.75615
MB3-2	11.74970	11.77500	11.75015	11.75035	11.75045	11.75060	11.75065	11.75085
MB3-3	11.83510	11.83525	11.83550	11.83570	11.83585	11.83615	11.83635	11.83665
MB3-4	11.70290	11.70305	11.70325	11.70340	11.70345	11.70345	11.70355	11.70360

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
MB3-1		11.75625	11.75640	11.75655	11.75660	11.75660	11.75665
MB3-2		11.75100	11.75105	11.75105	11.75105	11.75110	11.75115
MB3-3		11.83675	11.83690	11.87050	11.83710	11.83715	11.83715
MB3-4		11.70375	11.70385	11.70395	11.70400	11.70405	11.70410

SAND SAMPLE NAME: HARRY PERRY PIT
 MIX DESIGNATION : MB3
 DATE OF MIXING : 05//09/91
 TIME OF MIXING : 5 p.m.
 FLYASH PERCENT : 30 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
MC1-1	11.70160	11.70210	11.70295	11.70345	11.70425	11.70485	11.70560	11.70575
MC1-2	11.70190	11.70235	11.70315	11.70365	11.70405	11.70505	11.70555	11.70560
MC1-3	11.72000	11.72065	11.72135	11.72205	11.72285	11.72355	11.72465	11.72485
MC1-4	11.66835	11.66905	11.66975	11.67015	11.67100	11.67165	11.67220	11.67240

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
MC1-1		11.70600	11.70615	11.70630	11.70635	11.70640	11.70640
MC1-2		11.70560	11.70585	11.70610	11.70610	11.70615	11.70620
MC1-3		11.72500	11.72510	11.72540	11.72545	11.72545	11.72550
MC1-4		11.67255	11.67280	11.67300	11.67305	11.67310	11.67315

SAND SAMPLE NAME: OPPERMAN HERRICK PIT
 MIX DESIGNATION : MC1
 DATE OF MIXING : 05/09/91
 TIME OF MIXING : 6 p.m.
 FLYASH PERCENT : 10 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
MC2-1	11.70030	11.70060	11.70100	11.70135	11.70205	11.70275	11.70350	11.70375
MC2-2	11.72625	11.72675	11.72715	11.72775	11.72855	11.72915	11.72950	11.72965
MC2-3	11.70490	11.70560	11.70585	11.70600	11.70645	11.70705	11.70735	11.70795
MC2-4	11.71880	11.71950	11.71985	11.71985	11.72015	11.72095	11.72150	11.72200

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
MC2-1		11.70375	11.70420	11.70420	11.70425	11.70435	11.70435
MC2-2		11.73000	11.73025	11.73025	11.73030	11.73035	11.73040
MC2-3		11.70855	11.70895	11.70905	11.70910	11.70910	11.70915
MC2-4		11.72200	11.72270	11.72275	11.72285	11.72285	11.72290

SAND SAMPLE NAME: OPPERMAN HERRICK PIT
 MIX DESIGNATION : MC2
 DATE OF MIXING : 05/20/91
 TIME OF MIXING : 4 p.m.
 FLYASH PERCENT : 20 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
MC3-1	11.71170	11.71190	11.71210	11.71220	11.71265	11.71295	11.71335	11.71370
MC3-2	11.71120	11.71145	11.71185	11.71205	11.71235	11.71275	11.71320	11.71345
MC3-3	11.72145	11.72165	11.72185	11.72225	11.72260	11.72270	11.72305	11.72350
MC3-4	11.69615	11.69630	11.69670	11.69700	11.69755	11.69775	11.69805	11.69835

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
MC3-1		11.71390	11.71405	11.71415	11.71420	11.71420	11.71430
MC3-2		11.71375	11.71390	11.71410	11.71415	11.71425	11.71425
MC3-3		11.72395	11.72435	11.72450	11.72450	11.72460	11.72465
MC3-4		11.69870	11.69900	11.69930	11.69935	11.69945	11.66690

SAND SAMPLE NAME: OPPERMAN HERRICK PIT
 MIX DESIGNATION : MC3
 DATE OF MIXING : 05/10/91
 TIME OF MIXING : 5.30 p.m.
 FLYASH PERCENT : 30 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
MD1-1	11.69850	11.69895	11.69965	11.69995	11.70045	11.70075	11.70135	11.70205
MD1-2	11.80045	11.80075	11.80145	11.80215	11.80235	11.80335	11.80400	11.80545
MD1-3	11.71615	11.71680	11.71790	11.71865	11.71900	11.71985	11.72080	11.72185
MD1-4	11.80035	11.80080	11.80165	11.80210	11.80265	11.80310	11.80360	11.80445

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
MD1-1		11.70245	11.70305	11.70365	11.70370	11.70375	11.70375
MD1-2		11.80595	11.80615	11.80675	11.80675	11.80685	11.80690
MD1-3		11.72195	11.72220	11.72285	11.72290	11.72300	11.72305
MD1-4		11.80545	11.80595	11.80615	11.80615	11.80620	11.80630

SAND SAMPLE NAME: EVERIST BROOKINGS
 MIX DESIGNATION : MD1
 DATE OF MIXING : 05/14/91
 TIME OF MIXING : 4 p.m.
 FLYASH PERCENT : 10 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
MD2-1	11.73620	11.73675	11.73765	11.73815	11.73885	11.73910	11.73955	11.73995
MD2-2	11.72575	11.72685	11.72730	11.72765	11.72810	11.72845	11.72925	11.73005
MD2-3	11.71060	11.71120	11.71180	11.71235	11.71300	11.71320	11.71350	11.71475
MD2-4	11.69475	11.69535	11.69595	11.69615	11.69655	11.69665	11.69715	11.69805

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
MD2-1		11.74040	11.74090	11.74150	11.74155	11.74155	11.74155
MD2-2		11.73095	11.73165	11.73205	11.73210	11.73220	11.73225
MD2-3		11.71565	11.71655	11.71655	11.71660	11.71665	11.71675
MD2-4		11.69880	11.70050	11.70050	11.70060	11.70065	11.70065

SAND SAMPLE NAME: EVERIST BROOKINGS
 MIX DESIGNATION : MD1
 DATE OF MIXING : 05/14/91
 FLYASH PERCENT : 5 p.m.
 TIME OF MIXING : 20 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
MD3-1	11.67875	11.67905	11.67940	11.67960	11.67995	11.68005	11.68035	11.68055
MD3-2	11.76055	11.76090	11.76115	11.76155	11.76170	11.76195	11.76365	11.76205
MD3-3	11.73475	11.73500	11.73520	11.73550	11.73555	11.73565	11.73565	11.73585
MD3-4	11.77670	11.77675	11.77700	11.77715	11.77750	11.77760	11.77765	11.77775

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
MD3-1		11.68055	11.68060	11.68070	11.68075	11.68085	11.68085
MD3-2		11.76220	11.76220	11.76230	11.76235	11.76240	11.76250
MD3-3		11.73605	11.73605	11.73615	11.73625	11.73635	11.73635
MD3-4		11.77775	11.77785	11.77785	11.77795	11.77800	11.77810

SAND SAMPLE NAME: EVERIST BROOKINGS
 MIX DESIGNATION : MD3
 DATE OF MIXING : 05/15/91
 TIME OF MIXING : 4 p.m.
 FLYASH PERCENT : 30 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
ME1-1	11.78335	11.78440	11.78590	11.78660	11.78705	11.78755	11.78805	11.78890
ME1-2	11.75035	11.75145	11.75230	11.75305	11.75365	11.75415	11.75440	11.75475
ME1-3	11.75450	11.75530	11.75695	11.75780	11.75835	11.75890	11.75985	11.76060
ME1-4	11.77880	11.77960	11.78065	11.78105	11.78175	11.78210	11.78265	11.78305

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
ME1-1		11.78925	11.78925	11.78960	11.78960	11.78965	11.78975
ME1-2		11.75570	11.75570	11.75640	11.75640	11.75655	11.75655
ME1-3		11.76105	11.76120	11.76145	11.76150	11.76150	11.76155
ME1-4		11.78365	11.78400	11.78460	11.78465	11.78475	11.78480

SAND SAMPLE NAME: MISSION HILLS
 MIX DESIGNATION : ME1
 DATE OF MIXING : 05/15/91
 TIME OF MIXING : 5. p.m.
 FLYASH PERCENT : 10 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
ME2-1	11.75105	11.75265	11.75310	11.75385	11.75430	11.75500	11.75560	11.75605
ME2-2	11.76840	11.77050	11.77105	11.77160	11.77245	11.77275	11.77305	11.77375
ME2-3	11.80245	11.80430	11.80565	11.80625	11.80675	11.80705	11.80795	11.80845
ME2-4	11.71880	11.71990	11.72060	11.72090	11.72185	11.72235	11.72300	11.72335

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
ME2-1		11.75640	11.75700	11.75730	11.75735	11.75740	11.75750
ME2-2		11.77405	11.77425	11.77460	11.77470	11.77475	11.77475
ME2-3		11.80895	11.80930	11.80945	11.80950	11.80960	11.80960
ME2-4		11.72375	11.72415	11.72440	11.72445	11.72455	11.72460

SAND SAMPLE NAME: MISSION HILLS
 MIX DESIGNATION : ME2
 DATE OF MIXING : 05/16/91
 TIME OF MIXING : 4 p.m.
 FLYASH PERCENT : 20 %

TABLE 15 CONTD.,

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS						
		14	30	60	90	120	150	180
ME3-1	11.72490	11.72500	11.72500	11.72535	11.72540	11.72550	11.72555	11.72565
ME3-2	11.75685	11.75705	11.75710	11.75715	11.75730	11.75735	11.75770	11.75770
ME3-3	11.69560	11.69580	11.69600	11.69610	11.69645	11.69655	11.69655	11.69660
ME3-4	11.73590	11.73605	11.73625	11.73655	11.73655	11.73655	11.73685	11.73690

SPECIMEN #	INITIAL LENGTH INCHES	LENGTH IN INCHES AT DAYS					
		210	240	270	300	330	360
ME3-1		11.72565	11.72570	11.72570	11.72575	11.72585	11.72595
ME3-2		11.75770	11.75780	11.75785	11.75795	11.75800	11.75805
ME3-3		11.69685	11.69700	11.69700	11.69705	11.69710	11.69720
ME3-4		11.73710	11.73715	11.73715	11.73720	11.73725	11.73725

SAND SAMPLE NAME: MISSION HILLS
 MIX DESIGNATION : ME3
 DATE OF MIXING : 05/16/91
 TIME OF MIXING : 5 p.m.
 FLYASH PERCENT : 30 %

TABLE 16 EXPANSIONS OF MORTAR BARS MEASURED FROM ASTM C227 METHOD WITH FLY ASH

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT DAYS												
	14	30	60	90	120	150	180	210	240	270	300	330	360
MA1-1	.006	.021	.024	.049	.052	.066	.068	.070	.071	.072	.072	.073	.073
MA1-2	.008	.021	.025	.047	.052	.063	.066	.067	.069	.070	.070	.070	.081
MA1-3	.008	.021	.026	.055	.060	.075	.077	.079	.080	.081	.082	.082	.082
MA1-4	.005	.020	.024	.049	.056	.072	.075	.077	.079	.080	.081	.081	.082
MEAN	.006	.021	.024	.050	.055	.069	.071	.073	.075	.076	.076	.076	.079
S.D.	.001	.000	.001	.003	.003	.005	.005	.005	.005	.005	.006	.006	.004
%C.V.	19.1	1.94	4.75	7.3	7.1	8.0	7.1	7.6	7.7	7.6	7.8	7.8	5.2
MA2-1	.005	.017	.023	.051	.053	.070	.071	.073	.075	.076	.077	.077	.077
MA2-2	.004	.020	.024	.048	.050	.065	.068	.070	.071	.071	.072	.072	.073
MA2-3	.006	.019	.021	.039	.041	.053	.055	.056	.057	.060	.060	.061	.061
MA2-4	.007	.017	.019	.041	.046	.061	.065	.066	.068	.070	.070	.070	.070
MEAN	.005	.018	.022	.045	.047	.062	.065	.066	.068	.069	.069	.070	.070
S.D.	.001	.001	.002	.005	.004	.007	.007	.007	.007	.006	.006	.006	.006
%C.V.	23.4	8.2	10.6	12.4	10.4	11.1	10.8	10.9	11.3	9.9	9.8	9.7	9.8
MA3-1	.001	.001	.003	.005	.006	.007	.008	.008	.008	.009	.009	.010	.010
MA3-2	.001	.002	.005	.006	.007	.007	.010	.010	.012	.012	.012	.013	.014
MA3-3	.001	.002	.005	.005	.007	.008	.008	.008	.009	.009	.010	.010	.010
MA3-4	.001	.001	.003	.003	.007	.007	.008	.009	.010	.010	.010	.010	.011
MEAN	.001	.001	.004	.004	.006	.007	.008	.009	.009	.010	.010	.011	.011
S.D.	.000	.000	.001	.001	.001	.000	.001	.001	.001	.001	.001	.001	.001
%C.V.	0.00	0.00	28.8	15.8	9.1	0.00	13.6	12.1	15.6	16.1	12.3	15.3	16.6

* - Omitted for the calculation of Mean, S.D. and %C.V.

S.D. - STANDARD DEVIATION

% C.V. - % COEFFICIENT OF VARIATION

TABLE 16 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT DAYS												
	14	30	60	90	120	150	180	210	240	270	300	330	360
MB1-1	.006	.018	.022	.032	.034	.054	.072	.077	.078	.085	.085	.086	.086
MB1-2	.006	.016	.020	.028	.032	.051	.069	.069	.071	.071	.071	.072	.072
MB1-3	.010	.023	.028	.040	.046	.025	.039	.042	.045	.048	.049	.050	.051
MB1-4	.011	.026	.029	.044	.049	.064	.083	.087	.089	.090	.091	.092	.092
MEAN	.008	.021	.025	.036	.040	.048	.066	.069	.071	.073	.074	.075	.076
S.D.	.002	.004	.004	.007	.008	.016	.018	.019	.018	.018	.018	.018	.031
%C.V.	30.5	21.3	17.5	20.2	21.1	34.5	28.2	27.8	26.2	25.4	25.2	24.8	25.4
MB2-1	.006	.016	.020	.024	.028	.050	.055	.061	.065	.067	.067	.068	.069
MB2-2	.009	.019	.024	.027	.032	.056	.062	.068	.070	.072	.073	.074	.074
MB2-3	.007	.015	.023	.025	.034	.060	.064	.070	.070	.072	.072	.072	.073
MB2-4	.008	.019	.025	.029	.032	.052	.056	.059	.061	.064	.065	.065	.066
MEAN	.007	.017	.023	.026	.032	.054	.059	.064	.066	.069	.069	.070	.070
S.D.	.001	.002	.002	.002	.002	.004	.004	.005	.004	.003	.003	.003	.003
%C.V.	15.8	11.6	10.3	8.2	7.8	8.2	7.6	7.9	6.9	5.3	5.3	5.6	5.2
MB3-1	.002	.004	.005	.006	.007	.009	.011	.012	.014	.015	.016	.016	.016
MB3-2	.003	.004	.006	.007	.009	.009	.011	.013	.013	.013	.013	.014	.014
MB3-3	.001	.004	.006	.007	.010	.012	.015	.016	.018	.019	.020	.020	.020
MB3-4	.001	.003	.005	.005	.005	.006	.007	.008	.009	.010	.011	.011	.012
MEAN	.002	.004	.005	.006	.008	.009	.011	.012	.013	.014	.015	.015	.015
S.D.	.001	.000	.001	.001	.002	.002	.003	.003	.003	.003	.003	.003	.003
%C.V.	35.1	11.6	13.3	14.1	26.2	25.7	30.5	25.9	25.2	24.3	25.3	24.5	22.6

TABLE 16 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT DAYS												
	14	30	60	90	120	150	180	210	240	270	300	330	360
MC1-1	.005	.013	.018	.026	.032	.040	.041	.044	.045	.047	.047	.048	.048
MC1-2	.004	.012	.017	.021	.031	.036	.037	.037	.039	.042	.042	.042	.043
MC1-3	.006	.013	.020	.028	.035	.046	.048	.050	.051	.054	.054	.054	.055
MC1-4	.007	.014	.018	.026	.033	.038	.040	.042	.044	.046	.047	.047	.048
MEAN	.005	.013	.018	.025	.033	.040	.041	.043	.045	.047	.047	.048	.048
S.D.	.001	.010	.001	.002	.001	.004	.004	.005	.004	.004	.005	.004	.004
%C.V.	20.7	4.7	7.0	11.5	5.1	10.7	11.5	12.4	10.4	10.4	10.7	10.2	10.1
MC2-1	.003*	.007*	.010	.017	.024	.032	.034	.034	.039	.039	.039	.040	.040
MC2-2	.005	.009	.015	.023	.029	.032	.034	.037	.040	.040	.040	.041	.041
MC2-3	.007	.009	.011	.015	.021	.024	.030	.036	.040	.041	.042	.042	.042
MC2-4	.007	.010	.010	.013	.021	.027	.032	.032	.039	.039	.040	.040	.041
MEAN	.006	.009	.011	.017	.024	.029	.032	.035	.039	.040	.040	.041	.041
S.D.	.001	.001	.002	.004	.003	.003	.001	.002	.001	.001	.001	.001	.001
%C.V.	18.2	6.1	18.5	23.5	14.6	13.4	5.6	6.9	1.8	2.7	2.5	1.7	2.0
MC3-1	.002	.004	.005	.009	.012	.016	.020	.022	.023	.024	.025	.025	.026
MC3-2	.002	.006	.008	.011	.015	.020	.022	.025	.027	.029	.029	.030	.030
MC3-3	.002	.004	.008	.011	.012	.016	.020	.025	.029	.030	.030	.031	.032
MC3-4	.001	.005	.008	.014	.016	.019	.022	.025	.028	.031	.032	.033	.033
MEAN	.002	.005	.007	.011	.014	.017	.021	.024	.027	.028	.029	.030	.030
S.D.	.000	.001	.001	.001	.001	.001	.001	.001	.002	.003	.003	.003	.003
%C.V.	20.4	24.4	22.4	15.8	13.3	10.8	5.6	6.8	9.1	10.7	10.3	11.6	10.6

TABLE 16 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT DAYS												
	14	30	60	90	120	150	180	210	240	270	300	330	360
MD1-1	.004	.011	.014*	.019	.022	.028	.035	.039	.045	.051	.052	.052	.052
MD1-2	.003*	.010*	.017	.019	.029	.035	.050	.055	.057	.063	.063	.064	.064
MD1-3	.006	.017	.025	.028	.037	.046	.057	.058	.060	.067	.067	.068	.069
MD1-4	.004	.013	.017	.023	.027	.032	.041	.051	.056	.058	.058	.058	.059
MEAN	.004	.013	.019	.022	.029	.035	.045	.050	.054	.059	.060	.060	.061
S.D.	.001	.003	.004	.004	.006	.007	.009	.008	.006	.006	.006	.006	.007
%C.V.	24.7	22.3	23.4	19.4	20.7	21.5	20.7	15.9	11.8	11.1	11.0	11.3	11.5
MD2-1	.005	.014	.019	.026	.029	.033	.037	.042	.047	.053	.053	.053	.054
MD2-2	.011*	.015	.019	.023	.027	.035	.043	.052	.059	.063	.063	.064	.065
MD2-3	.006	.012	.017	.024	.026	.029	.041	.050	.060	.059	.060	.060	.061
MD2-4	.006	.012	.014	.018	.019	.024	.033	.040	.057	.057	.058	.059	.059
MEAN	.005	.013	.017	.023	.025	.030	.038	.046	.056	.058	.058	.059	.060
S.D.	.001	.001	.002	.003	.004	.004	.004	.005	.006	.004	.004	.004	.004
%C.V.	10.1	13.1	14.1	15.5	17.2	16.3	11.5	12.6	10.9	7.1	7.0	7.6	7.3
MD3-1	.003	.006	.008	.012	.013	.016	.018	.018	.018	.019	.020	.021	.021
MD3-2	.003	.006	.010	.011	.014	.014	.015	.016	.016	.017	.018	.018	.019
MD3-3	.002	.004	.007	.008	.009	.009	.011	.013	.013	.014	.015	.016	.016
MD3-4	.000*	.003*	.004*	.008	.009	.009	.010	.010	.011	.011	.012	.013	.014
MEAN	.002	.005	.008	.009	.011	.012	.013	.014	.014	.015	.016	.017	.017
S.D.	.001	.001	.001	.002	.002	.003	.003	.003	.003	.003	.003	.003	.003
%C.V.	21.6	21.6	18.3	22.0	23.3	29.6	26.0	23.3	21.5	22.8	20.1	19.9	18.1

TABLE 16 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT DAYS												
	14	30	60	90	120	150	180	210	240	270	300	330	360
ME1-1	.010	.025	.032	.037	.042	.047	.055	.059	.059	.062	.062	.063	.064
ME1-2	.011	.018	.027	.033	.038	.040	.044	.053	.053	.060	.042	.062	.062
ME1-3	.008	.024	.033	.038	.044	.053	.061	.065	.067	.069	.070	.070	.070
ME1-4	.008	.018	.022	.029	.033	.038	.042	.048	.052	.058	.058	.059	.060
MEAN	.009	.021	.028	.034	.039	.044	.050	.056	.057	.062	.058	.063	.064
S.D.	.001	.003	.004	.004	.004	.006	.008	.007	.006	.004	.011	.004	.004
%C.V.	17.0	17.7	17.3	11.7	12.3	15.1	17.6	12.9	11.7	7.8	19.8	7.0	7.1
ME2-1	.016	.020	.028	.032	.039	.045	.050	.053	.059	.062	.063	.063	.064
ME2-2	.021	.026	.032	.040	.043	.046	.053	.056	.058	.062	.063	.063	.063
ME2-3	.018	.032*	.038	.043	.046	.055	.060	.065*	.068	.070	.070	.071	.071
ME2-4	.011*	.018	.021*	.030	.035	.042	.045	.055	.053	.056	.056	.057	.058
MEAN	.018	.021	.032	.036	.041	.047	.052	.054	.060	.062	.063	.064	.064
S.D.	.002	.004	.005	.006	.004	.005	.006	.001	.006	.005	.005	.005	.005
%C.V.	13.7	19.5	15.4	16.5	11.2	11.6	11.7	2.7	10.4	9.1	9.0	8.9	8.6
ME3-1	.001	.001*	.004	.005	.006*	.006	.007	.007	.008	.008	.008	.009	.010
ME3-2	.002	.002	.003*	.004*	.005*	.008	.008	.008	.009	.010	.011	.011	.012
ME3-3	.002	.004	.005	.008	.009	.009	.010	.012	.014	.014	.014	.015	.016
ME3-4	.001	.003	.006	.006	.006	.009	.010	.012	.012	.012	.013	.013	.013
MEAN	.001	.003	.005	.006	.007	.008	.009	.010	.011	.011	.011	.012	.013
S.D.	.000	.001	.001	.001	.001	.001	.001	.002	.002	.002	.002	.002	.002
%C.V.	29.4	33.3	2.0	24.1	24.7	16.6	13.3	24.6	24.8	23.8	22.1	19.3	18.0

TABLE 17** EXPANSIONS OF MORTAR BARS MEASURED FROM ASTM C227 METHOD WITHOUT FLY ASH

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT DAYS												
	14	30	60	90	120	150	180	210	240	270	300	330	360
M1A-1	.006	.022	.025	.053	.055	.072	.073	.075	.077	.077	.080	.081	.084
M1A-2	.003*	.013*	.018*	.033	.036	.058	.061	.062	.065	.067	.070	.073	.075
M1A-3	.009	.016	.022	.036	.036	.066	.068	.069	.071	.073	.073	.077	.079
M1A-4	.009	.021	.034	.043	.045	.050	.051	.054	.056	.056	.057	.061	.063
MEAN	.008	.019	.027	.041	.043	.061	.063	.065	.067	.068	.070	.073	.075
S.D.	.001	.003	.006	.009	.009	.010	.009	.009	.009	.009	.009	.009	.009
%C.V.	21.6	16.3	23.1	21.8	21.4	15.9	15.0	13.7	13.4	13.7	13.6	11.8	12.2
M2A-1	.008	.020	.025	.032	.036	.065	.072	.076	.075	.076	.077	.080	.083
M2A-2	.009	.020	.029	.039	.039	.046	.050	.052	.054	.055	.056	.057	.060
M2A-3	.007	.020	.029	.039	.041	.048	.059	.062	.065	.069	.070	.073	.077
M2A-4	.014*	.027	.039	.045	.048	.061	.095*	.099*	.100*	.103*	.105*	.109*	.114*
MEAN	.008	.022	.030	.039	.041	.055	.060	.063	.064	.066	.067	.070	.073
S.D.	.001	.004	.006	.005	.005	.009	.011	.012	.010	.010	.010	.011	.011
%C.V.	12.5	16.6	19.7	13.8	11.9	17.3	18.3	19.0	16.2	16.0	15.8	16.8	16.2
M3A-1	.011	.012*	.016*	.024*	.028*	.042	.043	.045	.049	.051	.052	.056	.061
M3A-2	.008*	.016	.017	.026	.028	.035	.036	.037	.039	.041	.043	.045	.048
M3A-3	.017	.028	.034	.046	.047	.068*	.070	.071	.073	.075	.076	.078	.079
M3A-4	.013	.022	.026	.039	.041	.052	.054	.056	.057	.060	.062	.065	.067
MEAN	.013	.022	.025	.037	.038	.043	.051	.052	.054	.057	.058	.061	.063
S.D.	.003	.006	.008	.010	.009	.008	.015	.015	.014	.014	.014	.014	.013
%C.V.	22.3	27.6	33.1	27.4	25.1	19.8	29.4	28.2	26.5	25.6	24.2	23.1	20.4

** - Table from reference No. 9

* - omitted for calculation of Mean, S.D. and % C.V.

TABLE 17 CONTD.,

SPECIMEN #	MEAN PERCENTAGE EXPANSION AT DAYS												
	14	30	60	90	120	150	180	210	240	270	300	330	360
M6A-1	.012	.022	.025	.029	.036	.045	.084	.086	.098	.100	.102	.103	.105
M6A-2	.012	.016	.027	.037	.043	.054	.064	.072	.084	.089	.092	.096	.101
M6A-3	.005*	.016	.027	.037	.040	.052	.075	.079	.103	.108	.112	.118	.122
MEAN	.012	.018	.026	.034	.039	.050	.074	.079	.095	.099	.102	.106	.109
S.D.	.000	.004	.001	.005	.004	.005	.010	.007	.010	.010	.010	.011	.011
%C.V.	0.00	20.3	4.47	14.4	9.02	9.64	13.5	8.56	10.4	9.68	10.1	10.9	10.3
M7A-1	.013*	.023*	.032*	.039*	.042*	.045*	.056*	.057*	.058*	.061*	.063*	.067*	.068*
M7A-2	.018	.044	.067	.080	.083	.086	.098	.098	.099	.102	.106	.108	.112
M7A-3	.014	.053*	.065	.084	.088	.089	.109	.110	.112	.115	.118	.122	.125
M7A-4	.015	.036	.051	.070	.074	.076	.085	.087	.090	.092	.096	.098	.102
MEAN	.015	.040	.061	.078	.081	.083	.097	.098	.100	.103	.106	.109	.113
S.D.	.002	.005	.008	.007	.007	.006	.012	.011	.011	.011	.011	.012	.011
%C.V.	13.2	14.1	14.2	9.2	8.6	8.1	12.3	11.6	11.0	11.1	10.3	11.0	10.2

TABLE 18** EXPANSIONS OF MORTAR BARS WITH AND WITHOUT FLY
ASH FROM ASTM P214 TEST METHOD

SPECIMEN #	PERCENTAGE EXPANSION			
	3 DAYS	7 DAYS	11 DAYS	14 DAYS
M1R-1	0.023	0.056	0.131	0.157
M1R-2	0.032	0.049*	0.149	0.174
M1R-3	0.025	0.069	0.143	0.185
M1R-4	0.024	0.080	0.150	0.191
MEAN	0.026	0.068	0.143	0.177
S.D.	0.004	0.012	0.009	0.015
% C.V.	16.5	17.5	5.95	8.50
M2R-1	0.072	0.176	0.224	0.247
M2R-2	0.070	0.175	0.220	0.249
M2R-3	0.081	0.188	0.216	0.245
M2R-4	0.078	0.188	0.222	0.249
MEAN	0.075	0.181	0.220	0.248
S.D.	0.005	0.007	0.003	0.002
% C.V.	7.05	3.90	1.49	0.77
M3R-1	0.039	0.069	0.176	0.197
M3R-2	0.028	0.085	0.193	0.218
M3R-3	0.021*	0.092	0.178	0.223
M3R-4	0.035	0.100	0.179	0.231
MEAN	0.034	0.086	0.181	0.217
S.D.	0.005	0.013	0.008	0.014
% C.V.	16.3	15.5	4.42	6.59
M6R-1	0.043	0.062	0.115	0.159
M6R-2	0.060	0.079	0.147	0.165
M6R-3	0.051	0.082	0.118	0.152
M6R-4	0.058	0.085	0.139	0.175
MEAN	0.053	0.077	0.130	0.163
S.D.	0.008	0.011	0.016	0.010
% C.V.	15.0	13.7	12.3	5.98
M7R-1	0.028	0.145	0.248	0.298
M7R-2	0.069	0.106	0.204	0.236
M7R-3	0.068	0.149	0.263	0.292
M7R-4	0.017*	0.106*	0.219	0.248
MEAN	0.055	0.133	0.233	0.268
S.D.	0.023	0.023	0.027	0.031
% C.V.	42.5	17.8	11.5	11.6

** - Table from reference from No. 9

* - Omitted for the calculation of Mean, S.D. and %C.V.

TABLE 18 CONTD.,

SPECIMEN #	PERCENTAGE EXPANSION			
	3 DAYS	7 DAYS	11 DAYS	14 DAYS
M1B-1	0.006	0.030*	0.059	0.073
M1B-2	0.002*	0.019	0.052	0.069
M1B-3	0.017	0.018	0.029	0.069
MEAN	0.011	0.018	0.055	0.070
S.D.	0.007	0.007	0.004	0.002
% C.V.	67.6	3.8	8.9	3.31
M2B-1	0.045	0.152	0.187	0.219
M2B-2	0.038	0.170	0.204	0.245
M2B-3	0.043	0.139	0.159	0.206
MEAN	0.042	0.153	0.183	0.223
S.D.	0.003	0.016	0.023	0.020
% C.V.	7.99	10.3	12.3	9.03
M3B-1	0.017	0.064	0.076	0.089
M3B-2	0.010	0.094	0.142	0.162
M3B-3	0.017	0.098	0.138	0.167
M3B4	0.010	0.070	0.130	0.166
MEAN	0.013	0.081	0.121	0.146
S.D.	0.004	0.017	0.031	0.038
% C.V.	29.2	21.0	25.2	26.0
M6B-1	0.015*	0.021*	0.041	0.067
M6B-2	0.004	0.009	0.020*	0.036*
M6B-3	0.002	0.012	0.034	0.044
MEAN	0.003	0.016	0.037	0.055
S.D.	0.001	0.006	0.004	0.016
% C.V.	47.1	38.5	13.1	29.3
M7B-1	0.007	0.034	0.076	0.093
M7B-2	0.002*	0.052	0.106	0.132
M7B-3	0.019	0.045	0.092	0.115
MEAN	0.013	0.043	0.091	0.113
S.D.	0.008	0.009	0.015	0.019
% C.V.	65.2	21.0	16.2	17.1
M1C-1	0.014*	0.021	0.031	0.043
M1C-2	0.005	0.009*	0.010*	0.013*
M1C-3	0.010	0.018	0.021	0.025
M1C4	0.002*	0.010	0.015	0.026
MEAN	0.012	0.016	0.022	0.031
S.D.	0.002	0.005	0.005	0.010
% C.V.	23.5	34.8	36.1	32.2

TABLE 18 CONTD.,

SPECIMEN #	PERCENTAGE EXPANSION			
	3 DAYS	7 DAYS	11 DAYS	14 DAYS
M2C-1	0.007	0.041	0.051	0.053
M2C-2	0.004	0.016*	0.016*	0.031*
M2C-3	0.034*	0.049	0.050	0.052
M2C-4	0.007	0.038	0.051	0.052
MEAN	0.006	0.042	0.050	0.052
S.D.	0.001	0.005	0.001	0.001
% C.V.	28.8	13.3	1.1	1.1
M3C-1	0.010	0.011*	0.015*	0.021
M3C-2	0.013	0.018	0.021	0.024
M3C-3	0.013	0.020	0.023	0.025
MEAN	0.012	0.019	0.022	0.023
S.D.	0.002	0.001	0.001	0.002
% C.V.	14.4	7.4	6.4	9.12
M6C-1	0.007	0.016	0.020	0.031
M6C-2	0.053*	0.054*	0.056*	0.075*
M6C-3	0.001*	0.021	0.023	0.036
M6C-4	0.011	0.020	0.023	0.031
MEAN	0.009	0.019	0.022	0.032
S.D.	0.002	0.002	0.001	0.002
% C.V.	31.4	13.9	7.8	8.8
M7C-1	0.013	0.017	0.019	0.021
M7C-2	0.007	0.008	0.011	0.013
M7C-3	0.046*	0.052*	0.060*	0.063*
MEAN	0.009	0.011	0.015	0.017
S.D.	0.003	0.005	0.005	0.005
% C.V.	31.5	47.2	37.7	33.2
M1D-1	0.001	0.002	0.007	0.008
M1D-2	0.002	0.004	0.010	0.013
M1D-3	0.005*	0.005*	0.010	0.010
MEAN	0.001	0.004	0.009	0.010
S.D.	0.001	0.001	0.002	0.003
% C.V.	47.1	15.7	21.8	25.0

TABLE 18 CONTD.,

SPECIMEN #	PERCENTAGE EXPANSION			
	3 DAYS	7 DAYS	11 DAYS	14 DAYS
M2D-1	0.006*	0.017*	0.026*	0.027*
M2D-2	0.004	0.010	0.016	0.018
M2D-3	0.003	0.010	0.014	0.017
MEAN	0.003	0.010	0.015	0.017
S.D.	0.001	0.000	0.001	0.001
% C.V.	20.2	0.00	9.4	4.0
M3D-1	0.014*	0.019*	0.021*	0.025*
M3D-2	0.004	0.010	0.012	0.018
M3D-3	0.004	0.008	0.011	0.012
MEAN	0.004	0.009	0.011	0.015
S.D.	0.000	0.001	0.001	0.004
% C.V.	0.00	15.7	6.1	28.2
M6D-1	0.001*	0.005	0.005	0.007
M6D-2	0.003	0.007	0.009	0.011
M6D-3	0.003	0.004	0.006	0.007
MEAN	0.003	0.005	0.006	0.008
S.D.	0.000	0.001	0.002	0.002
% C.V.	0.00	26.5	29.9	27.2
M7D-1	0.002*	0.004*	0.008*	0.012
M7D-2	0.004	0.007	0.009	0.012
M7D-3	0.005	0.007	0.008	0.008*
M7D-4	0.003	0.005	0.013	0.030*
MEAN	0.004	0.006	0.010	0.012
S.D.	0.001	0.001	0.002	0.000
% C.V.	2.5	18.2	26.4	0.00

**TABLE 19 COMPRESSIVE STRENGTH OF CUBES WITHOUT AND WITH
DIFFERENT PERCENTAGES OF FLY ASH**

SP. #	AGE (days)	DIMENSIONS length breadth (in) (in)		COMPRESSIVE STRENGTH (psi)
C0-1	3	2	2	1750
C0-2	3	2	2	1620
C0-3	3	2	2	1850
MEAN				1740
S.D.				115.32
C.V.				0.066
C0-4	7	2	2	4050
C0-5	7	2	2	2950
C0-6	7	2	2	3750
MEAN				3583
S.D.				568.62
C.V.				0.158
C0-7	28	2	2	5450
C0-8	28	2	2	5570
C0-9	28	2	2	4720
MEAN				5246
S.D.				460.03
C.V.				0.087
C0-10	56	2	2	6500
C0-11	56	2	2	8770
C0-12	56	2	2	5900
MEAN				7056
S.D.				1513.81
C.V.				0.214

S.D. - Standard Deviation
C.V. - Coefficient of variation

TABLE 19 CONTD.,

SP. #	AGE (days)	DIMENSIONS length breadth (in) (in)		COMPRESSIVE STRENGTH (psi)
C1-1	3	2	2	1350
C1-2	3	2	2	1120
C1-3	3	2	2	1400
MEAN				1290
S.D.				149.33
C.V.				0.115
C1-4	7	2	2	4320
C1-5	7	2	2	4100
C1-6	7	2	2	3820
MEAN				4080
S.D.				250.59
C.V.				0.061
C1-7	28	2	2	6370
C1-8	28	2	2	6220
C1-9	28	2	2	6200
MEAN				6263
S.D.				92.91
C.V.				0.014
C1-10	56	2	2	6170
C1-11	56	2	2	7270
C1-12	56	2	2	5820
MEAN				6420
S.D.				756.63
C.V.				0.117

S.D. - Standard Deviation
C.V. - Coefficient of variation

TABLE 19 CONTD.,

SP. #	AGE (days)	DIMENSIONS length breadth (in) (in)		COMPRESSIVE STRENGTH (psi)
C2-1	3	2	2	900
C2-2	3	2	2	1120
C2-3	3	2	2	1250
MEAN				1090
S.D.				176.91
C.V.				0.162
C2-4	7	2	2	3750
C2-5	7	2	2	3620
C2-6	7	2	2	2750
MEAN				3373
S.D.				543.72
C.V.				0.161
C2-7	28	2	2	5920
C2-8	28	2	2	5150
C2-9	28	2	2	4600
MEAN				5123
S.D.				810.32
C.V.				0.158
C2-10	56	2	2	6720
C2-11	56	2	2	6270
C2-12	56	2	2	7650
MEAN				6880
S.D.				703.77
C.V.				0.102

S.D. - Standard Deviation

C.V. - Coefficient of variation

TABLE 19 CONTD.,

SP. #	AGE (days)	DIMENSIONS		COMPRESSIVE STRENGTH (psi)
		length (in)	breadth (in)	
C3-1	3	2	2	1300
C3-2	3	2	2	2120
C3-3	3	2	2	1570
MEAN				1663
S.D.				417.89
C.V.				0.251
C3-4	7	2	2	4370
C3-5	7	2	2	4500
C3-6	7	2	2	4450
MEAN				4440
S.D.				65.57
C.V.				0.014
C3-7	28	2	2	3250
C3-8	28	2	2	3370
C3-9	28	2	2	4300
MEAN				3640
S.D.				574.71
C.V.				0.157
C3-10	56	2	2	7500
C3-11	56	2	2	4350
C3-12	56	2	2	6270
MEAN				6040
S.D.				1587.54
C.V.				0.262

S.D. - Standard Deviation
C.V. - Coefficient of variation

TABLE 19 CONTD.,

SP. #	AGE (days)	DIMENSIONS		COMPRESSIVE STRENGTH (psi)
		length (in)	breadth (in)	
C4-1	3	2	2	2220
C4-2	3	2	2	1750
C4-3	3	2	2	2350
MEAN				2106
S.D.				315.64
C.V.				0.149
C4-4	7	2	2	3370
C4-5	7	2	2	4100
C4-6	7	2	2	2750
MEAN				3406
S.D.				675.74
C.V.				0.198
C4-7	28	2	2	4150
C4-8	28	2	2	4570
C4-9	28	2	2	5270
MEAN				4663
S.D.				565.80
C.V.				0.121
C4-10	56	2	2	8420
C4-11	56	2	2	7770
C4-12	56	2	2	7120
MEAN				7770
S.D.				650.00
C.V.				0.083

S.D. - Standard Deviation
C.V. - Coefficient of variation

TABLE 19 CONTD.,

SP. #	AGE (days)	DIMENSIONS		COMPRESSIVE STRENGTH (psi)
		length (in)	breadth (in)	
C5-1	3	2	2	3120
C5-2	3	2	2	2900
C5-3	3	2	2	2900
MEAN				2973
S.D.				127.01
C.V.				0.042
C5-4	7	2	2	3920
C5-5	7	2	2	3820
C5-6	7	2	2	4050
MEAN				3930
S.D.				115.32
C.V.				0.029
C5-7	28	2	2	5520
C5-8	28	2	2	6220
C5-9	28	2	2	6570
MEAN				6103
S.D.				534.63
C.V.				0.087
C5-10	56	2	2	7620
C5-11	56	2	2	7550
C5-12	56	2	2	7900
MEAN				7190
S.D.				685.05
C.V.				0.095

S.D. - Standard Deviation
C.V. - Coefficient of variation

TABLE 19 CONTD.,

SP. #	AGE (days)	DIMENSIONS		COMPRESSIVE STRENGTH (psi)
		length (in)	breadth (in)	
C6-1	3	2	2	2000
C6-2	3	2	2	1700
C6-3	3	2	2	1870
MEAN				1858
S.D.				150.69
C.V.				0.081
C6-4	7	2	2	3820
C6-5	7	2	2	3950
C6-6	7	2	2	3300
MEAN				3690
S.D.				343.94
C.V.				0.093
C6-7	28	2	2	5570
C6-8	28	2	2	6970
C6-9	28	2	2	5020
MEAN				5853
S.D.				1005.40
C.V.				0.171
C6-10	56	2	2	6770
C6-11	56	2	2	7420
C6-12	56	2	2	6400
MEAN				6863
S.D.				516.36
C.V.				0.075

S.D. - Standard Deviation

C.V. - Coefficient of variation

TABLE 19 CONTD.,

SP. #	AGE (days)	DIMENSIONS		COMPRESSIVE STRENGTH (psi)
		length (in)	breadth (in)	
C7-1	3	2	2	2870
C7-2	3	2	2	1700
C7-3	3	2	2	2320
MEAN				2296
S.D.				585.34
C.V.				0.254
C7-4	7	2	2	2820
C7-5	7	2	2	2070
C7-6	7	2	2	3970
MEAN				2953
S.D.				956.99
C.V.				0.324
C7-7	28	2	2	5200
C7-8	28	2	2	6020
C7-9	28	2	2	6670
MEAN				5963
S.D.				736.63
C.V.				0.123
C7-10	56	2	2	7670
C7-11	56	2	2	7870
C7-12	56	2	2	5900
MEAN				7146
S.D.				1084.26
C.V.				0.151

S.D. - Standard Deviation
C.V. - Coefficient of variation

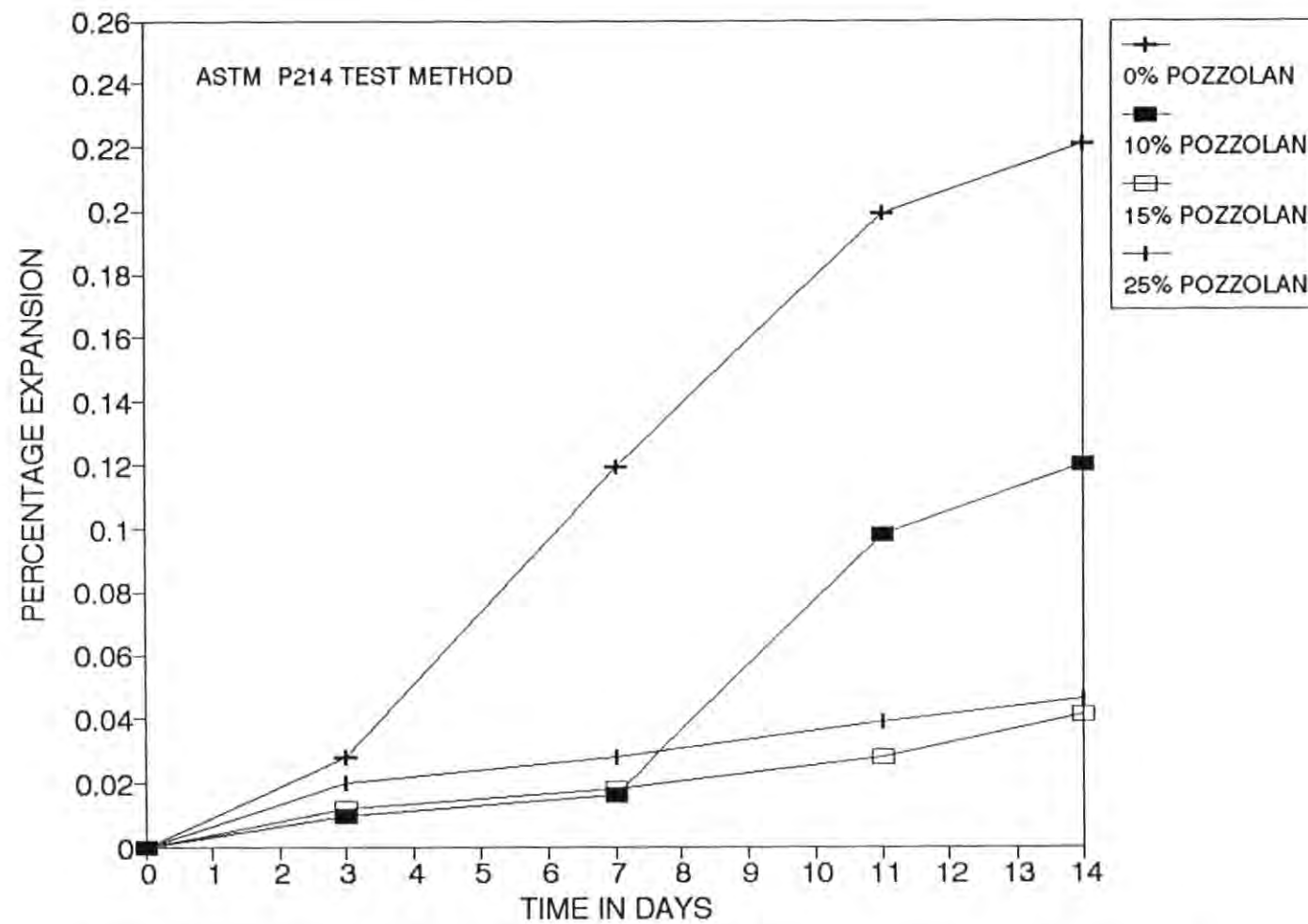


FIGURE 1 COMPARISON OF MORTAR BAR EXPANSION FOR SM2

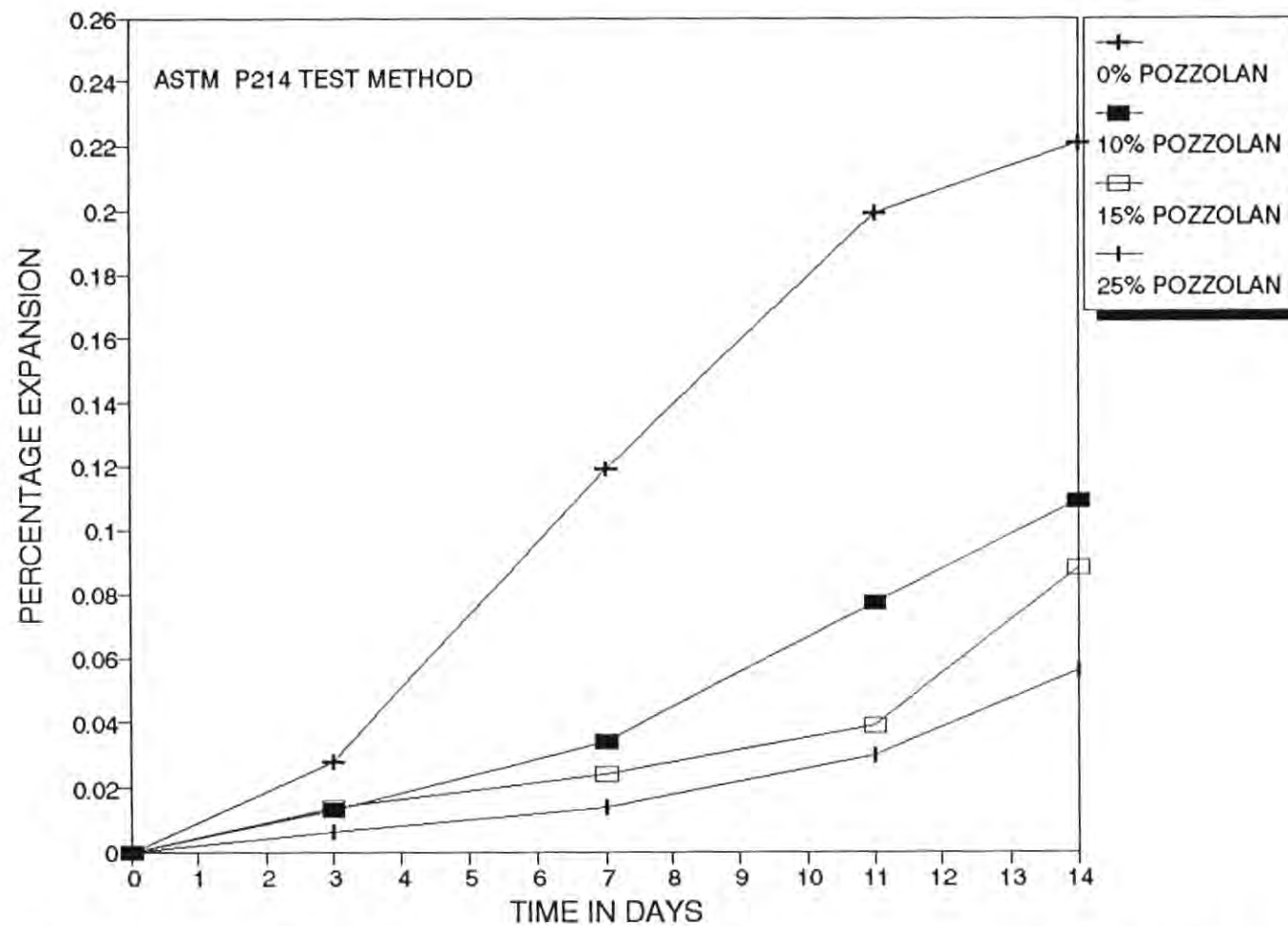


FIGURE 2 COMPARISON OF MORTAR BAR EXPANSION FOR CB1

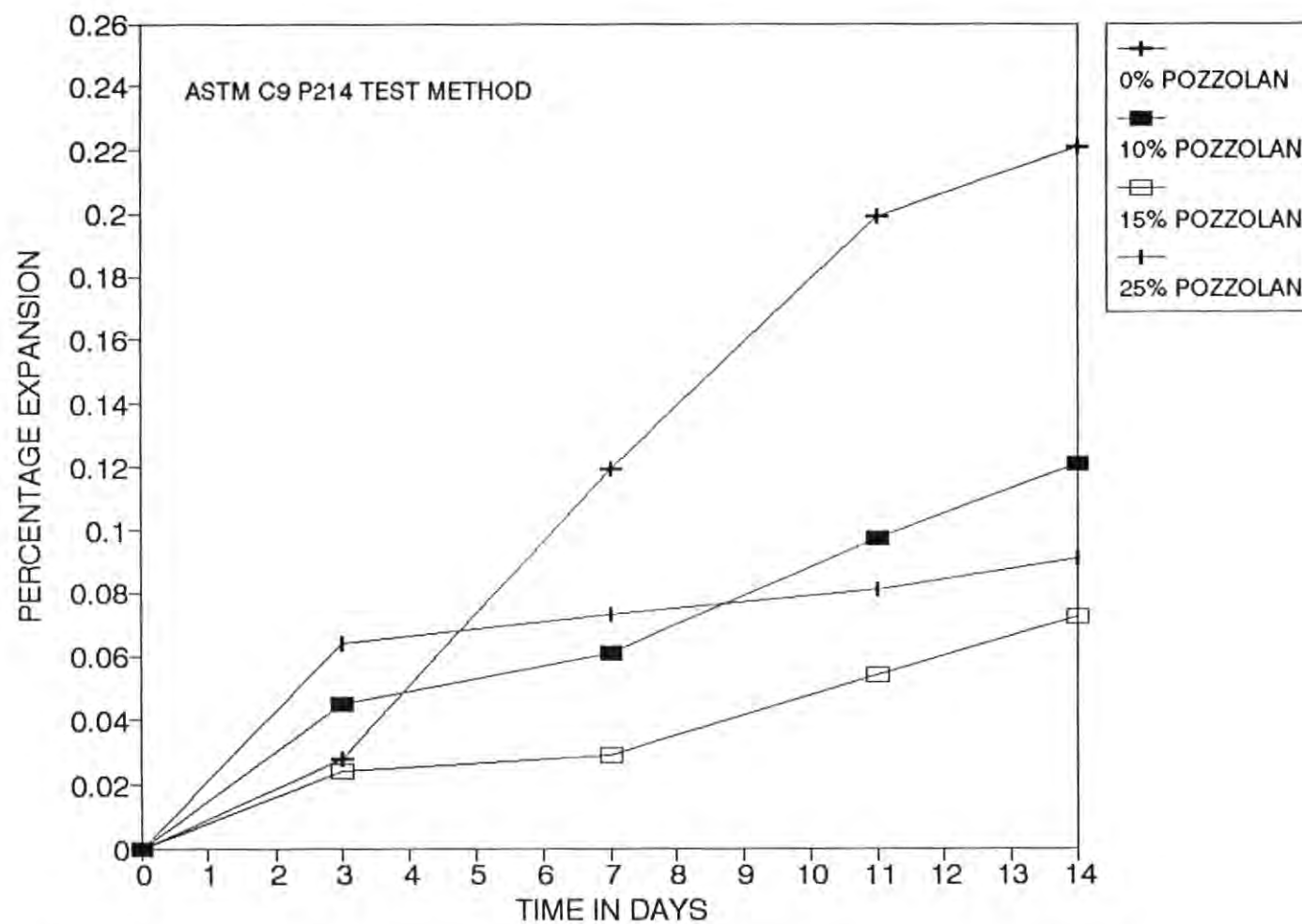


FIGURE 3 COMPARISON OF MORTAR BAR EXPANSION FOR CT1

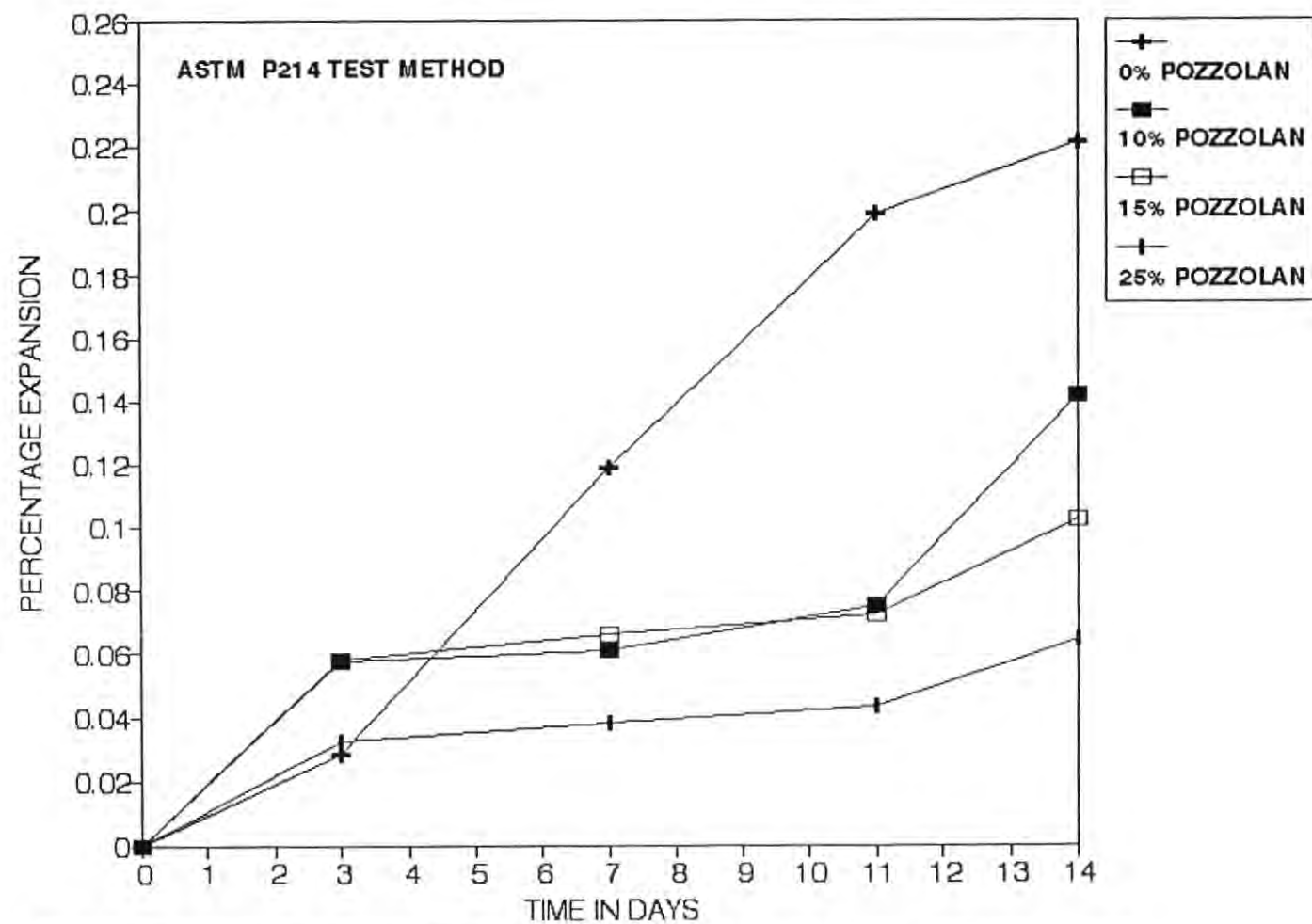


FIGURE 4 COMPARISON OF MORTAR BAR EXPANSION FOR MW1

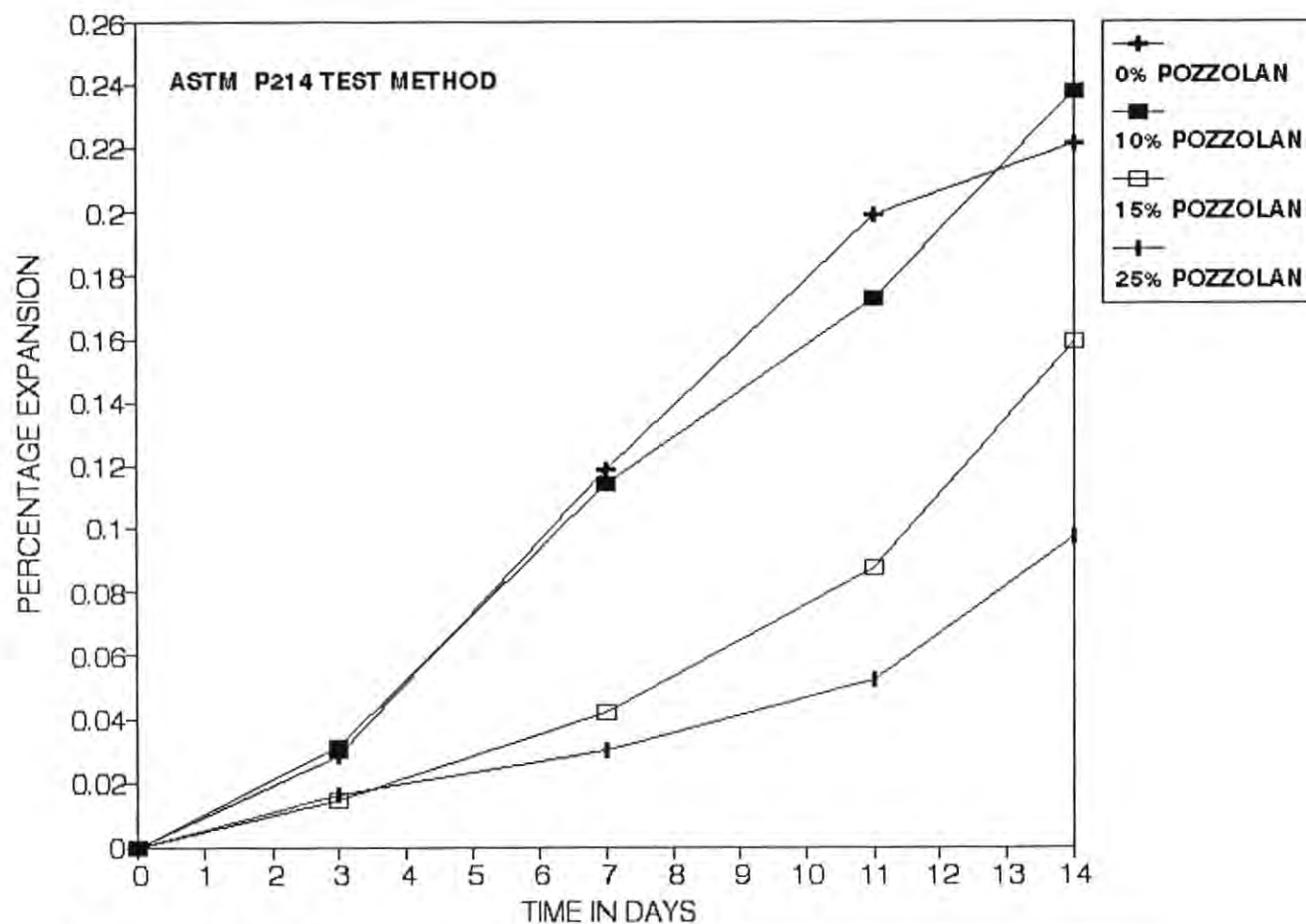


FIGURE 5 COMPARISON OF MORTAR BAR EXPANSION FOR PRC1

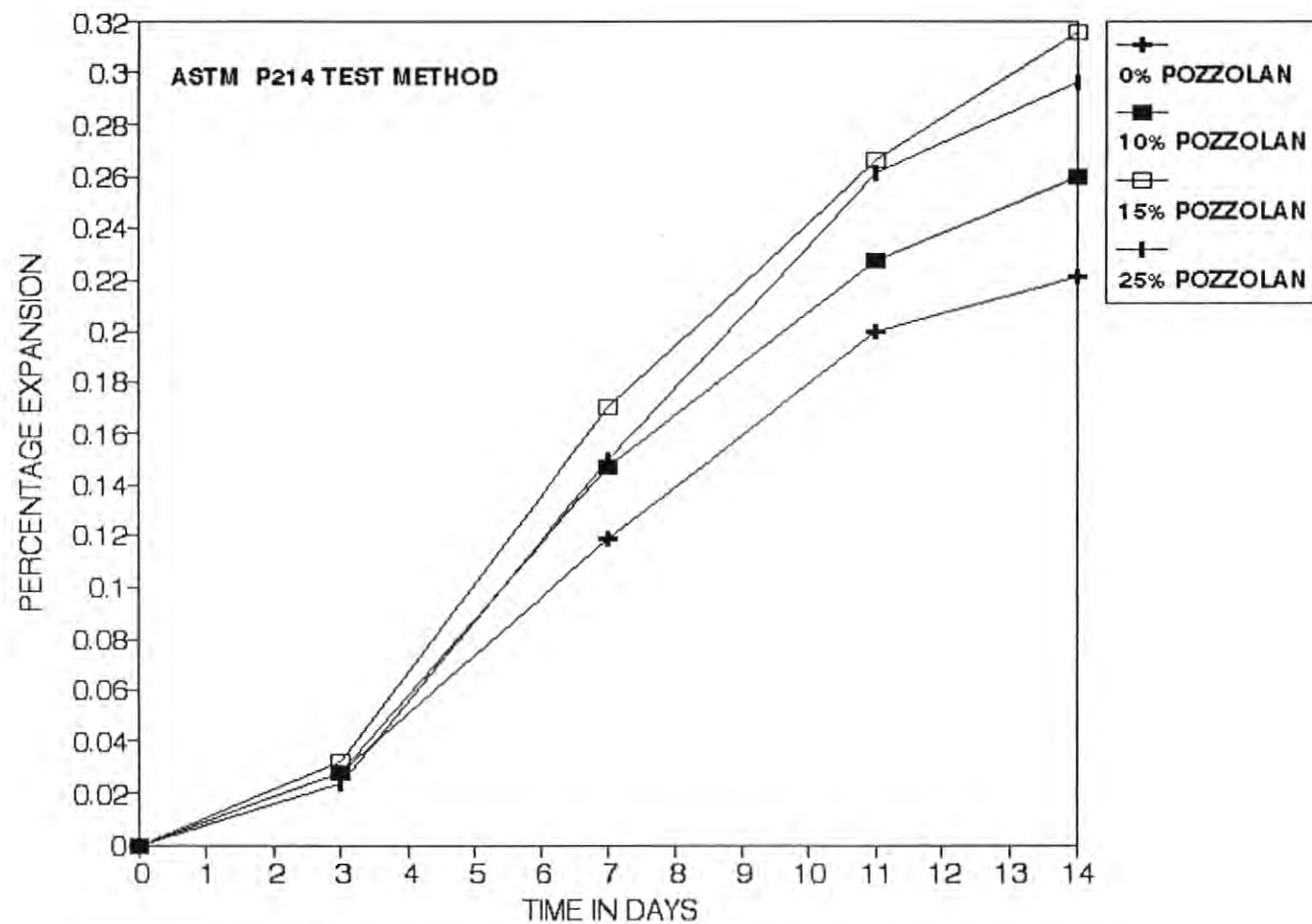


FIGURE 6 COMPARISON OF MORTAR BAR EXPANSION FOR VA2

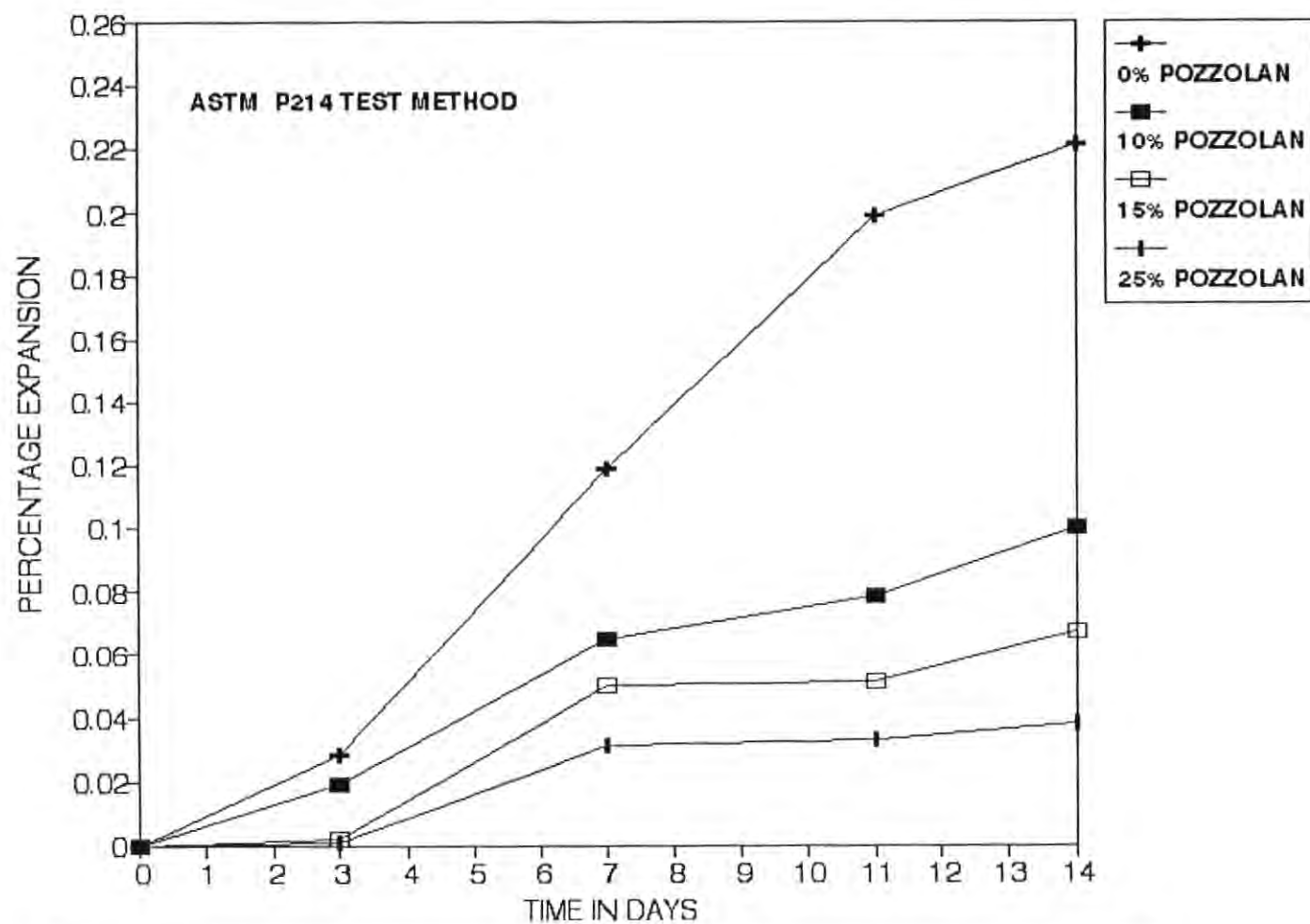


FIGURE 7 COMPARISON OF MORTAR BAR EXPANSION FOR PS1E

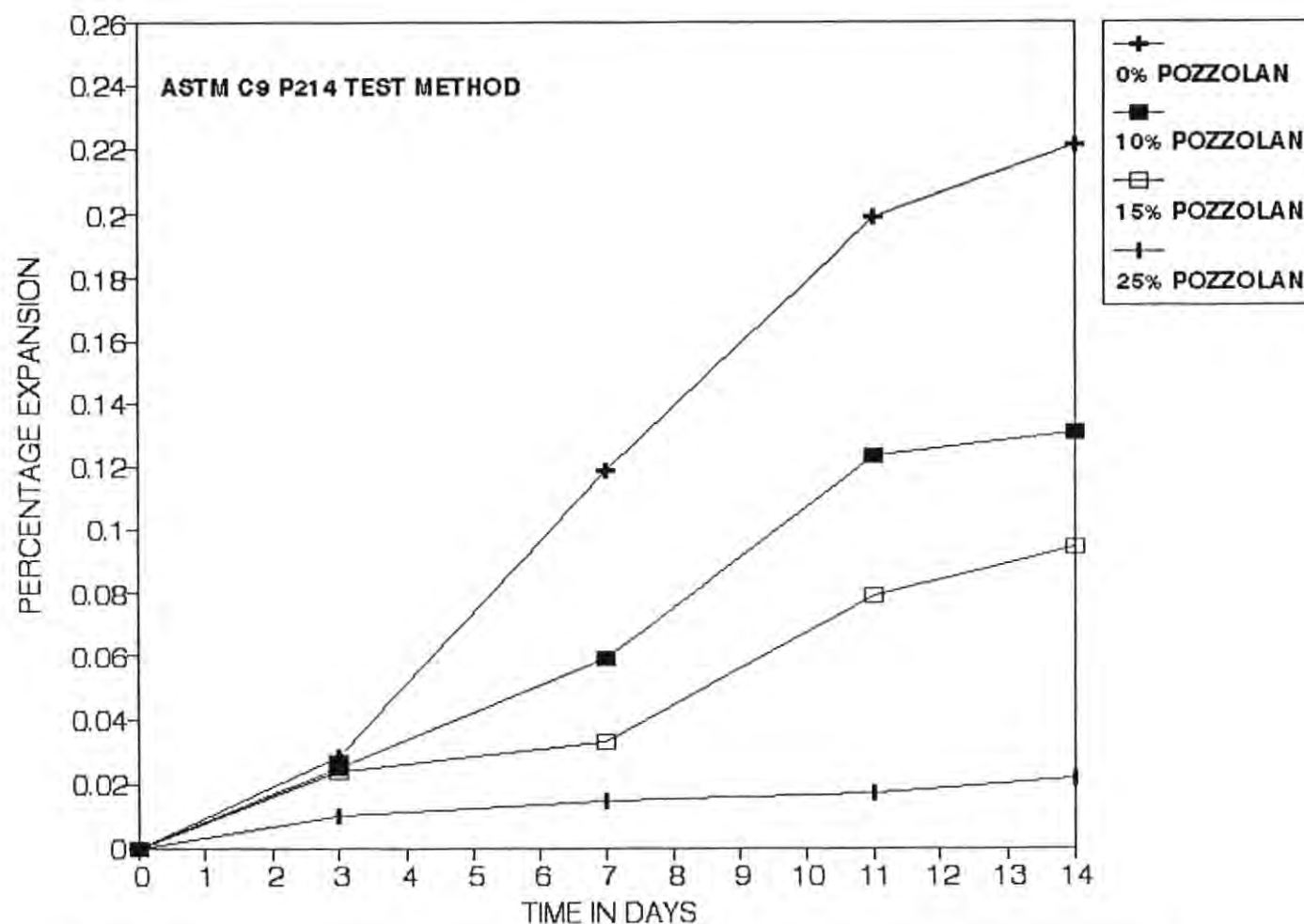


FIGURE 8 COMPARISON OF MORTAR BAR EXPANSION FOR US1

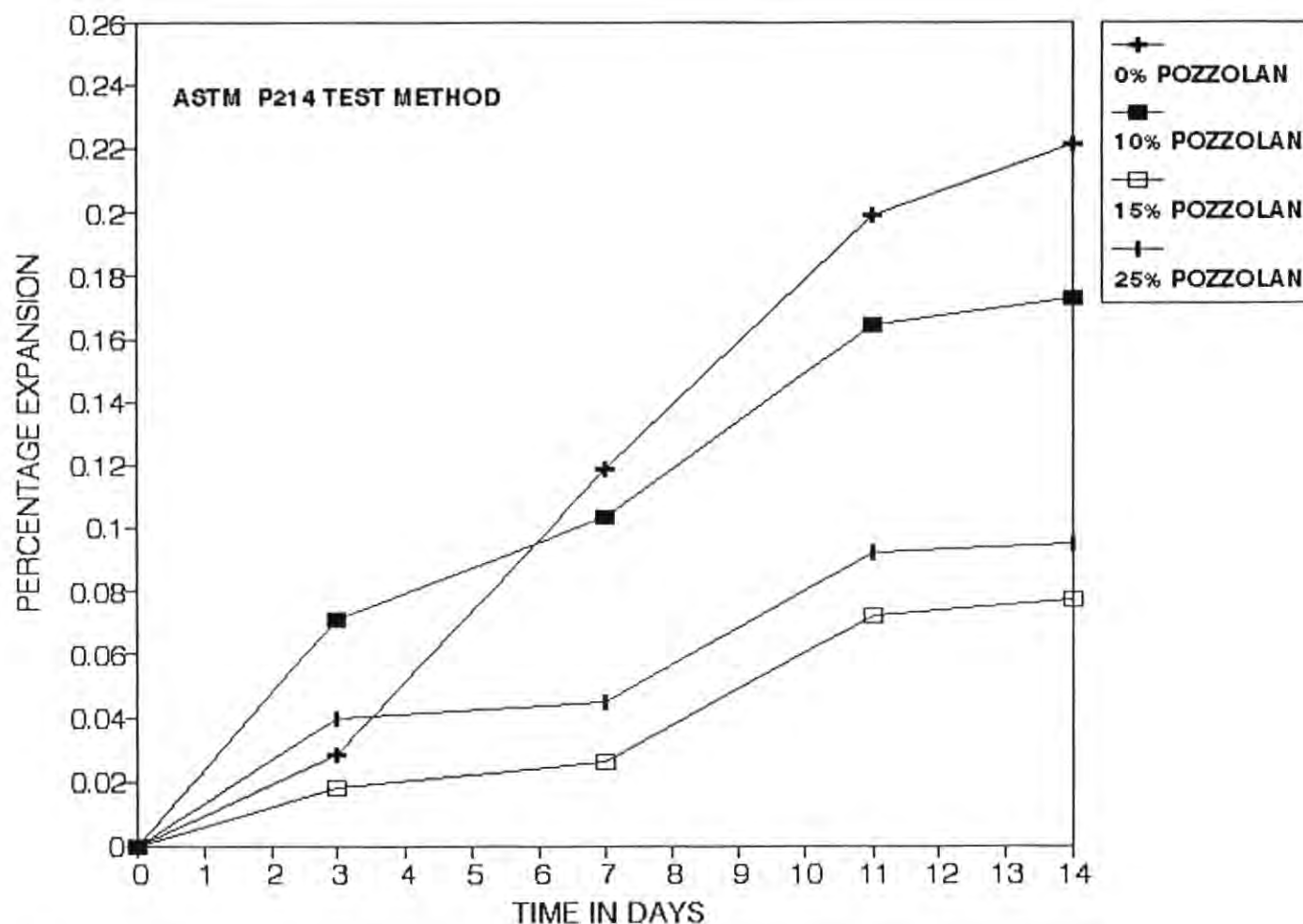


FIGURE 9 COMPARISON OF MORTAR BAR EXPANSION FOR F3

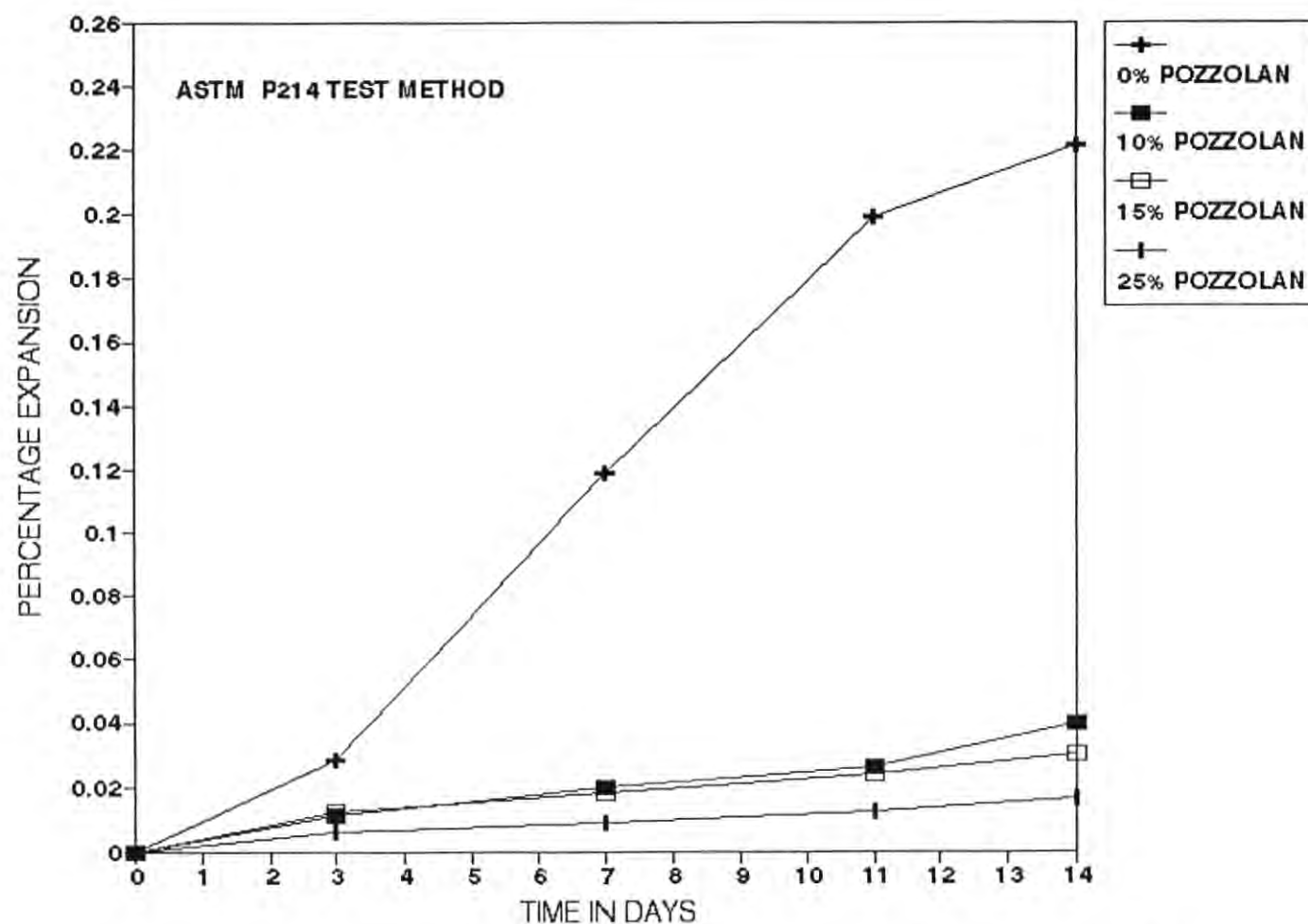


FIGURE 10 COMPARISON OF MORTAR BAR EXPANSION FOR LK2

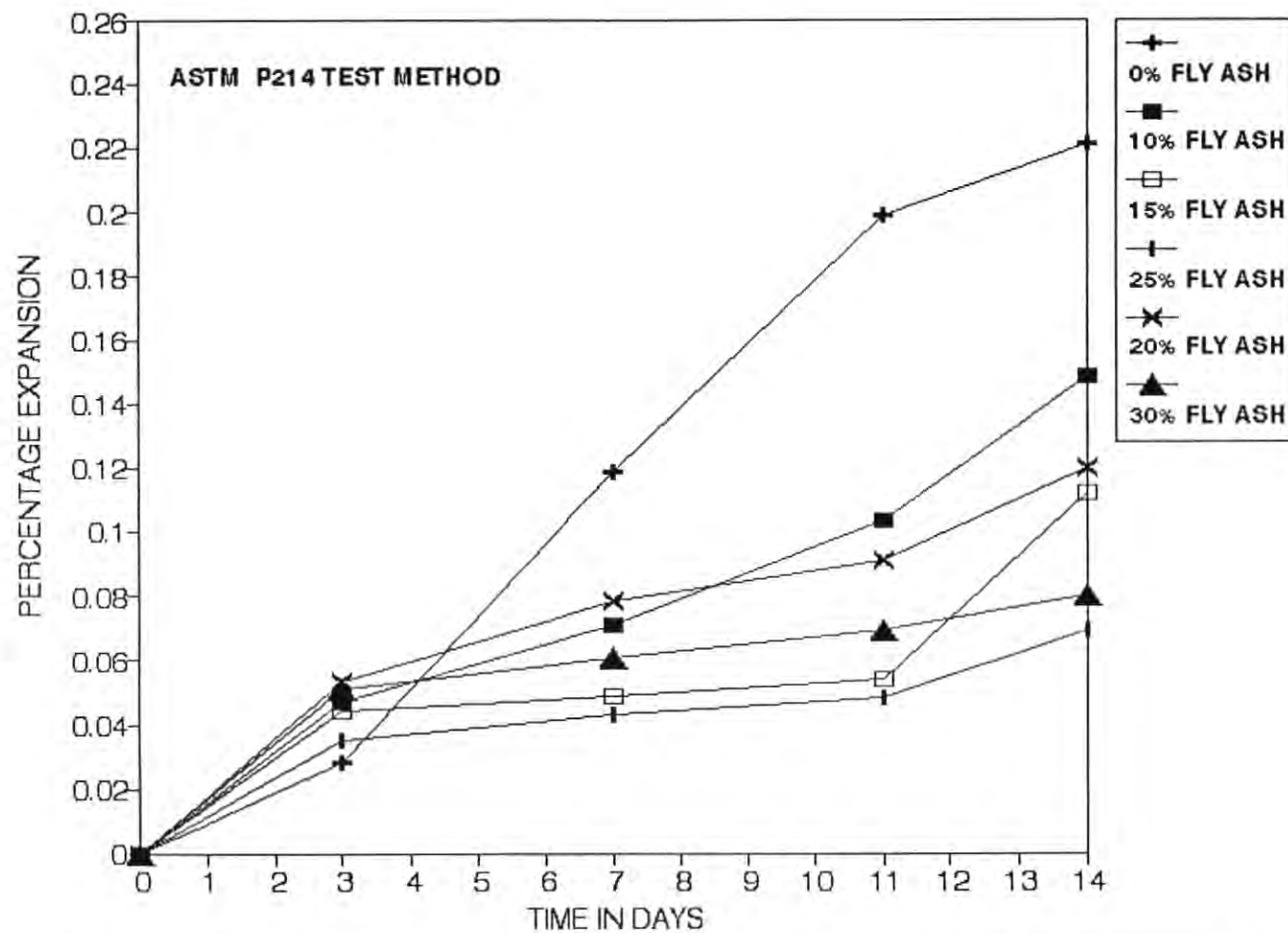


FIGURE 11 COMPARISON OF MORTAR BAR EXPANSION FOR FLY ASH

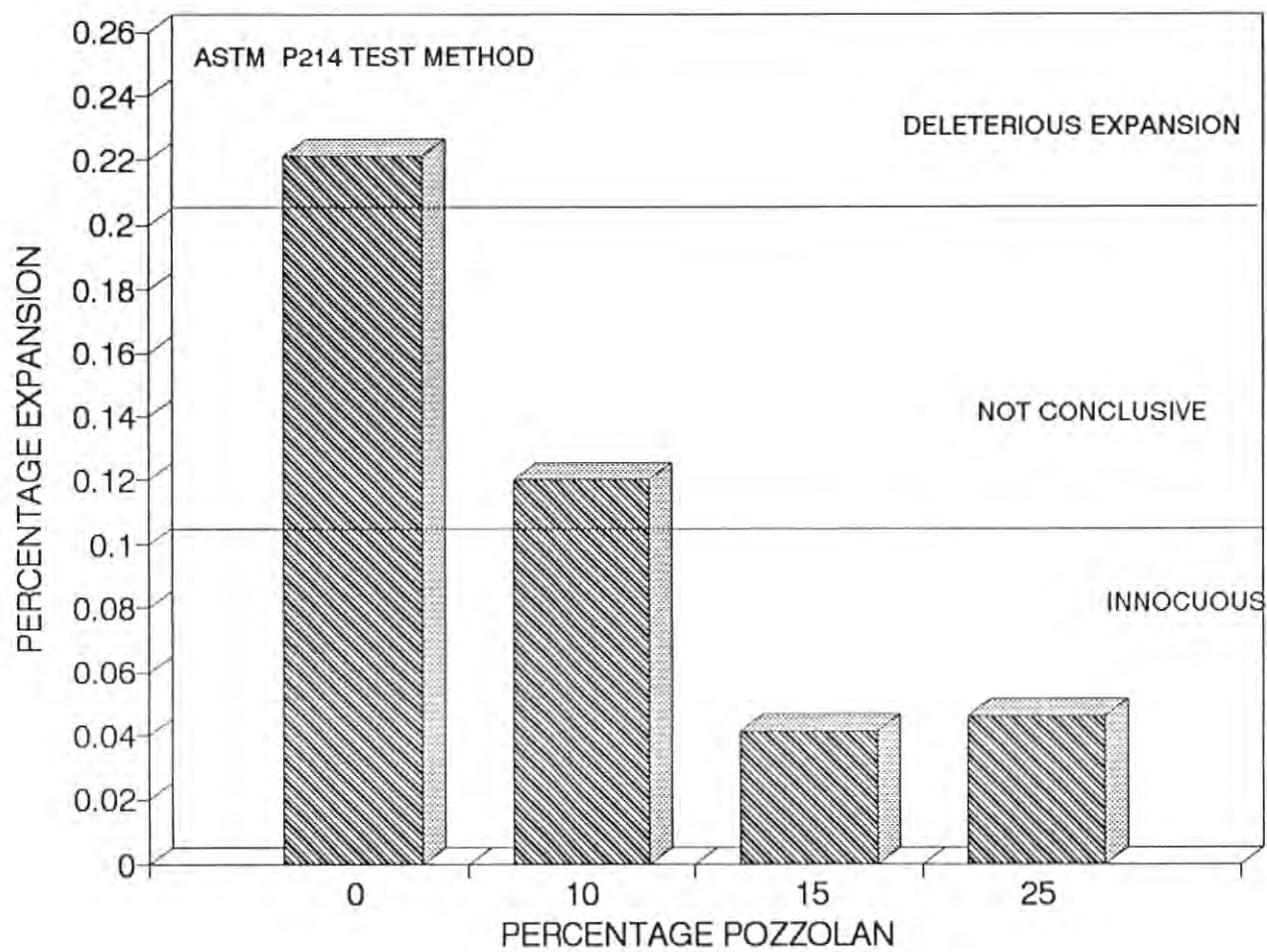


FIGURE 12 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE SM2

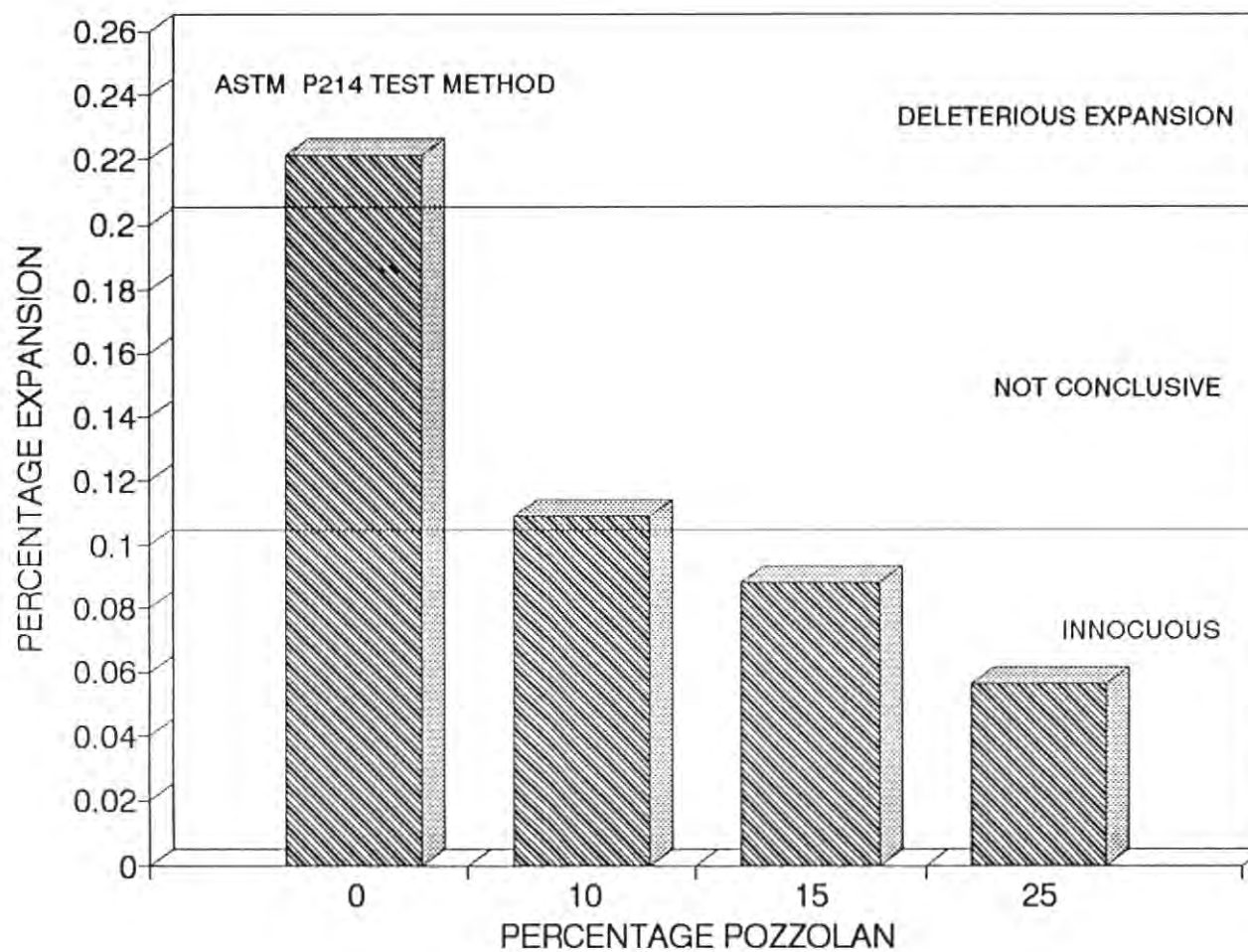


FIGURE 13 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE CB1

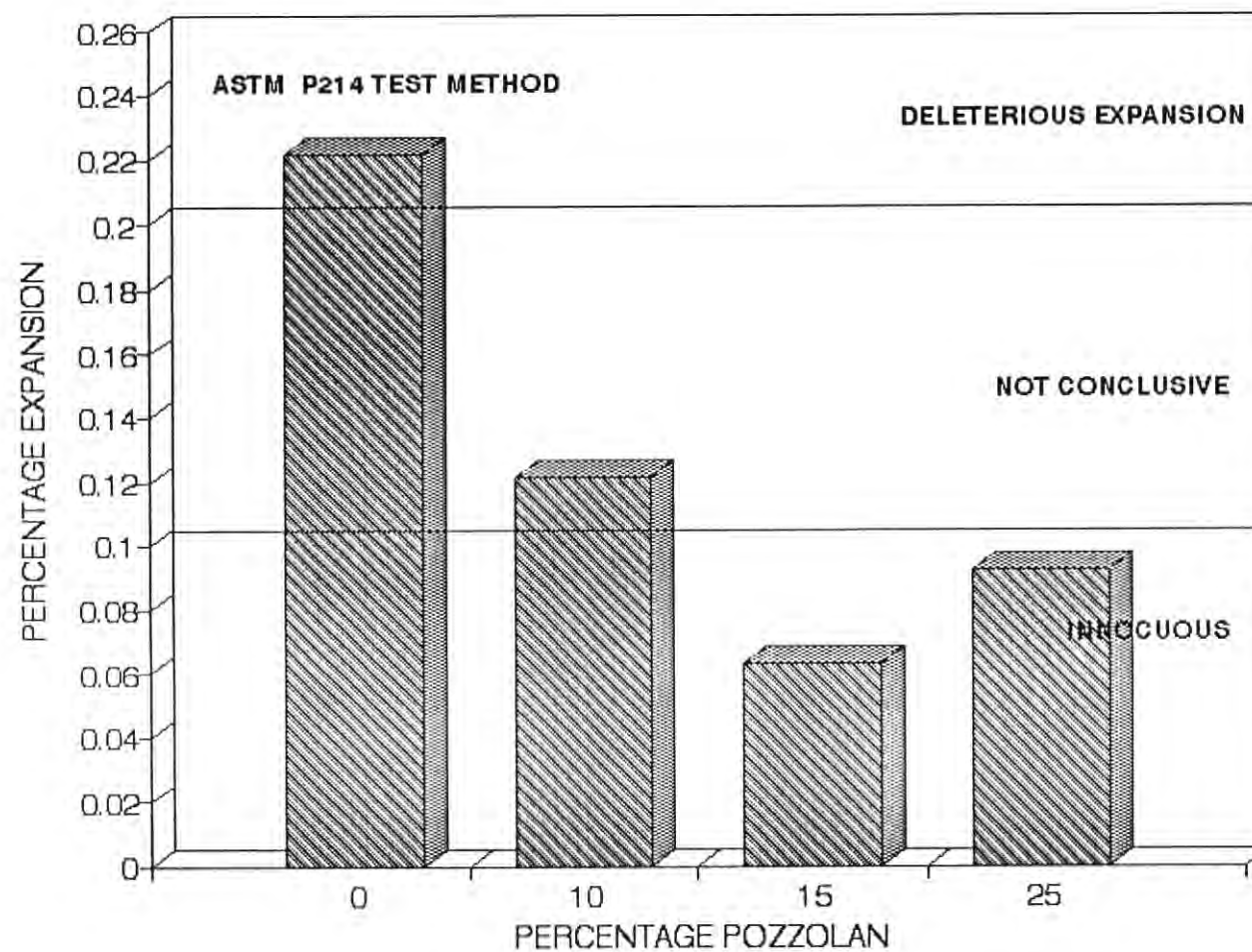


FIGURE 14 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE CT1

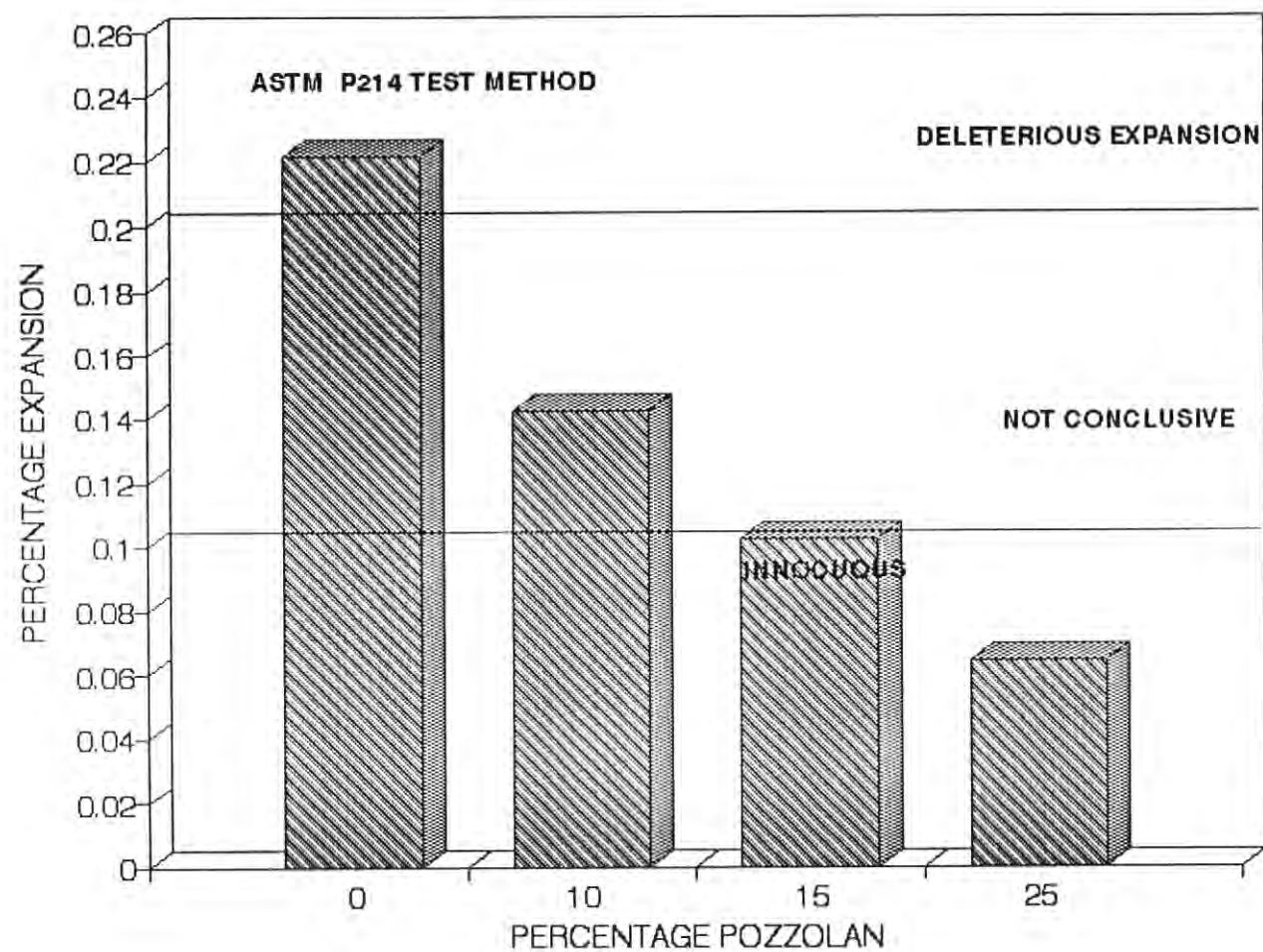


FIGURE 15 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE MW1

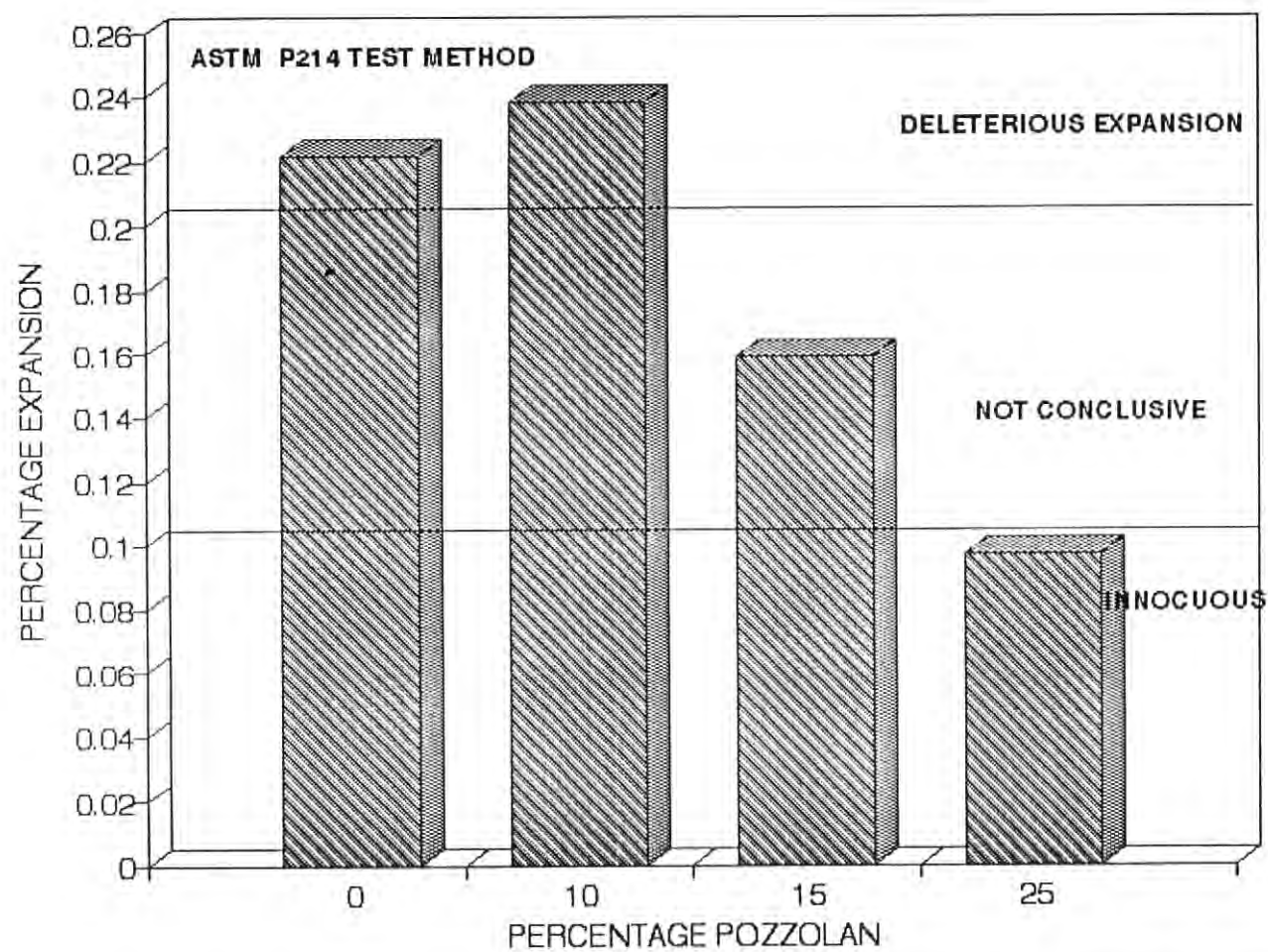


FIGURE 16 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE PRC1

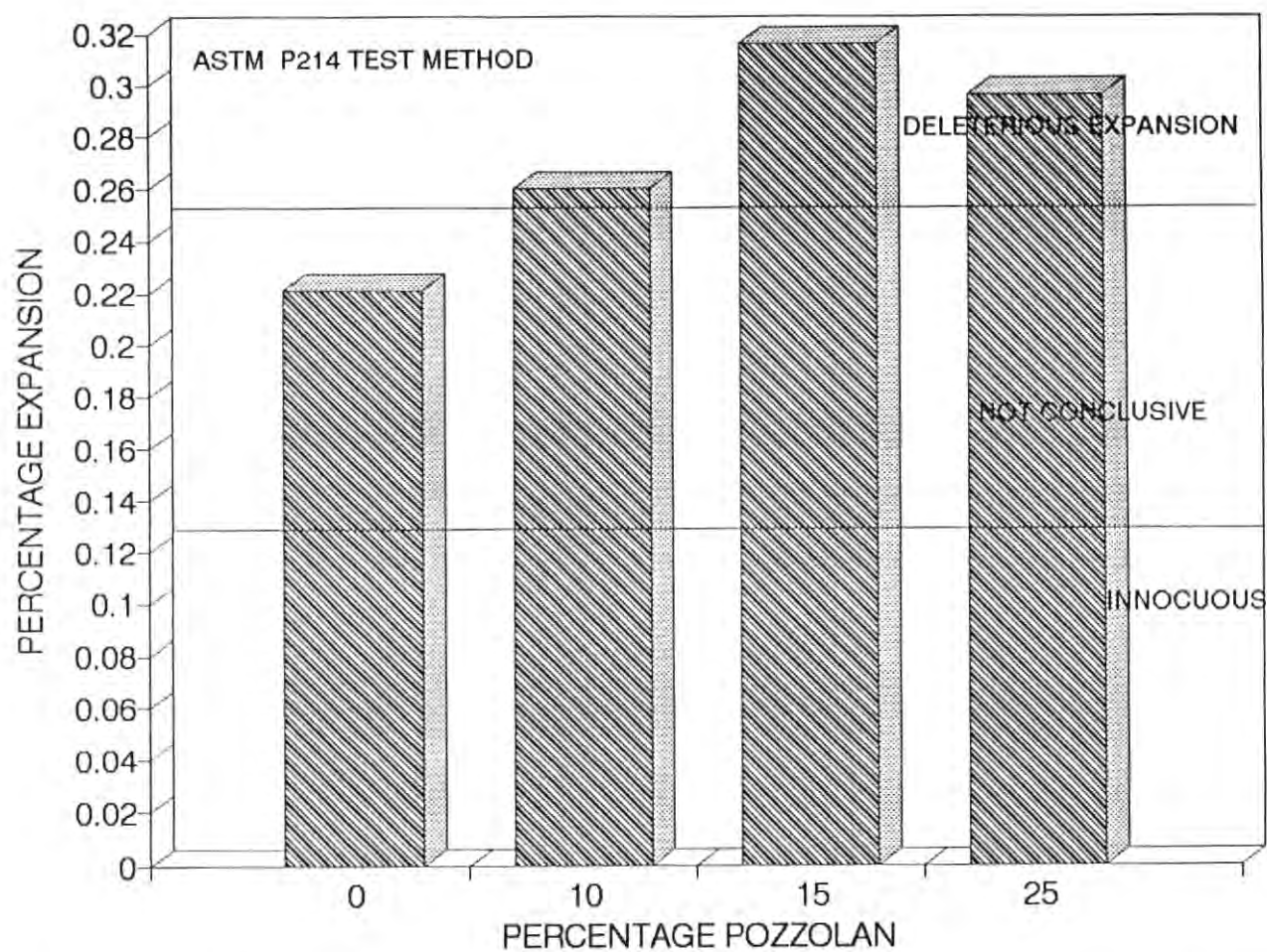


FIGURE 17 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE VA2

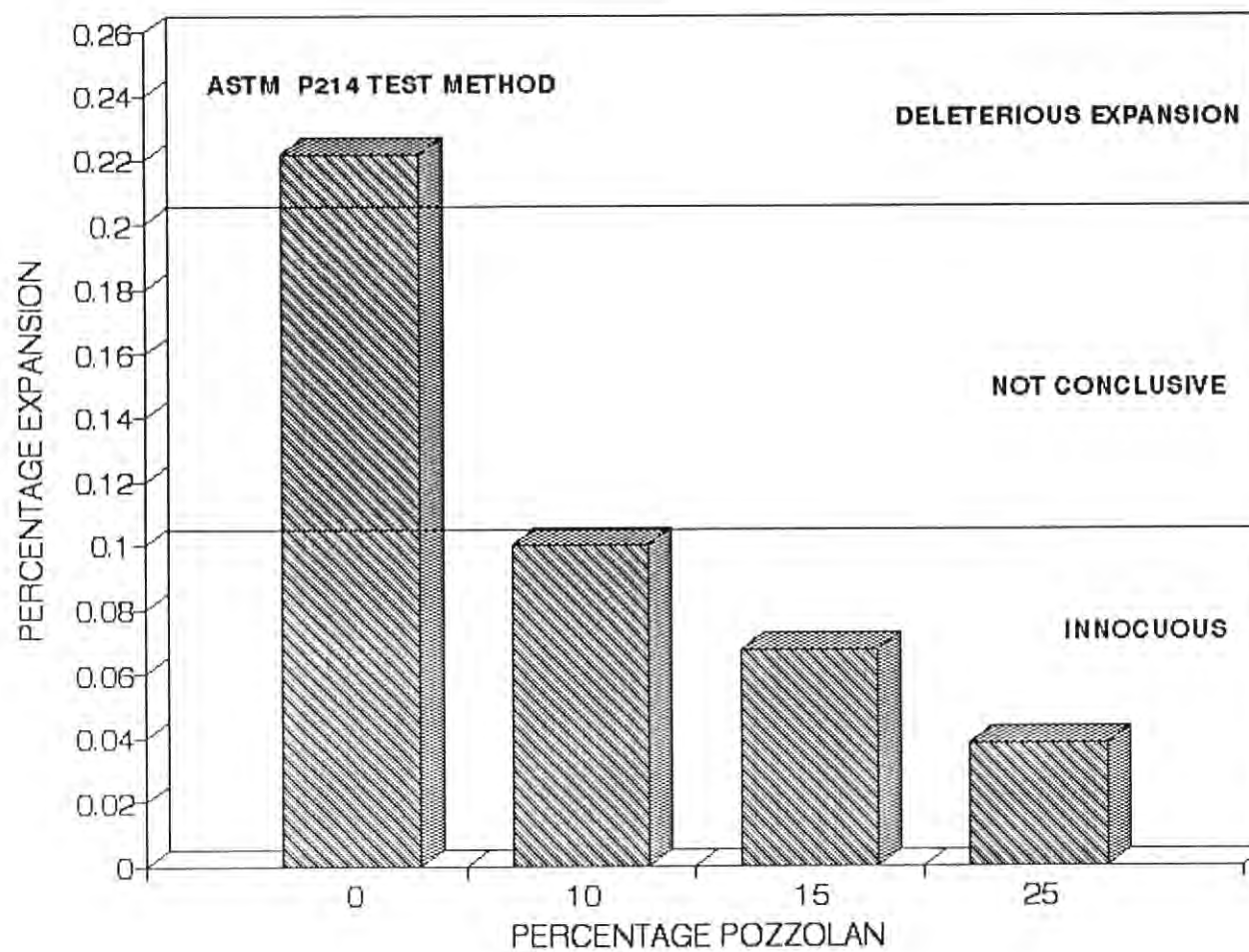


FIGURE 18 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE PS1E

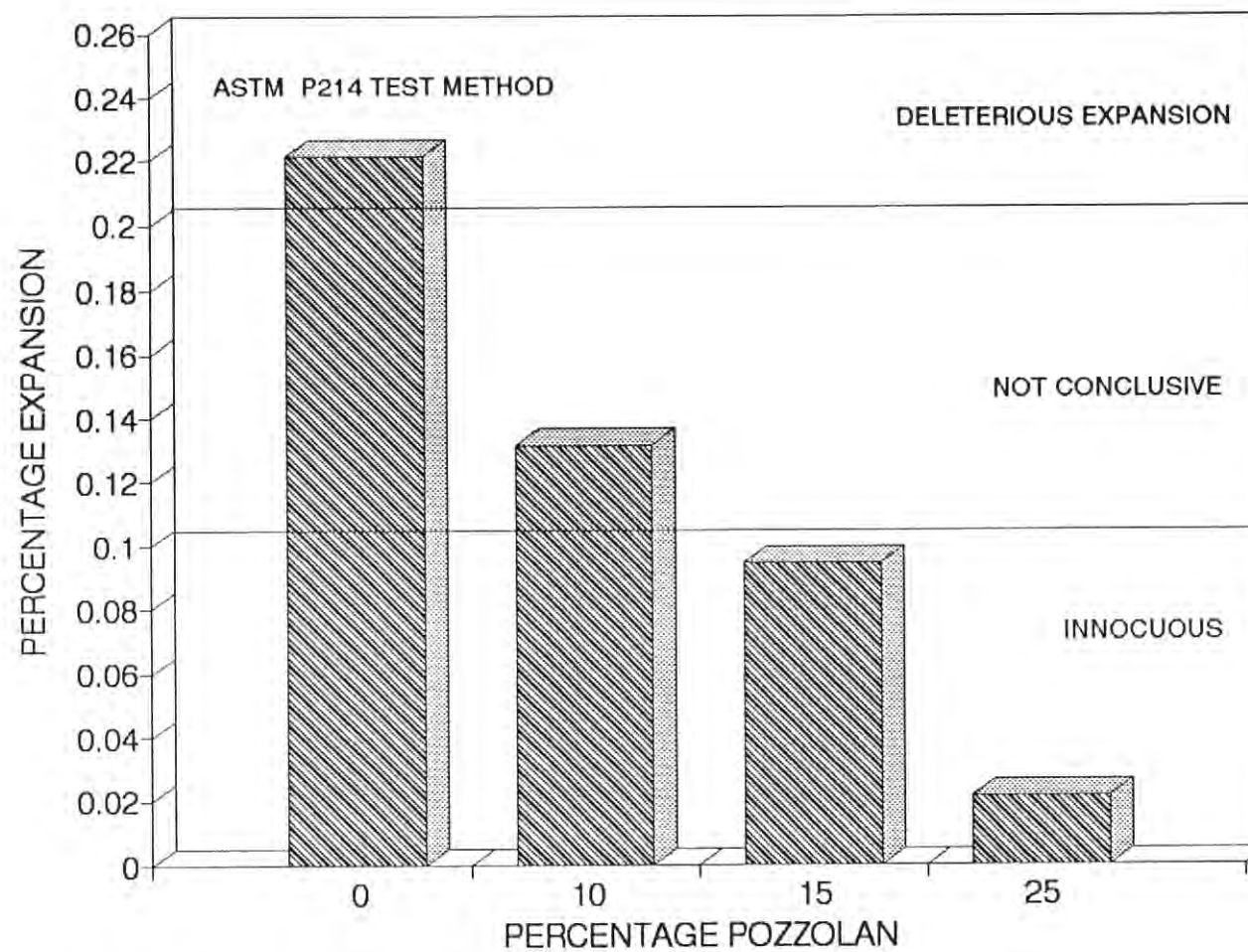


FIGURE 19 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE US1

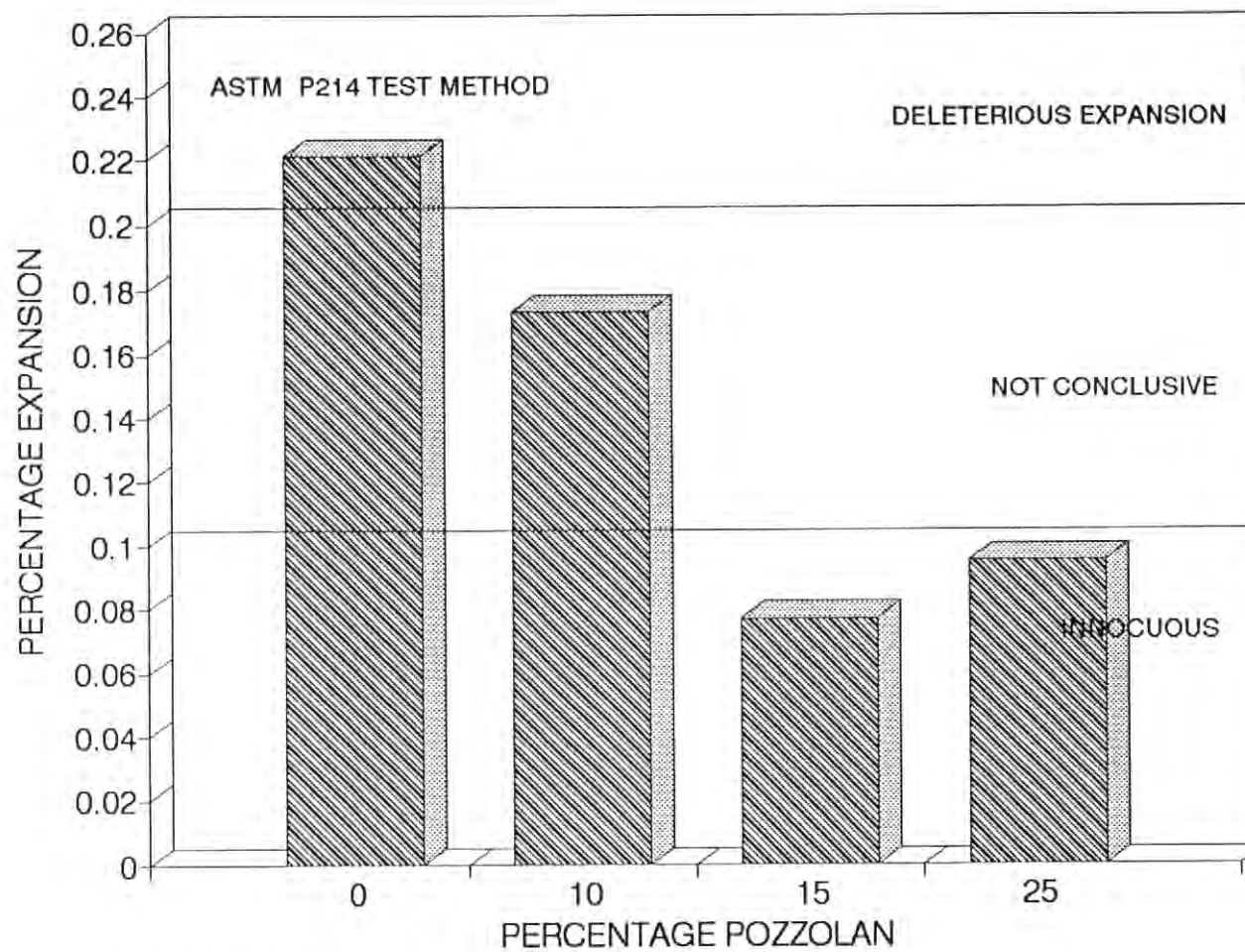


FIGURE 20 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE F3

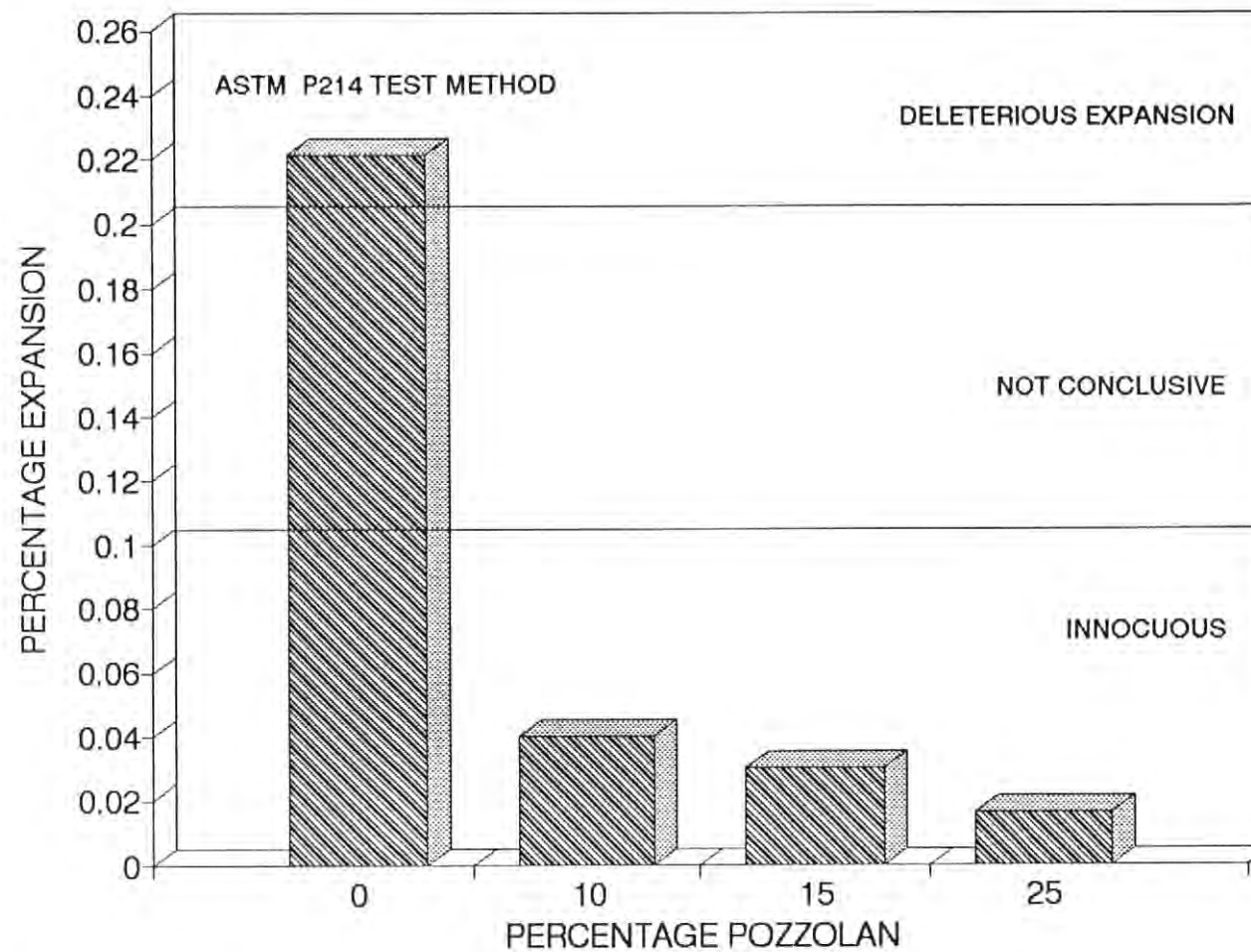


FIGURE 21 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE LK2

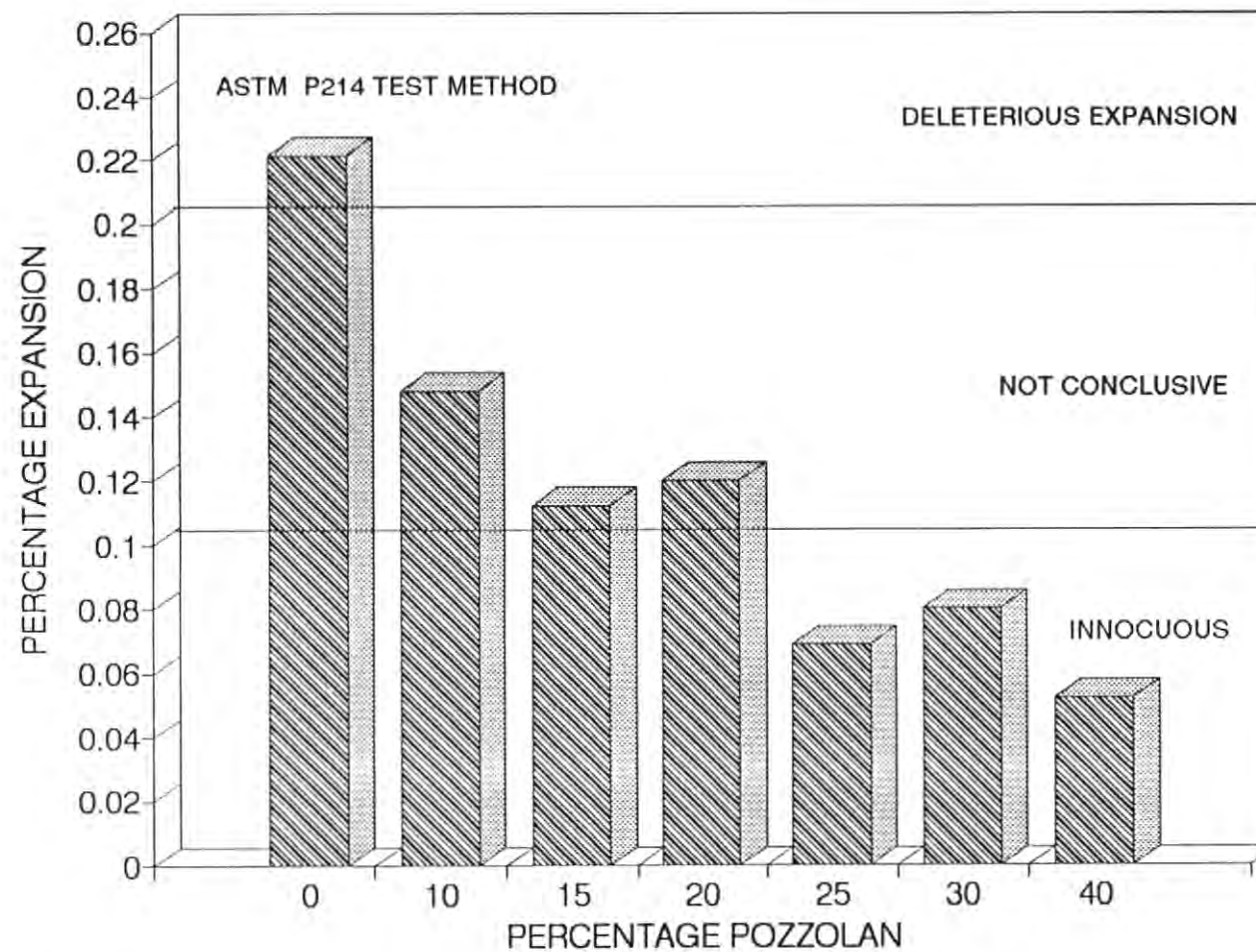


FIGURE 22 COMPARISON OF EXPANSIONS FOR FLY ASH

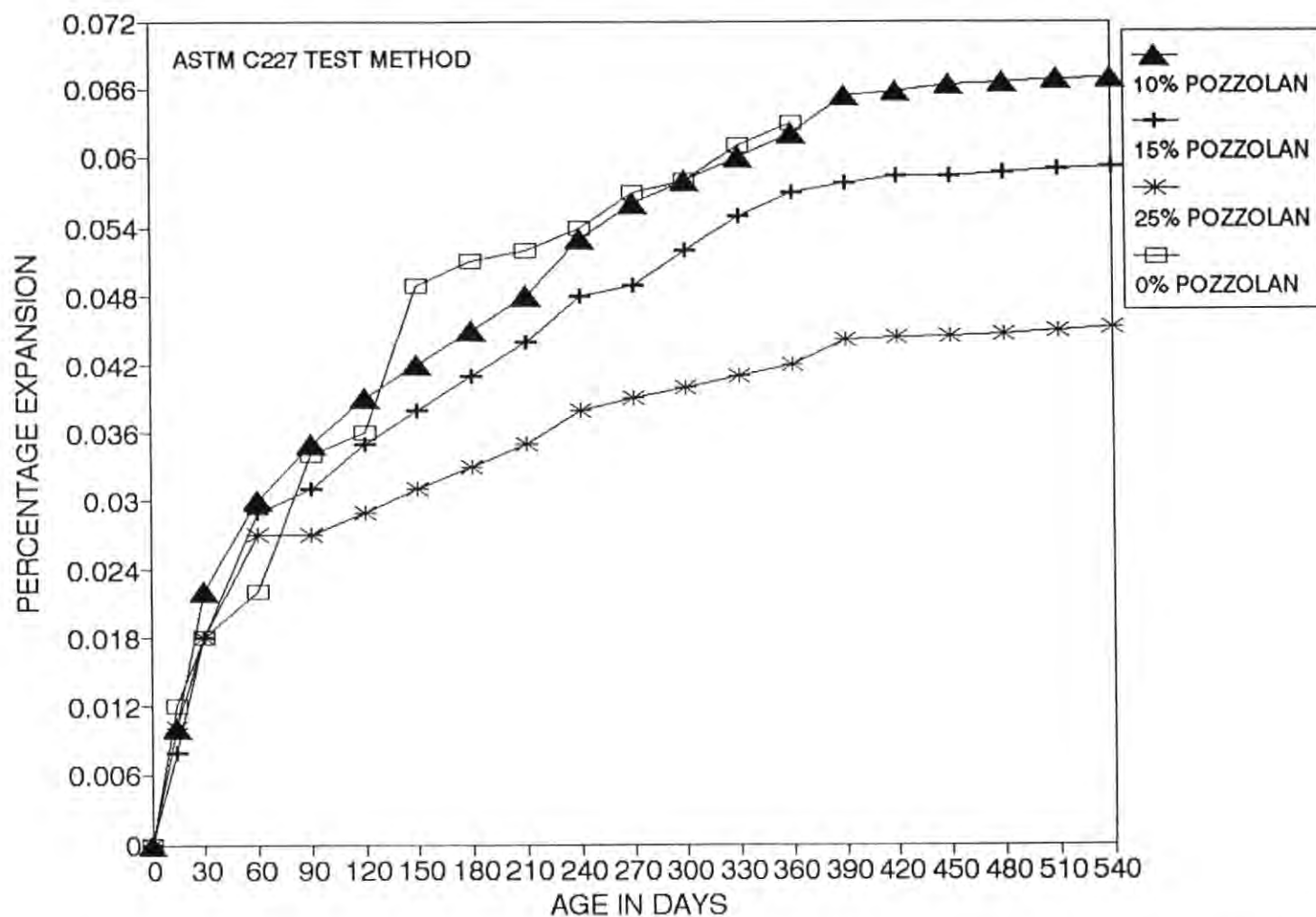


FIGURE 23 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE SM2

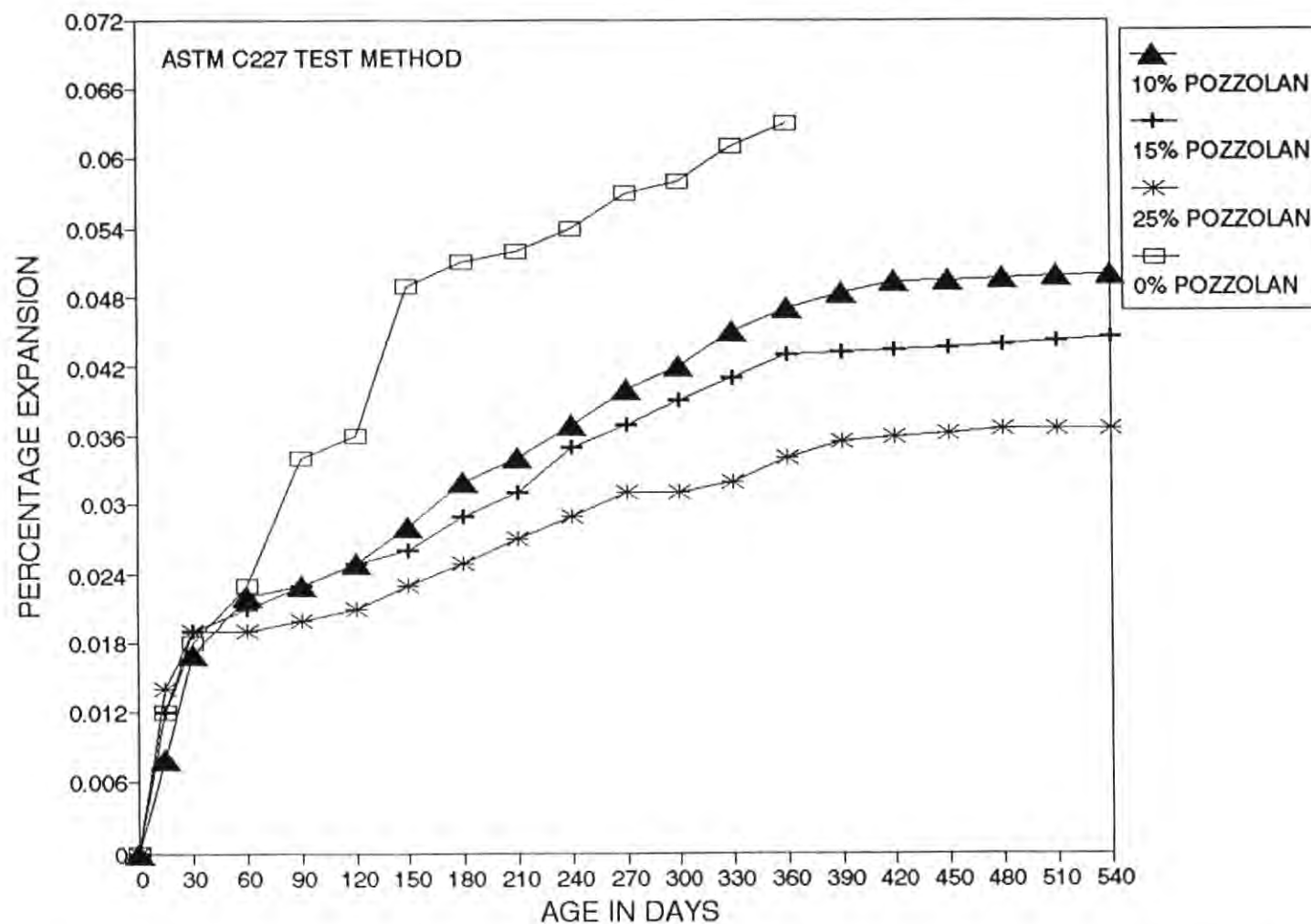


FIGURE 24 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE CB1

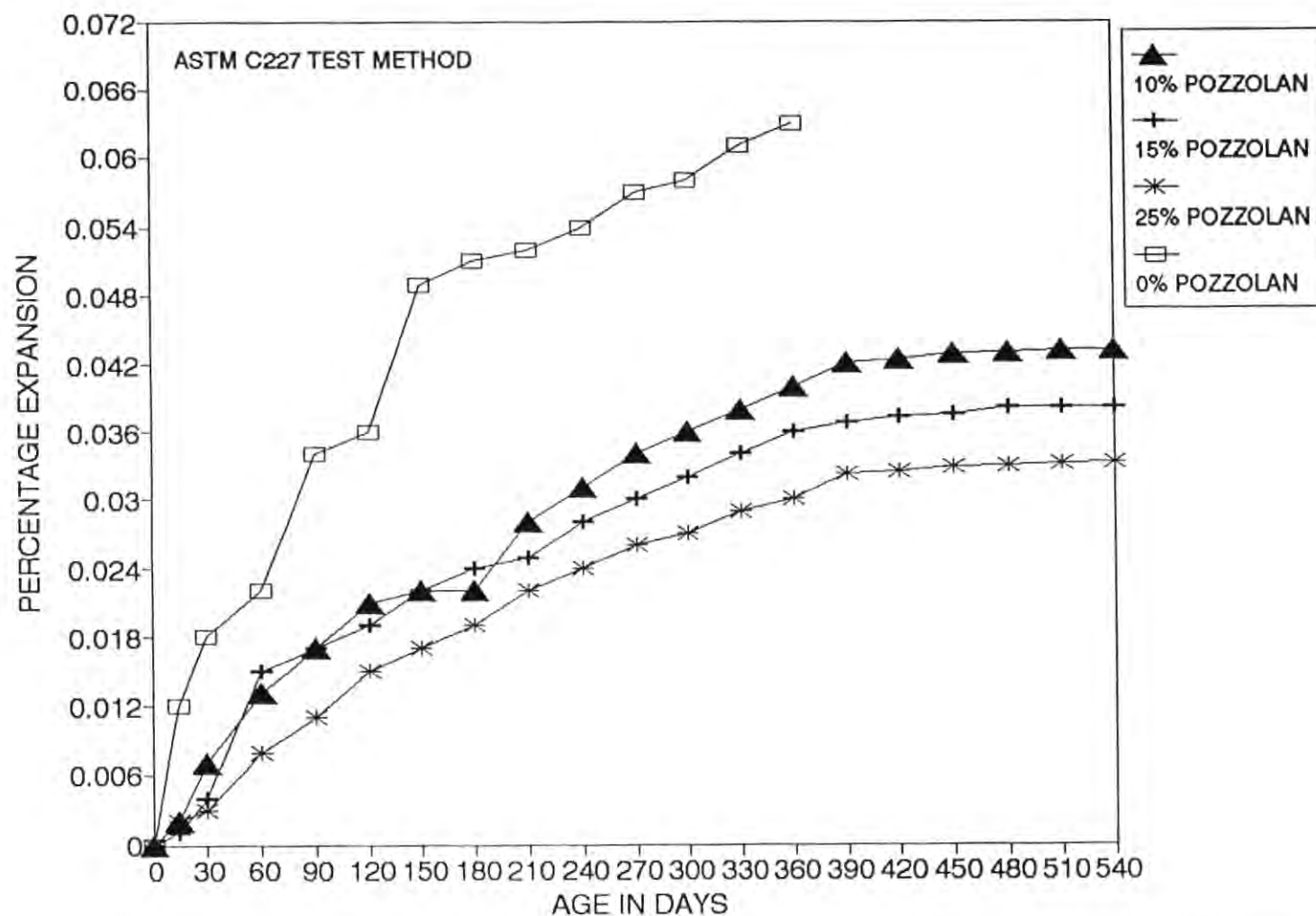


FIGURE 25 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE CT1

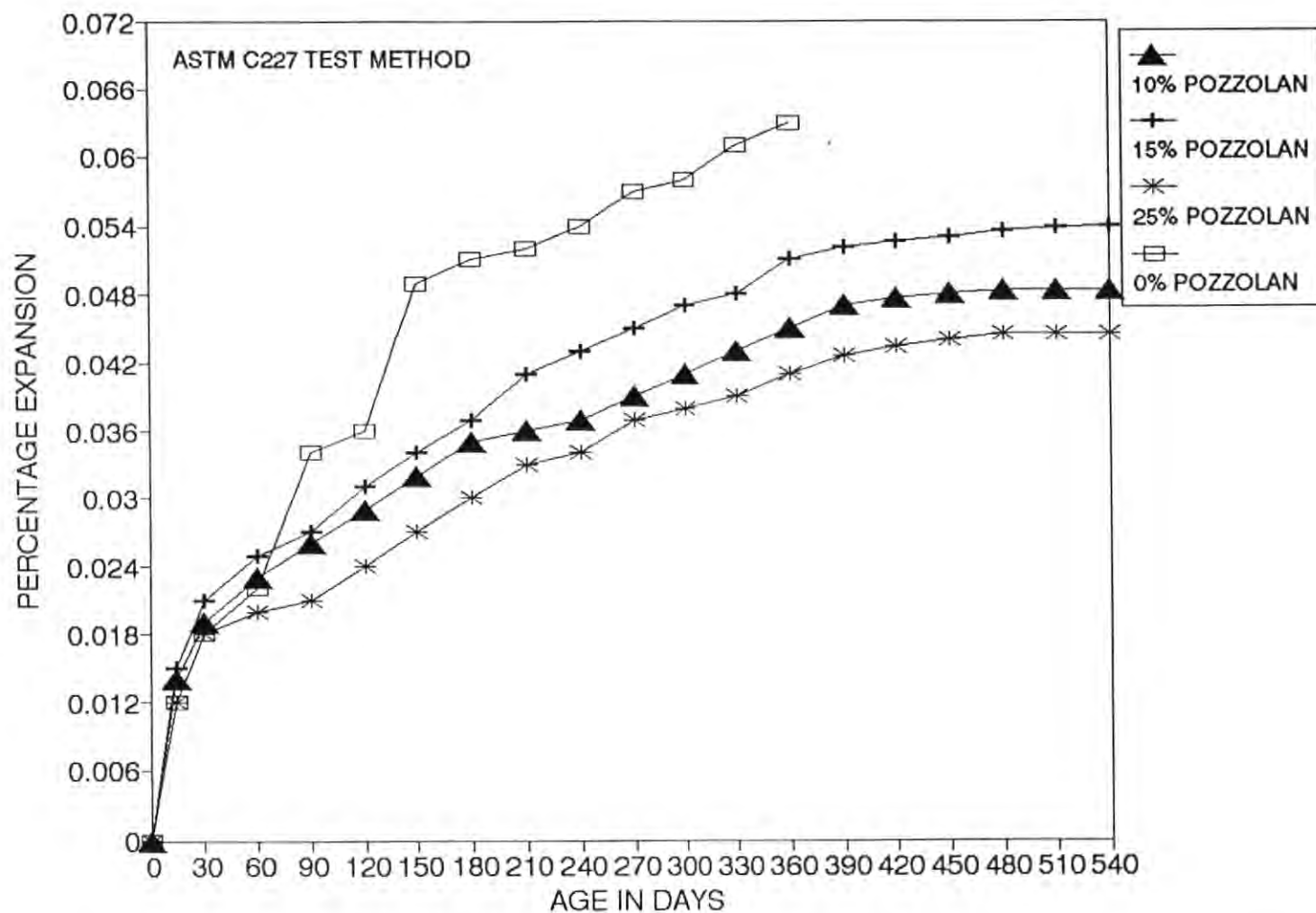


FIGURE 26 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE MW1

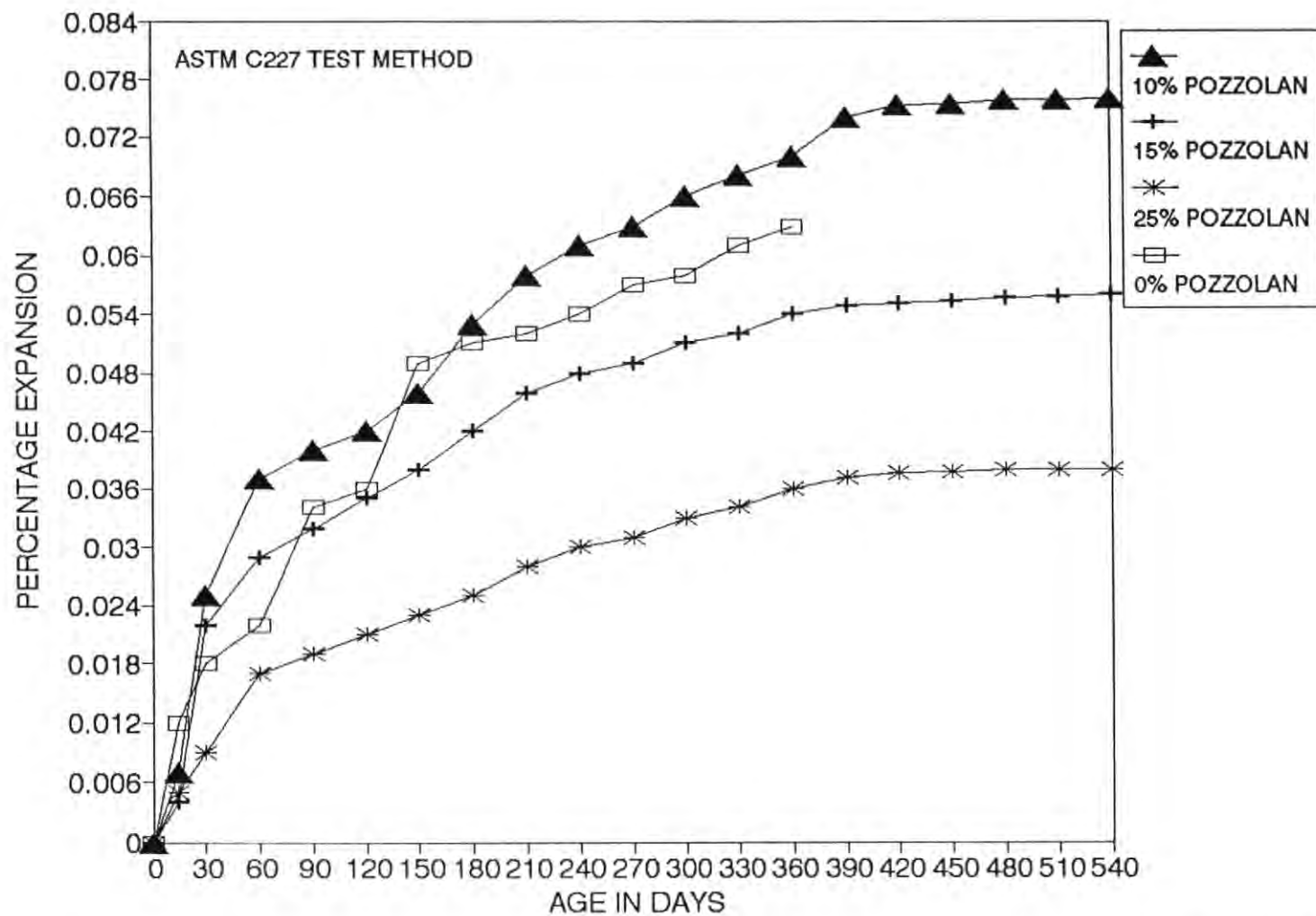


FIGURE 27 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE PRC1

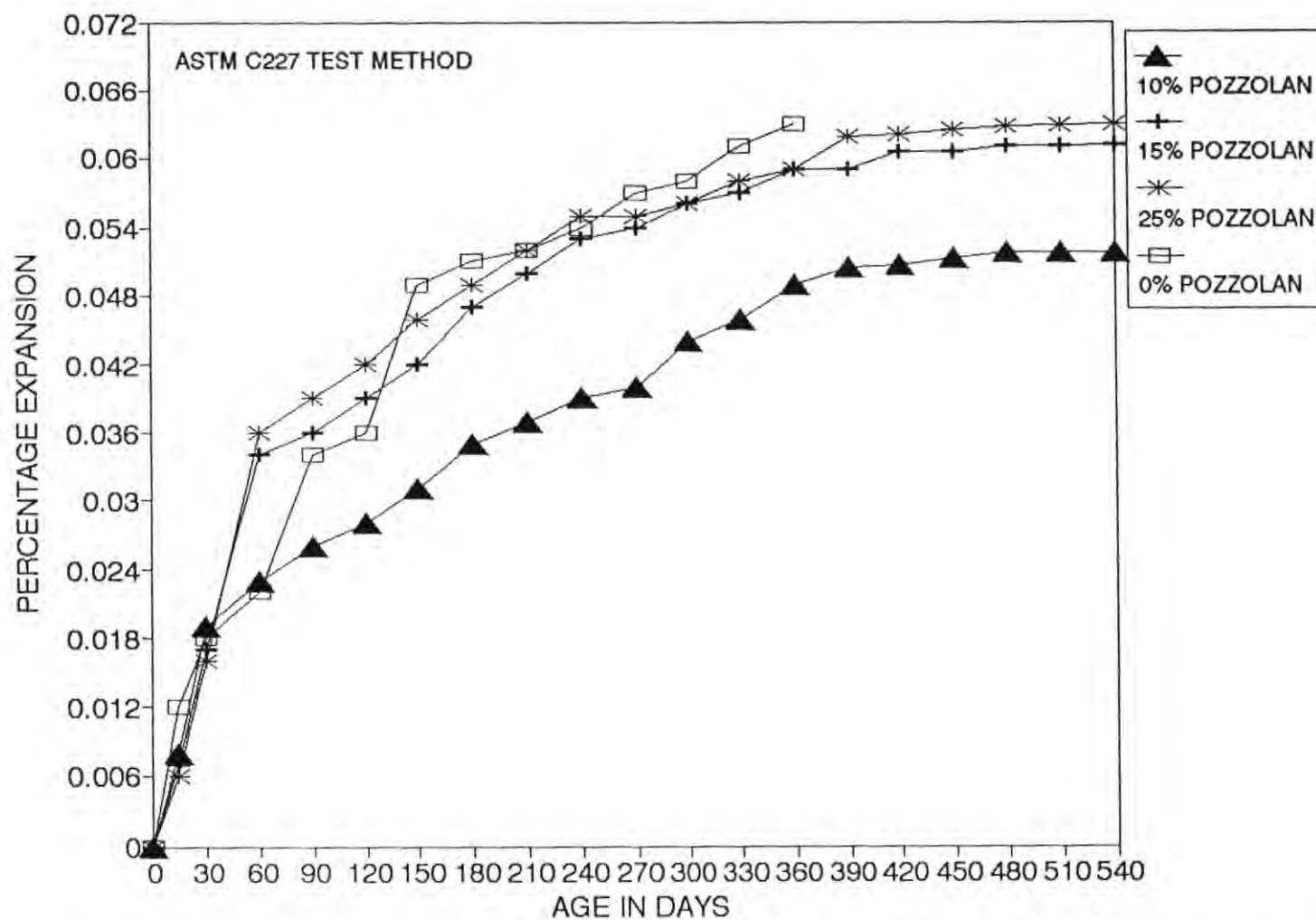


FIGURE 28 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE VA2

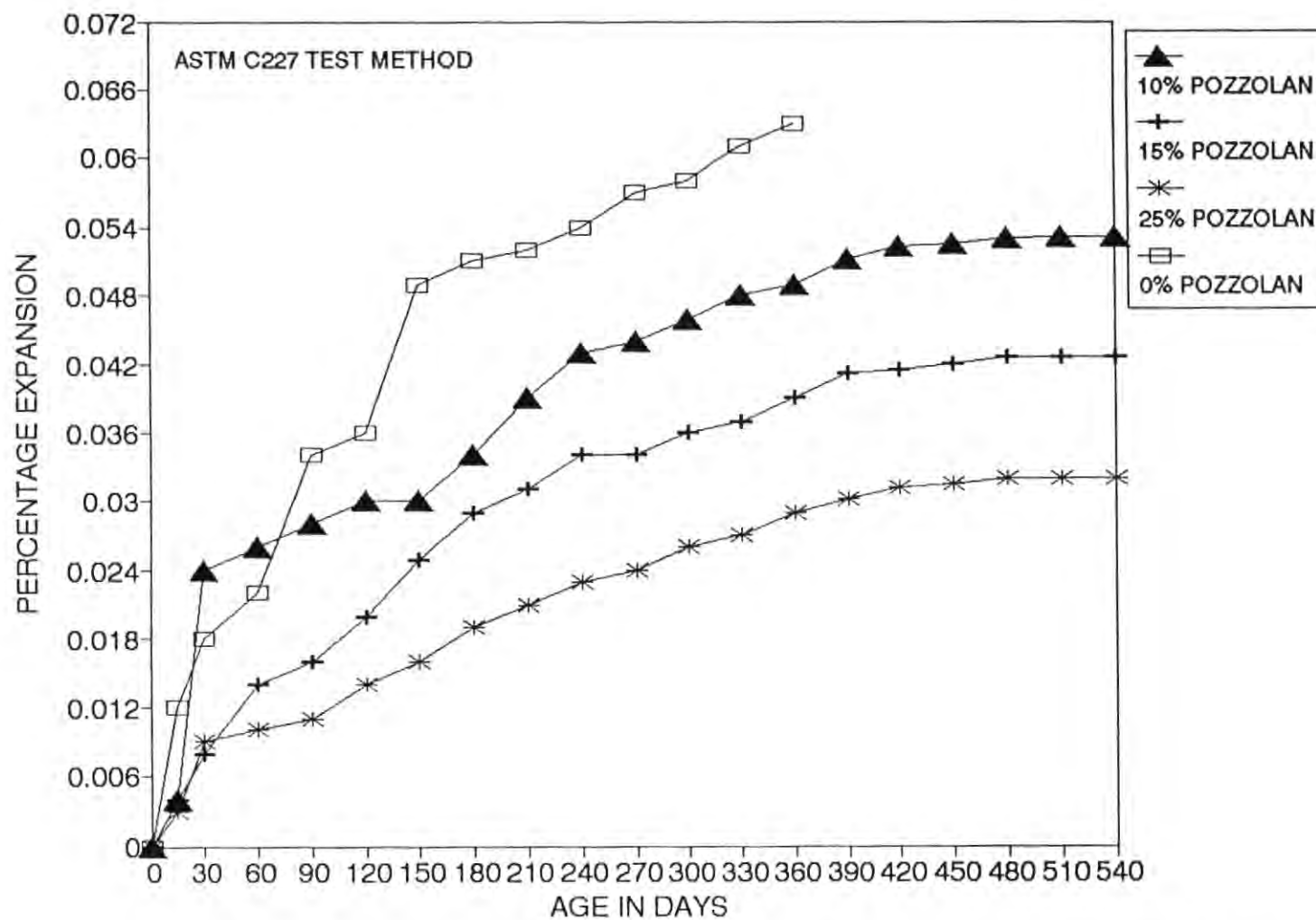


FIGURE 29 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE PS1E

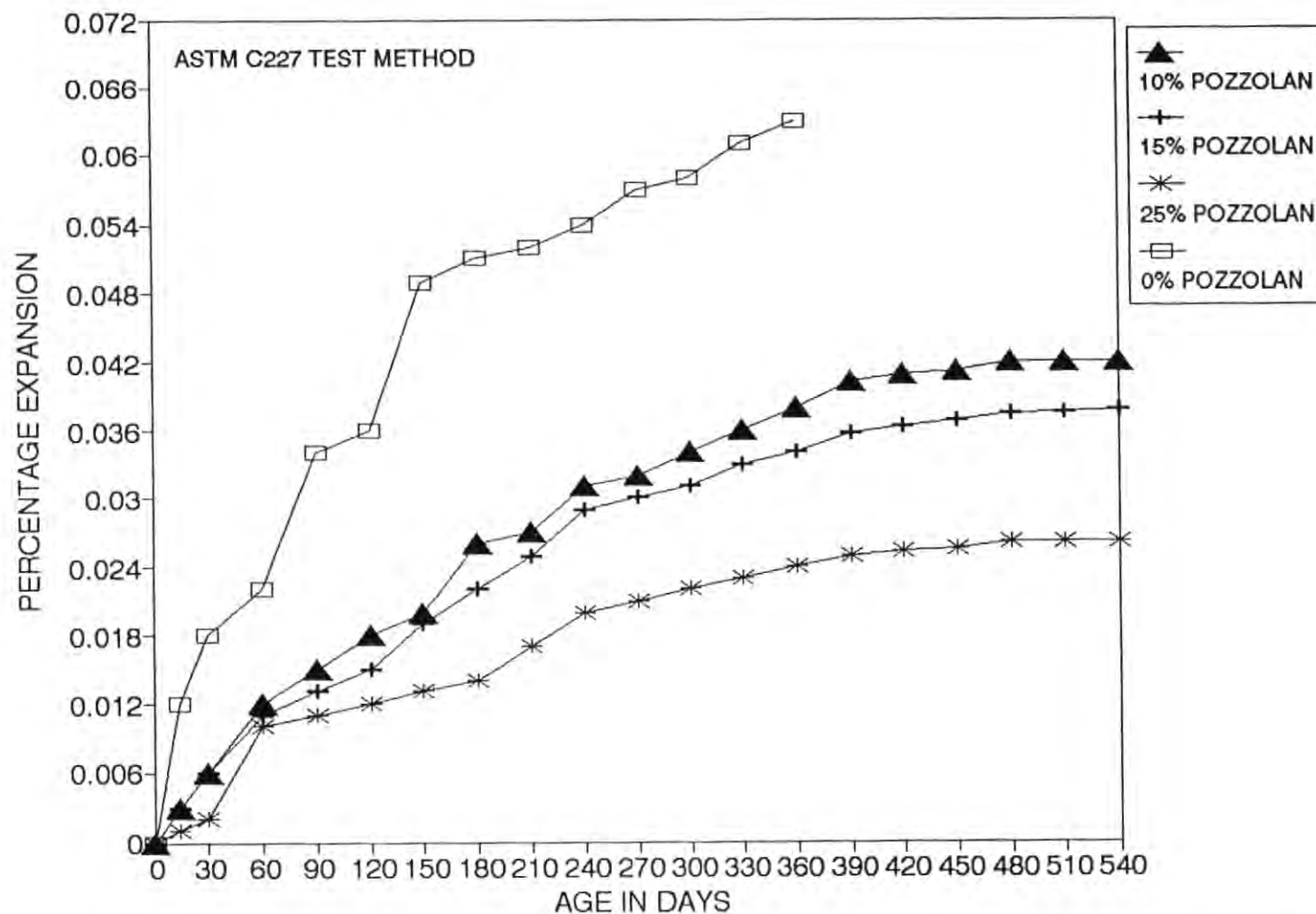


FIGURE 30 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE US1

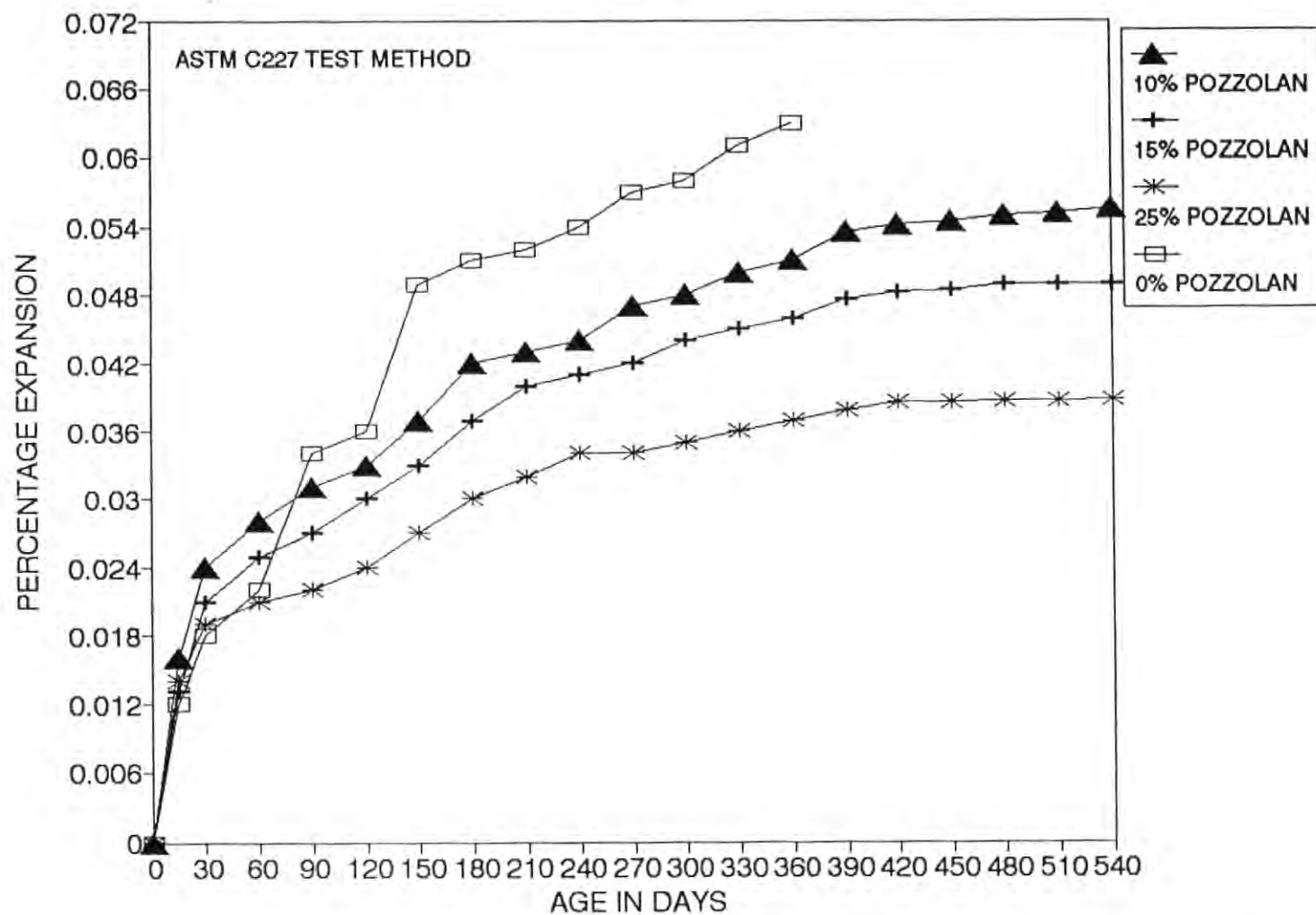


FIGURE 31 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE F3

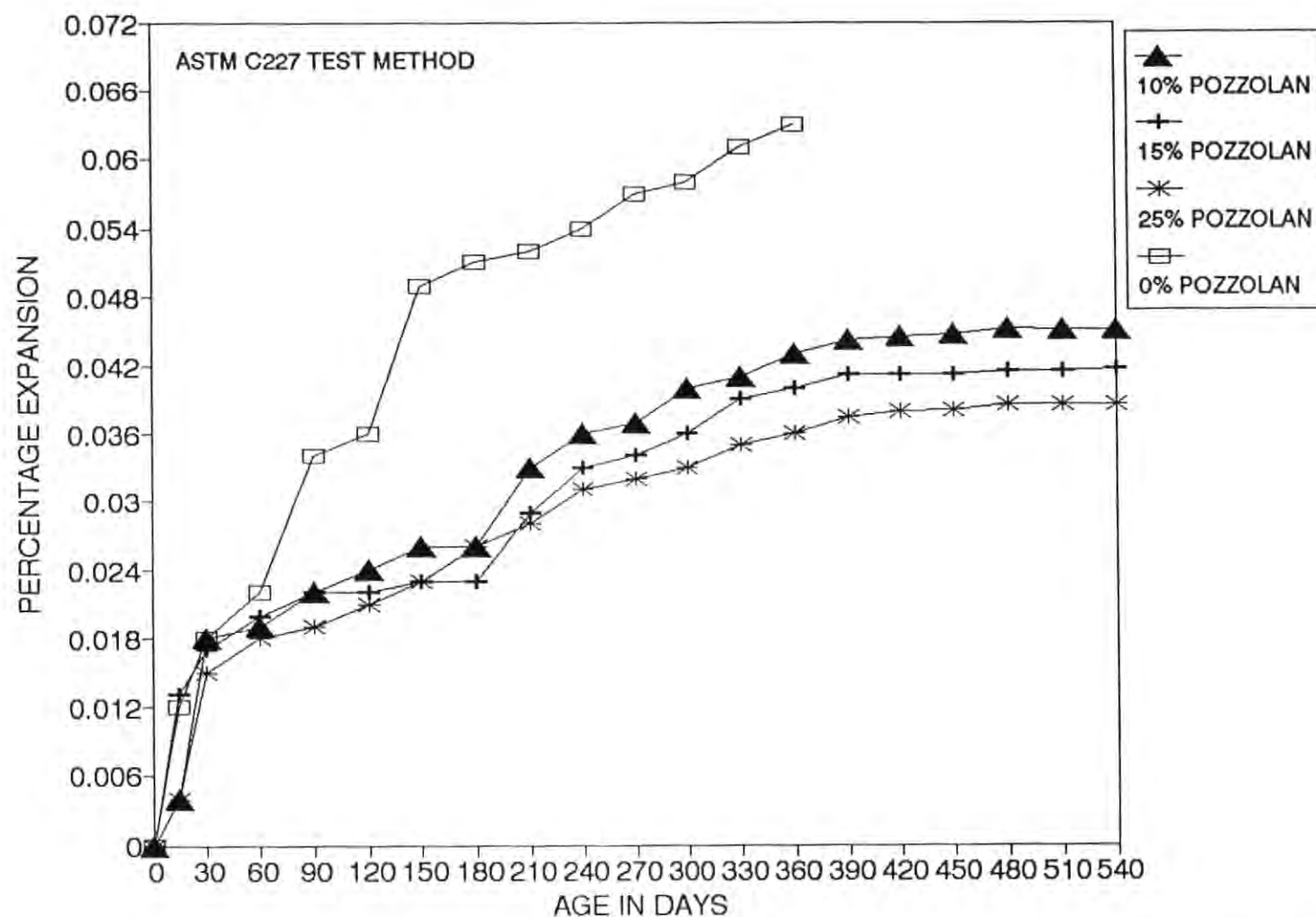


FIGURE 32 COMPARISON OF EXPANSIONS FOR POZZOLAN SAMPLE LK2

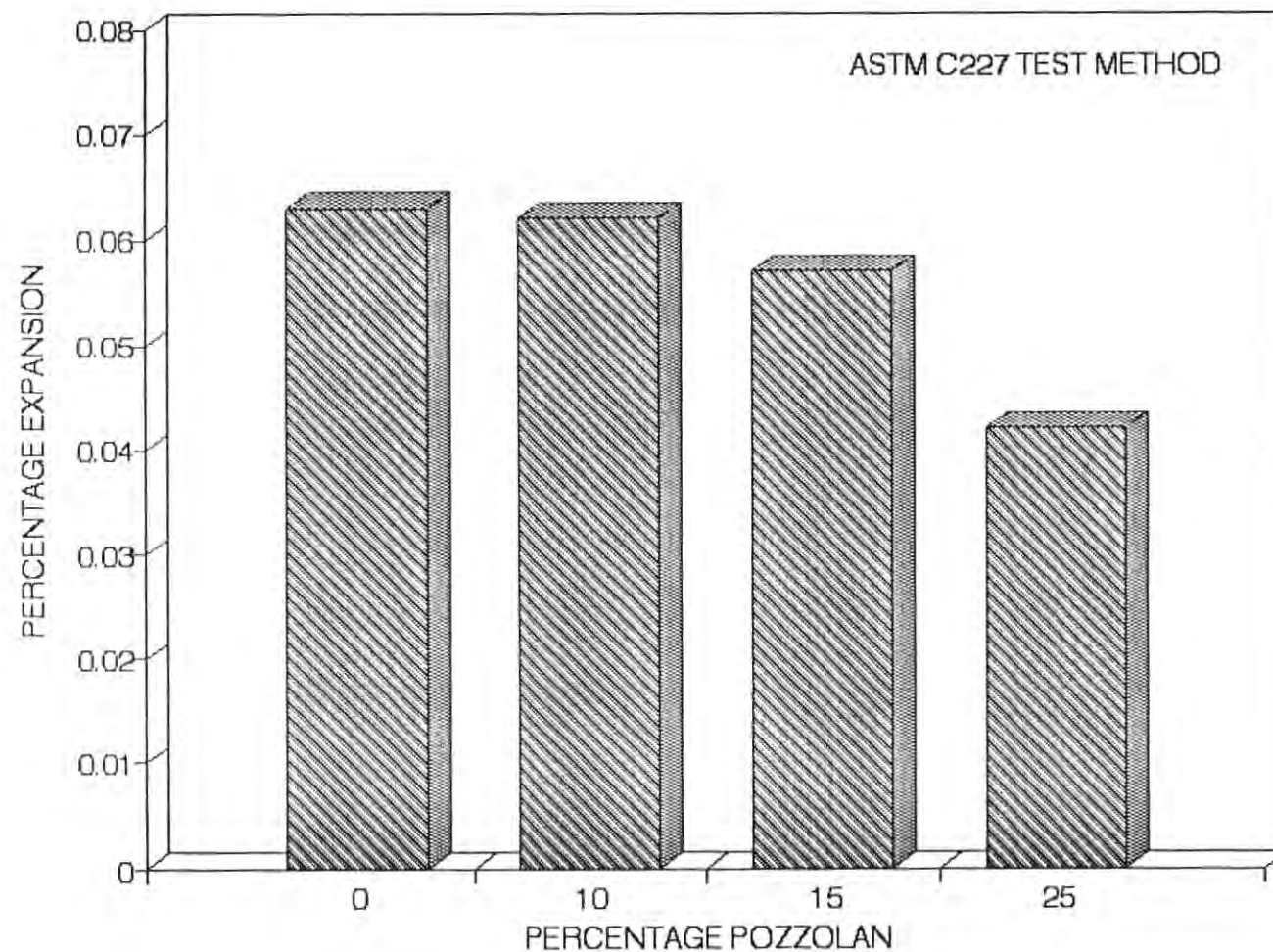


FIGURE 33 COMPARISON OF MORTAR BAR EXPANSION FOR SM2

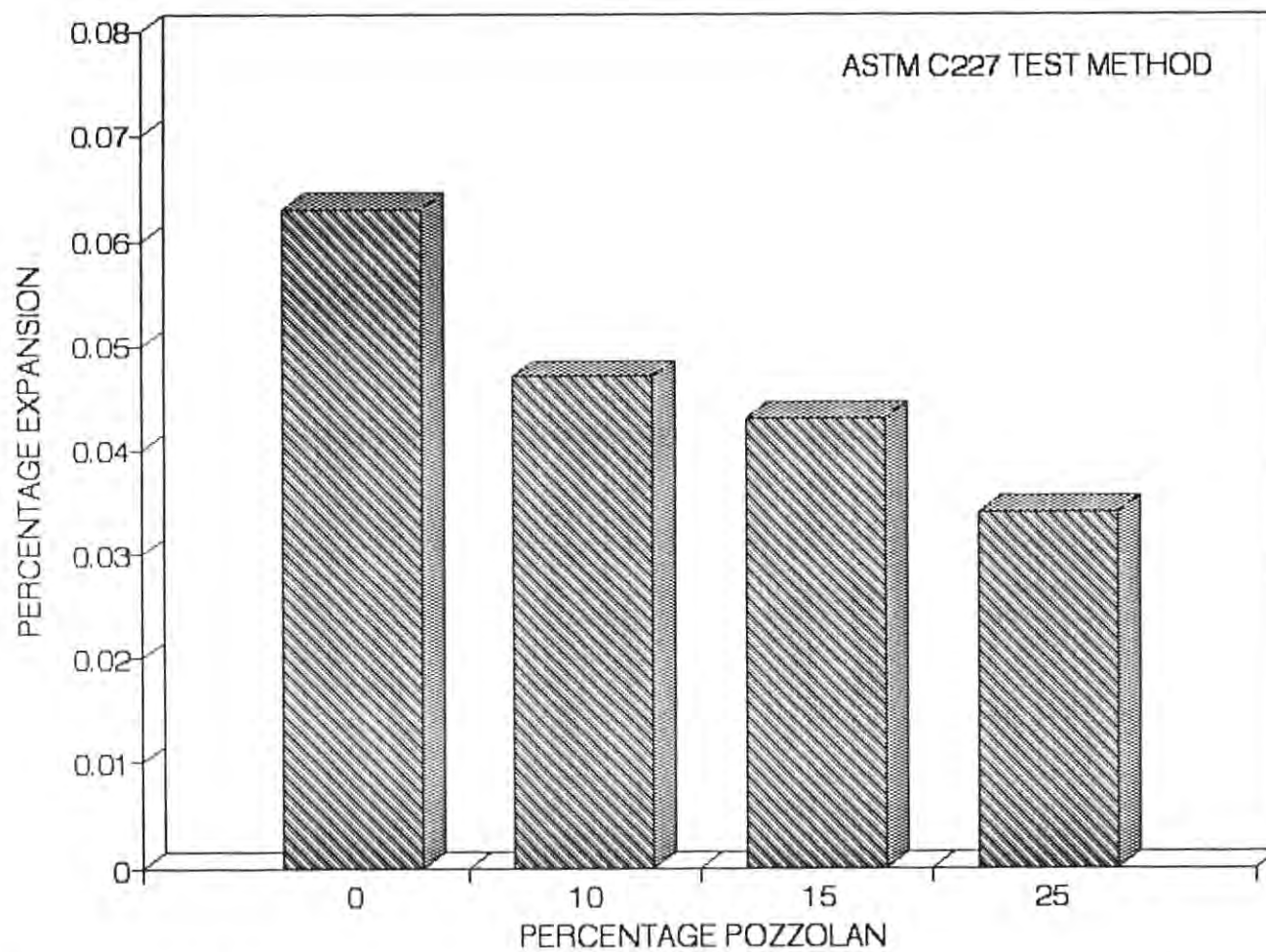


FIGURE 34 COMPARISON OF MORTAR BAR EXPANSION FOR CB1

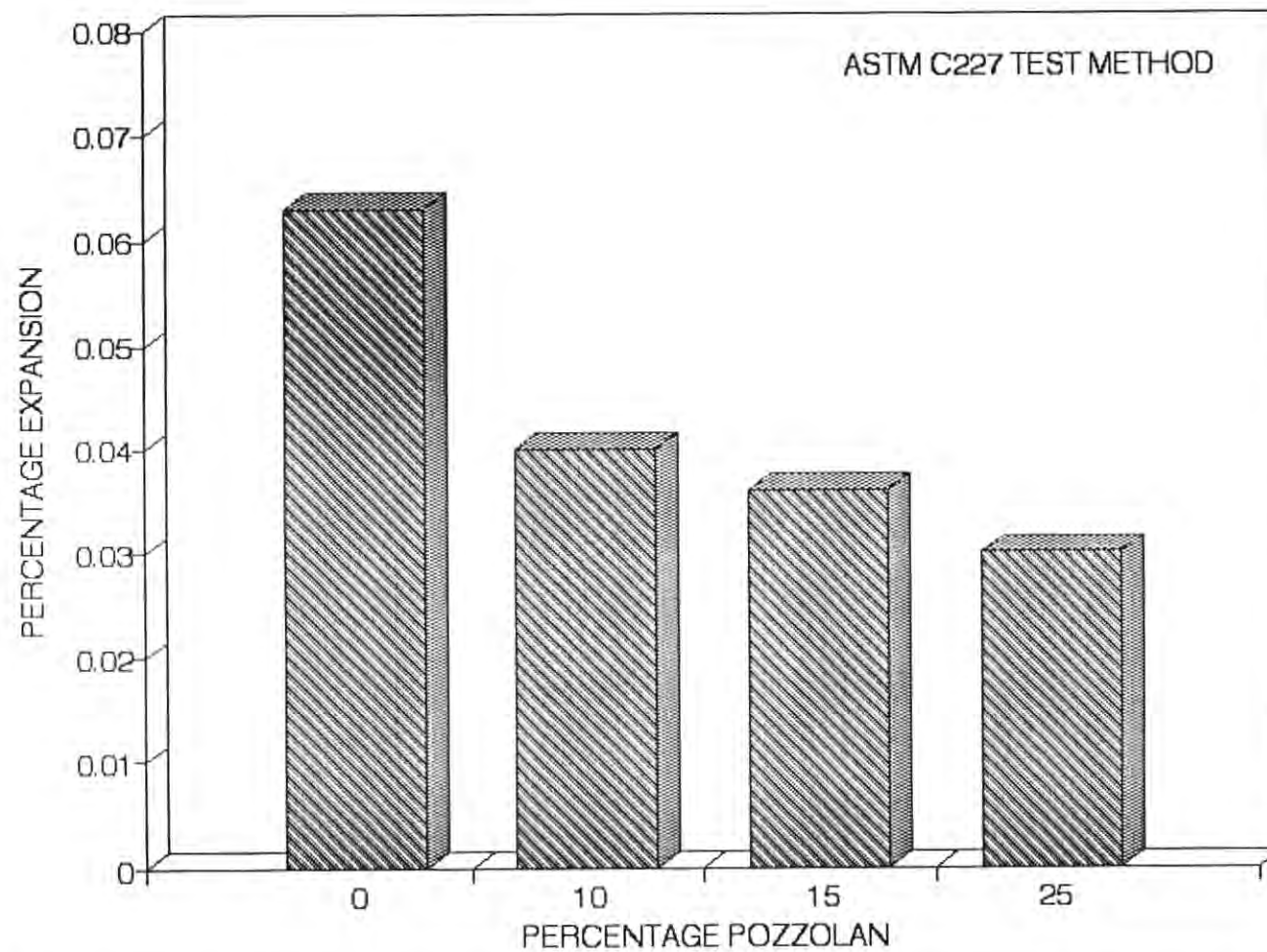


FIGURE 35 COMPARISON OF MORTAR BAR EXPANSION FOR CT1

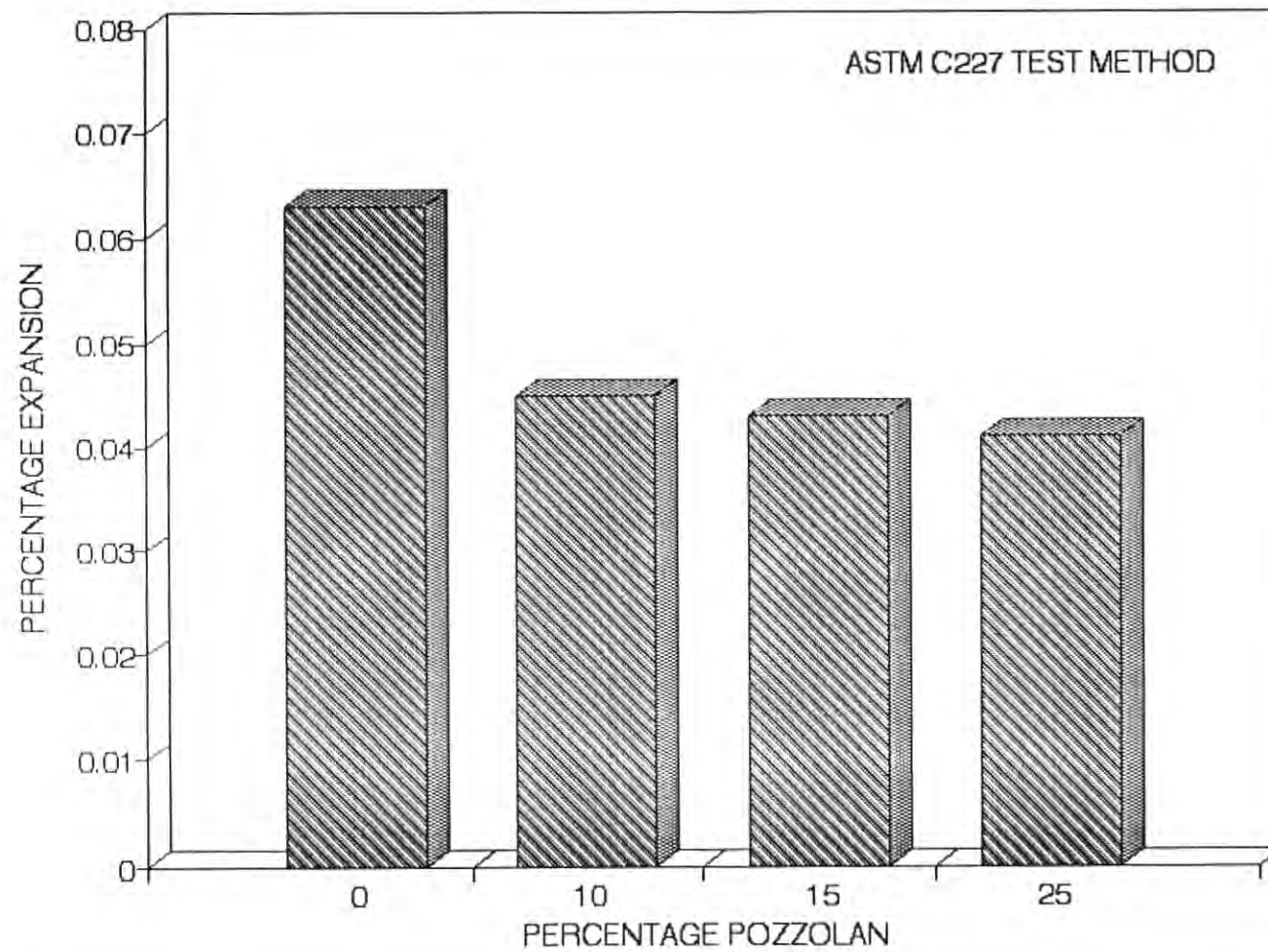


FIGURE 36 COMPARISON OF MORTAR BAR EXPANSION FOR MW1

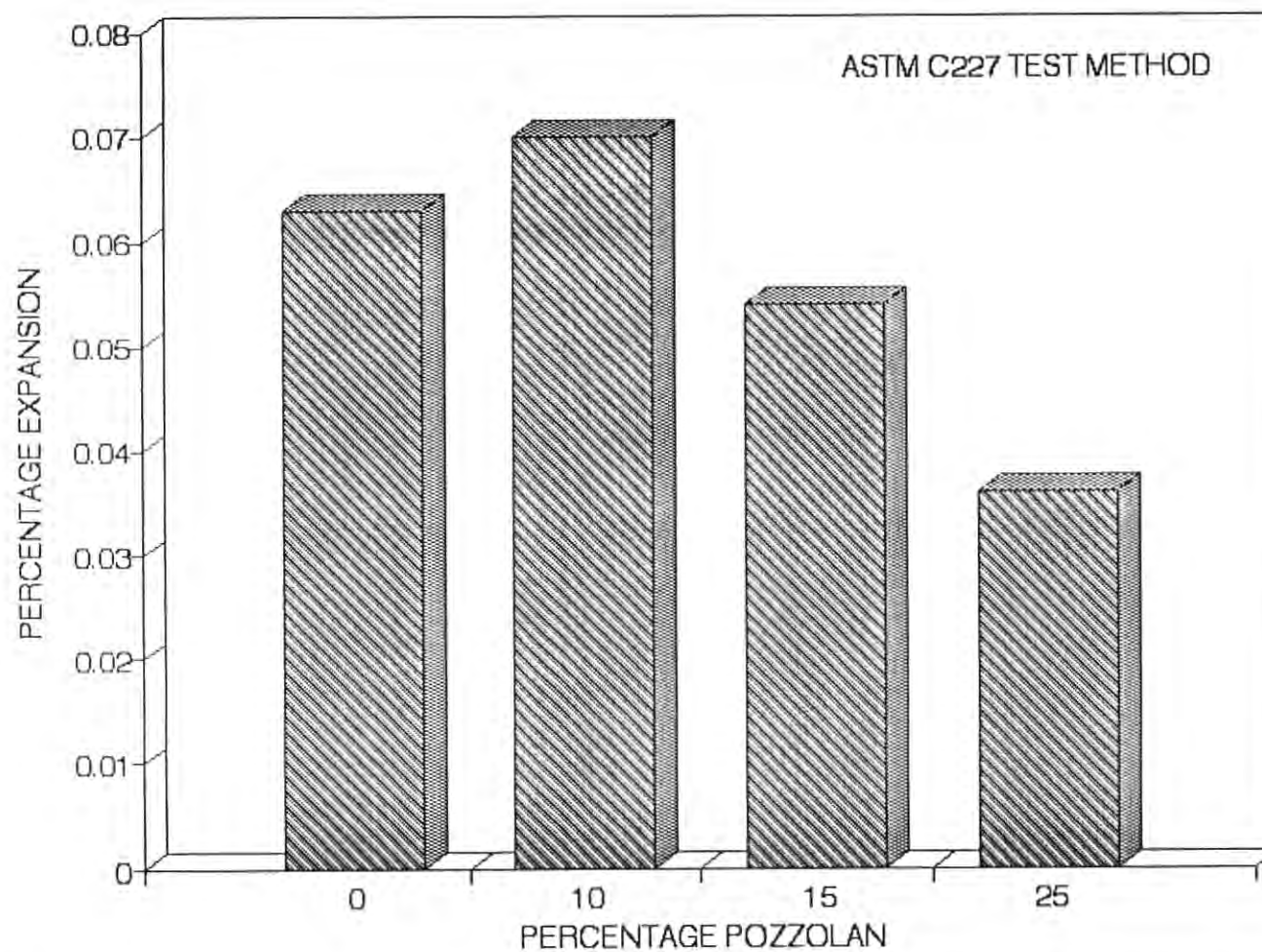


FIGURE 37 COMPARISON OF MORTAR BAR EXPANSION FOR PRC1

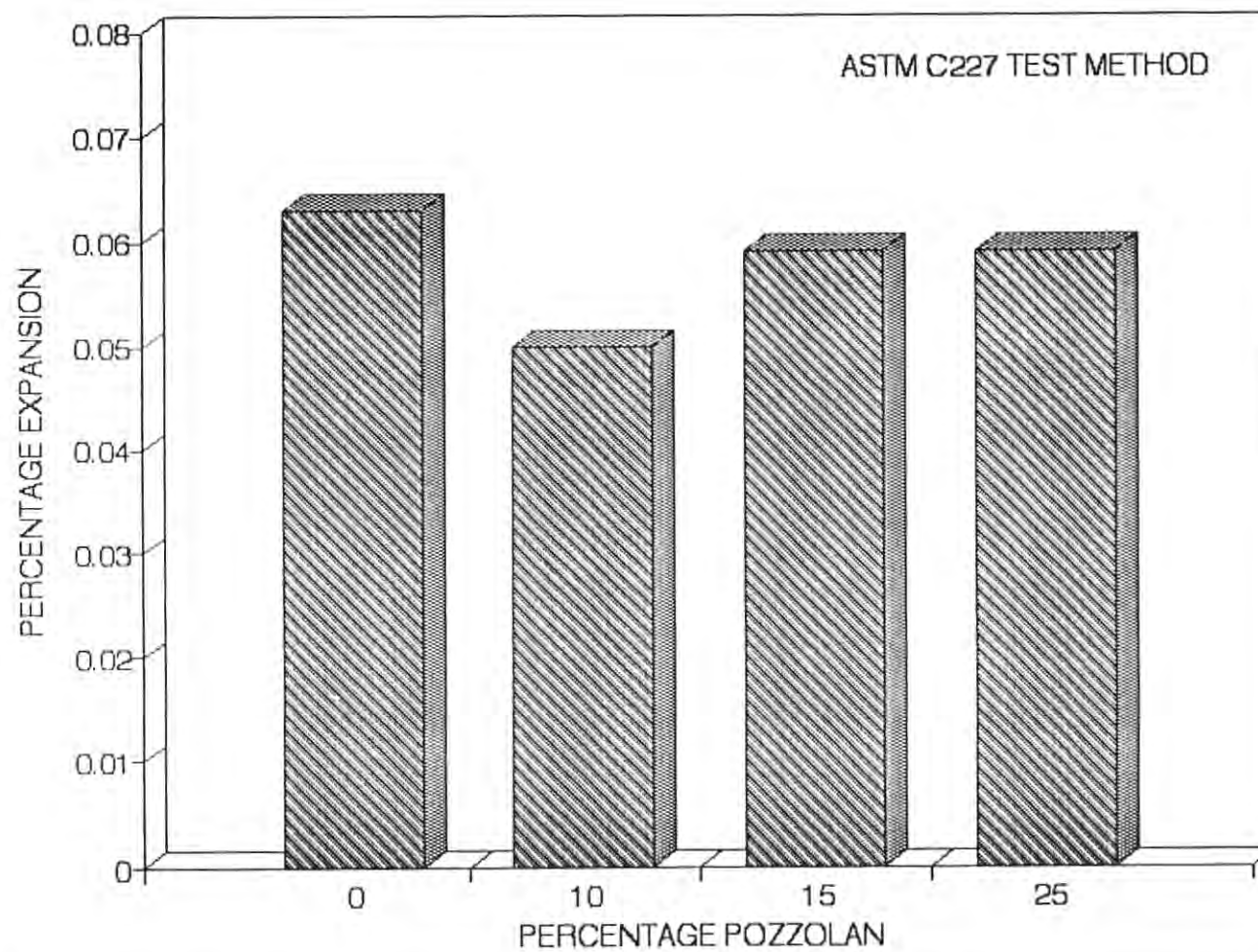


FIGURE 38 COMPARISON OF MORTAR BAR EXPANSION FOR VA2

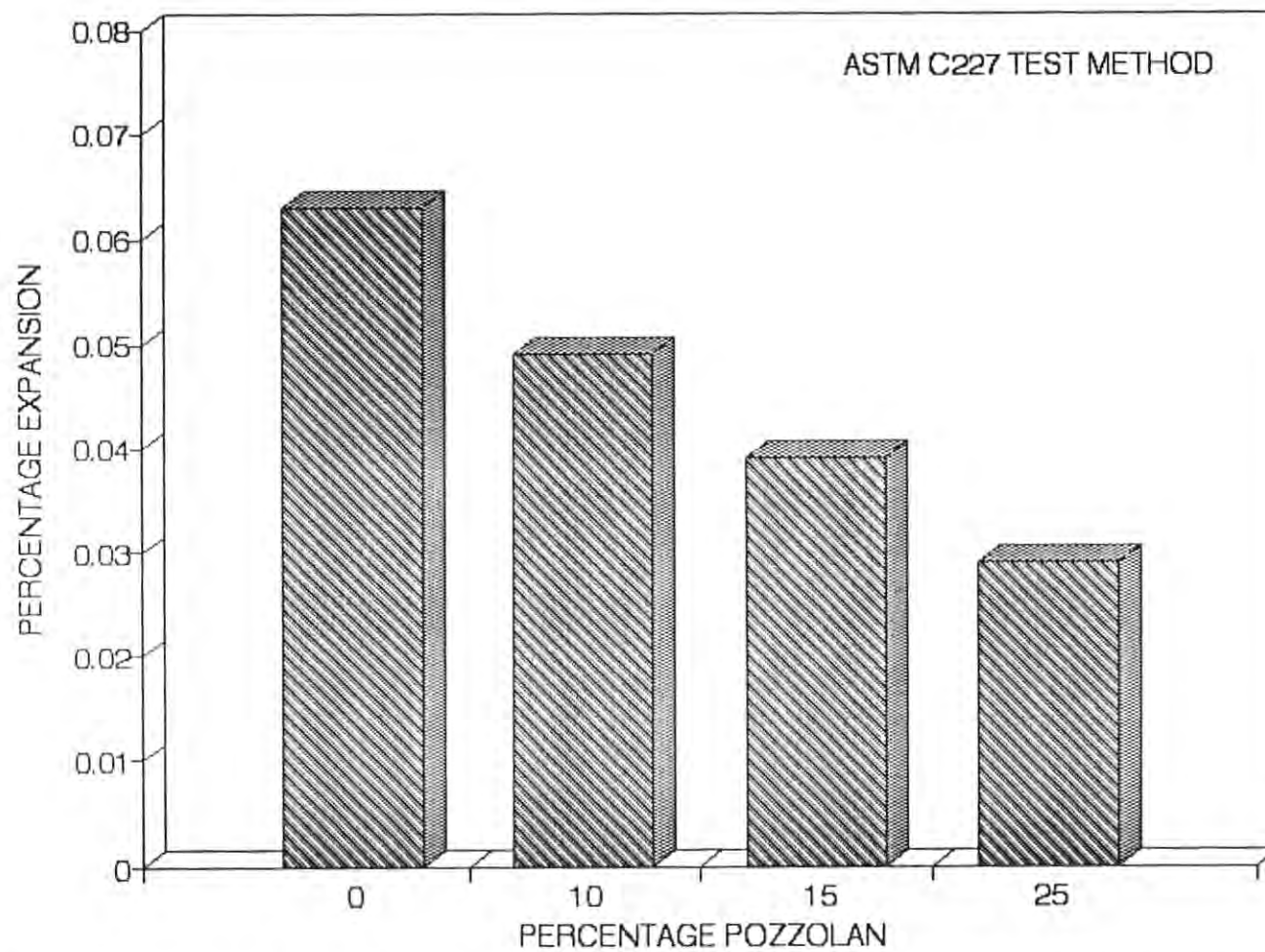


FIGURE 39 COMPARISON OF MORTAR BAR EXPANSION FOR PS1E

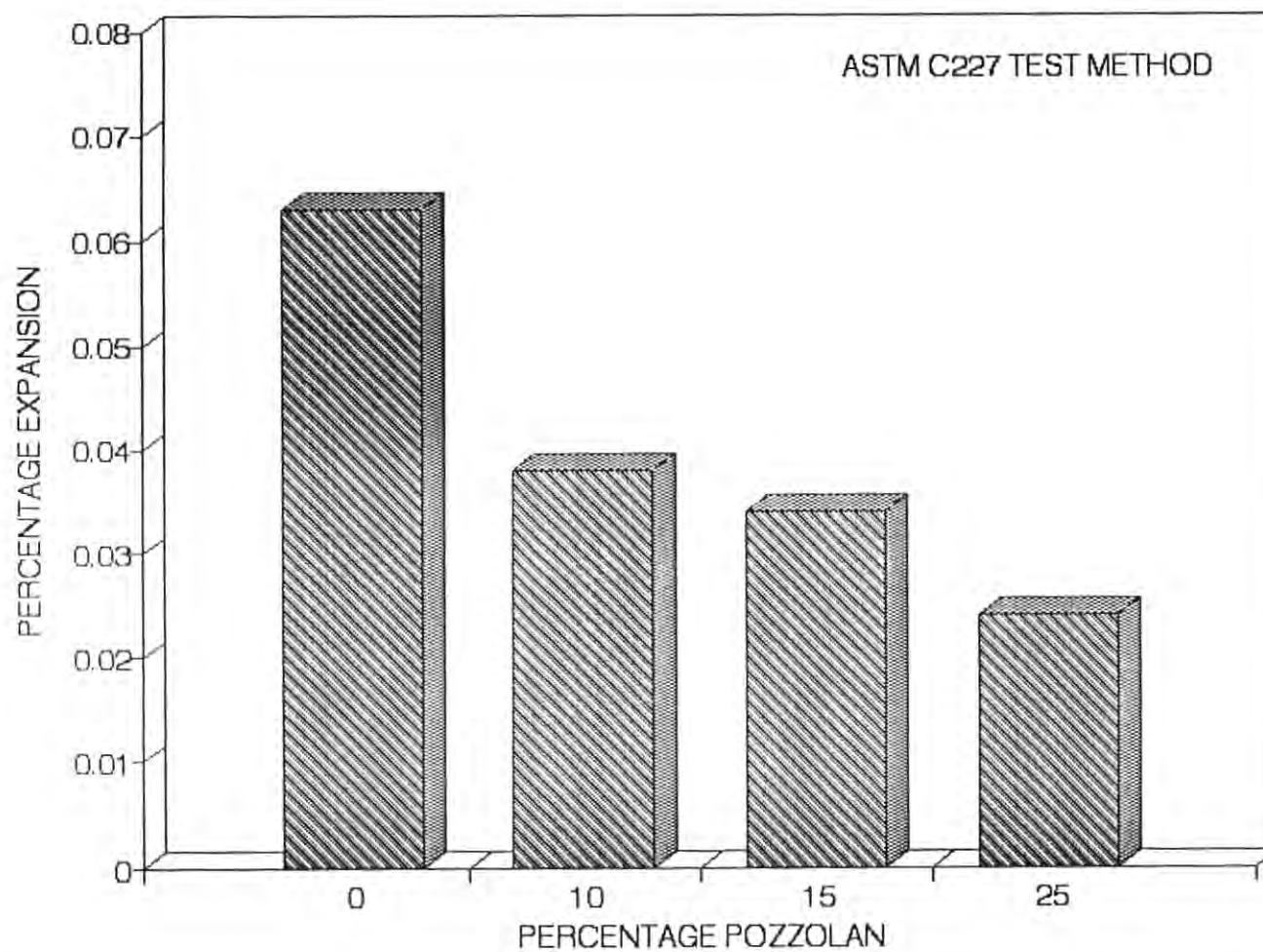


FIGURE 40 COMPARISON OF MORTAR BAR EXPANSION FOR US1

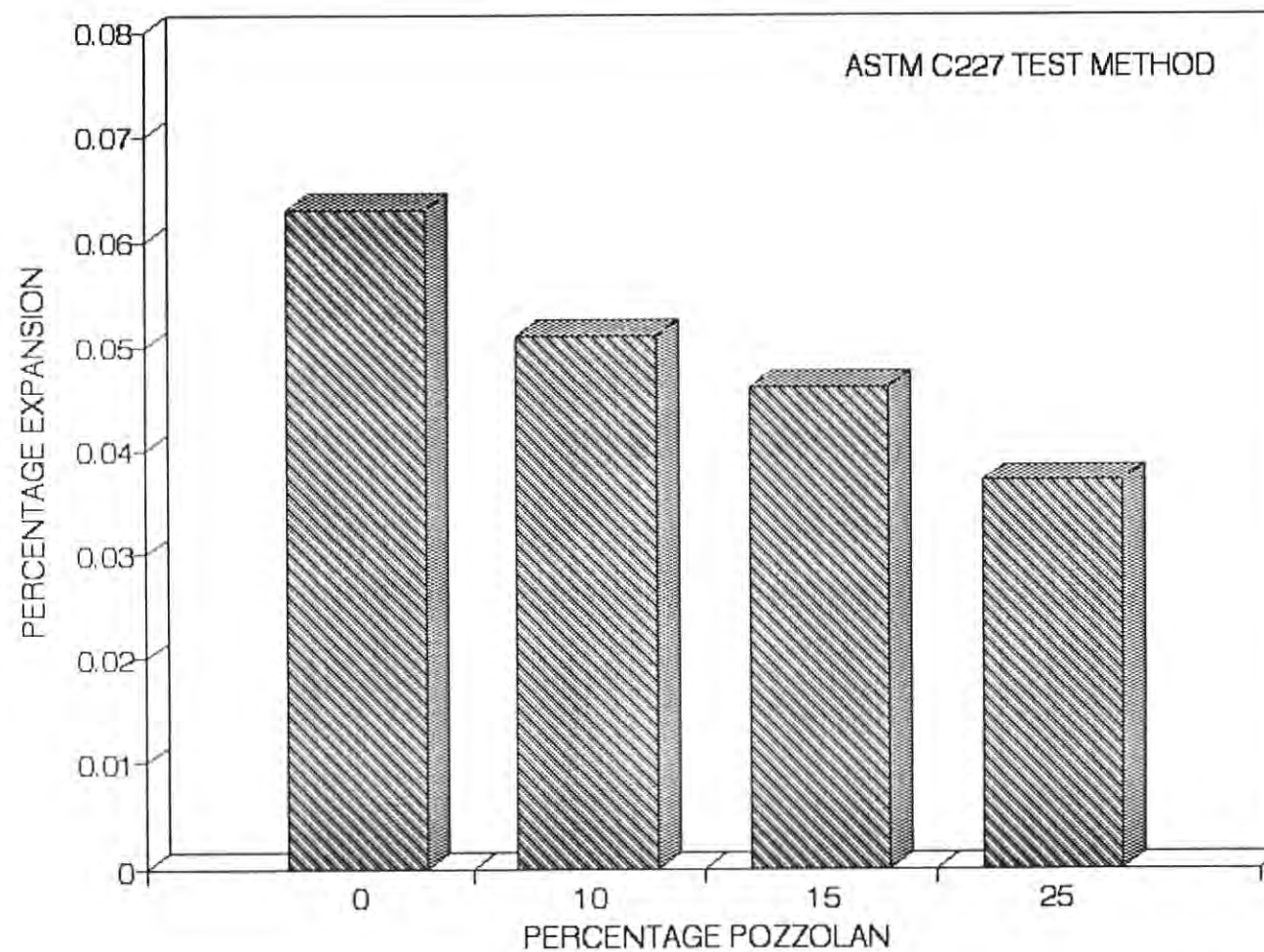


FIGURE 41 COMPARISON OF MORTAR BAR EXPANSION FOR F3

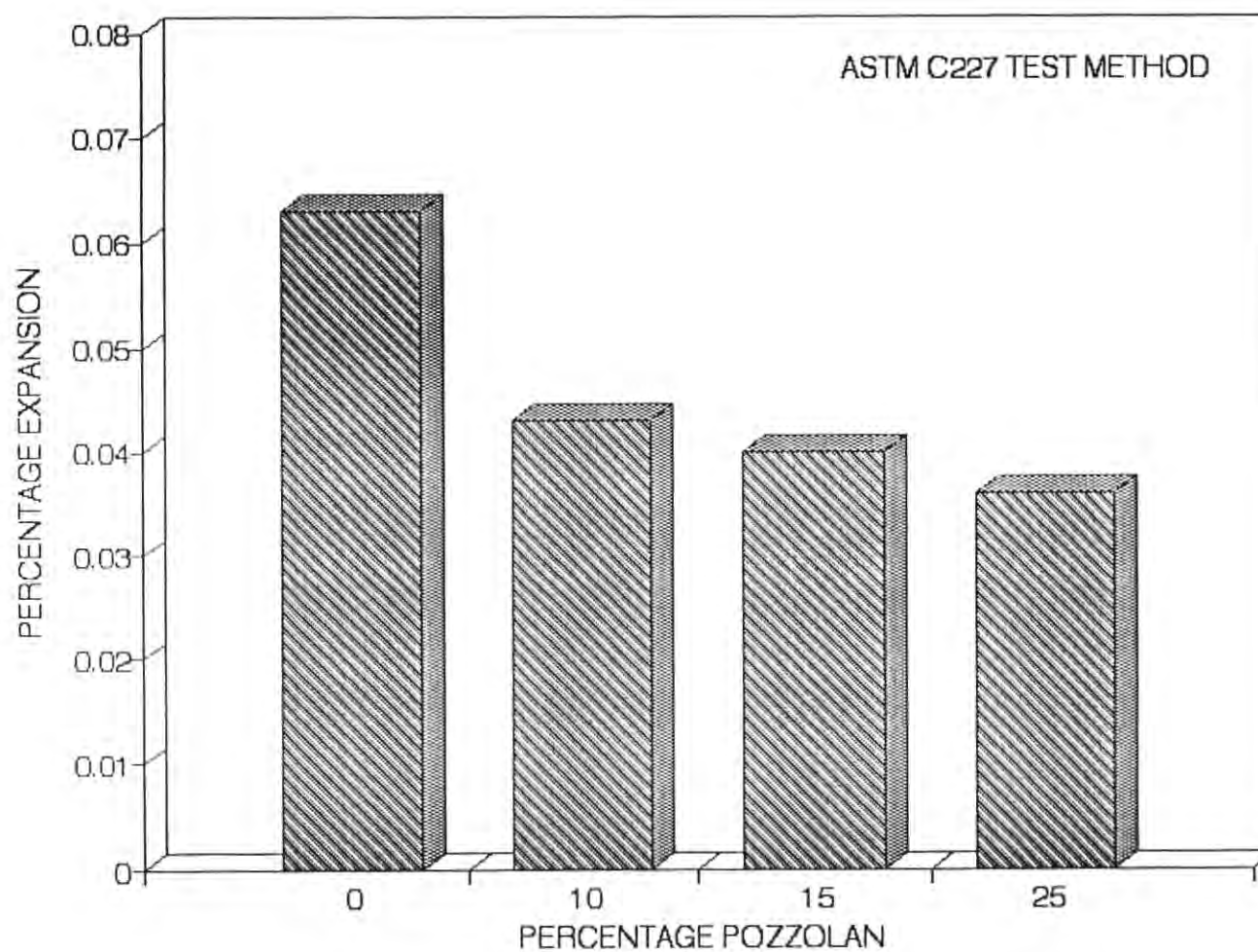


FIGURE 42 COMPARISON OF MORTAR BAR EXPANSION FOR LK2

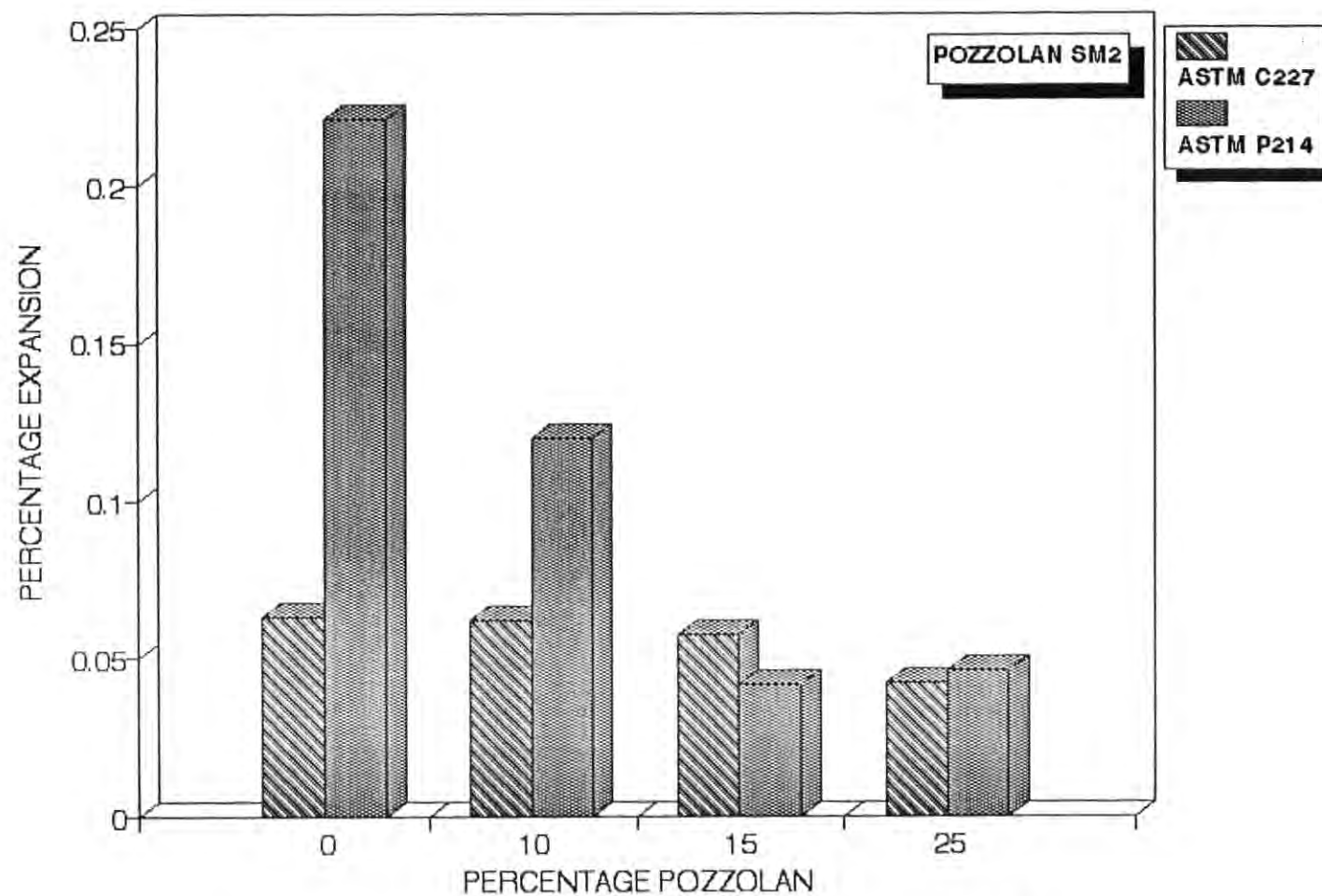


FIGURE 43 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

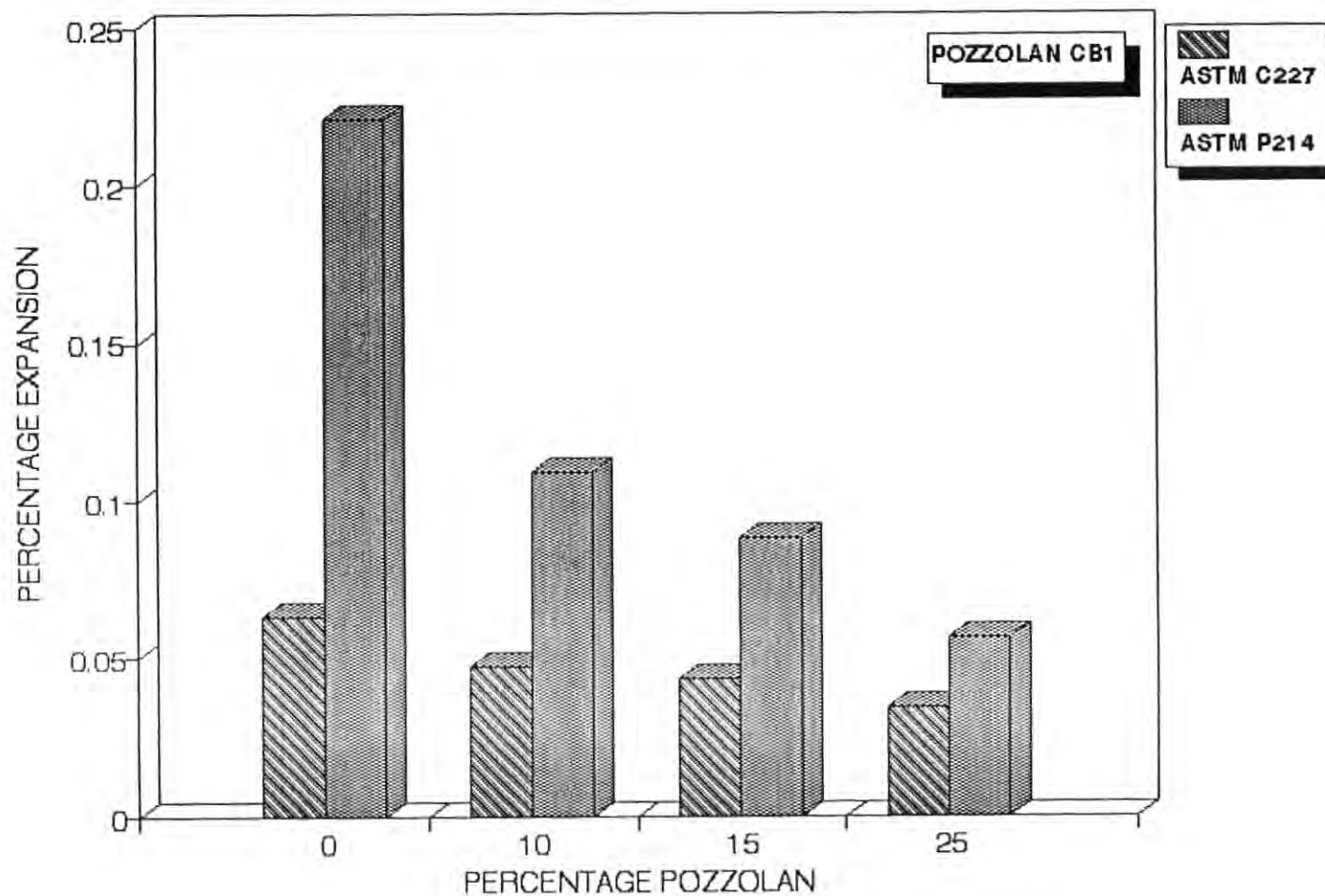


FIGURE 44 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

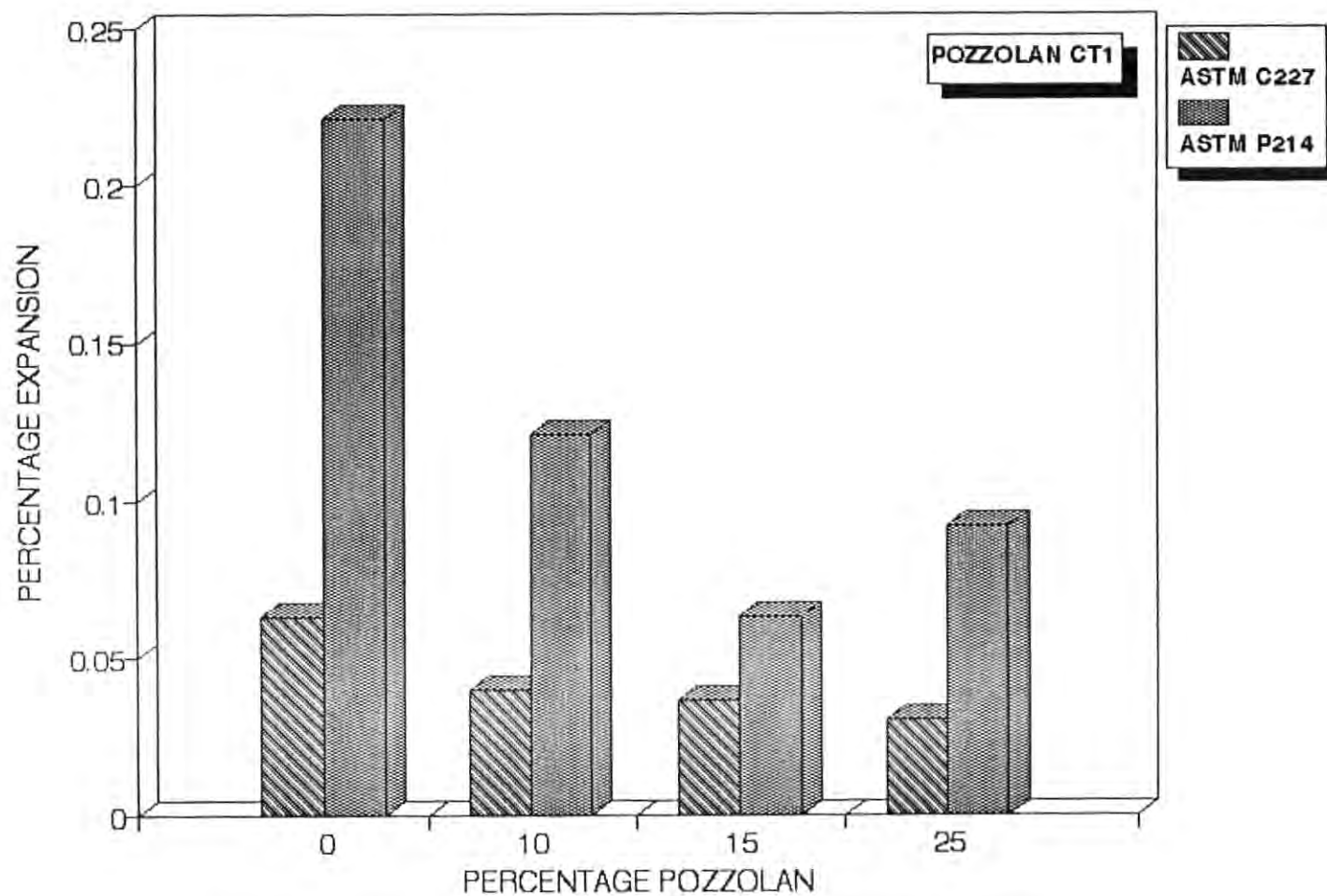


FIGURE 45 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

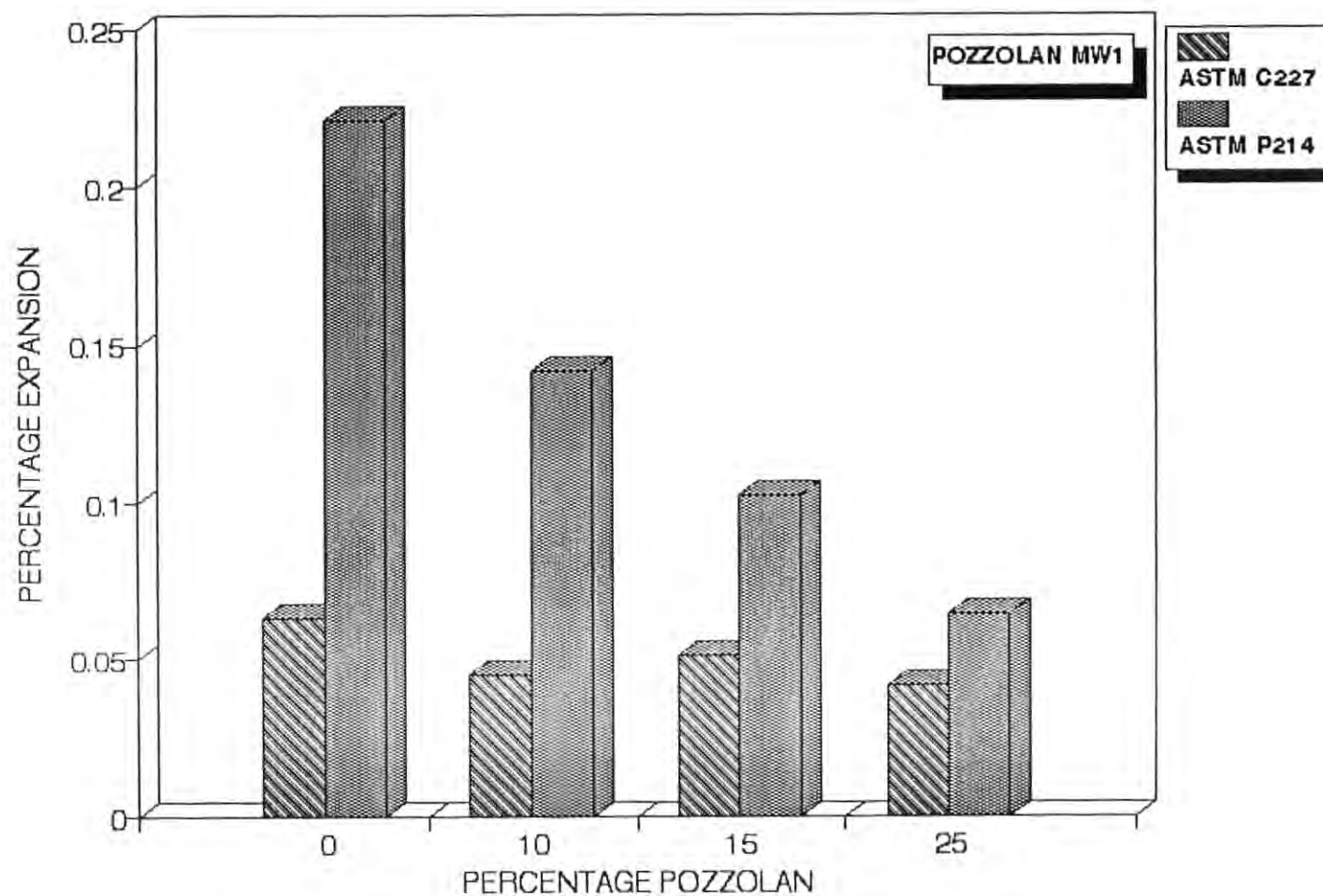


FIGURE 46 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

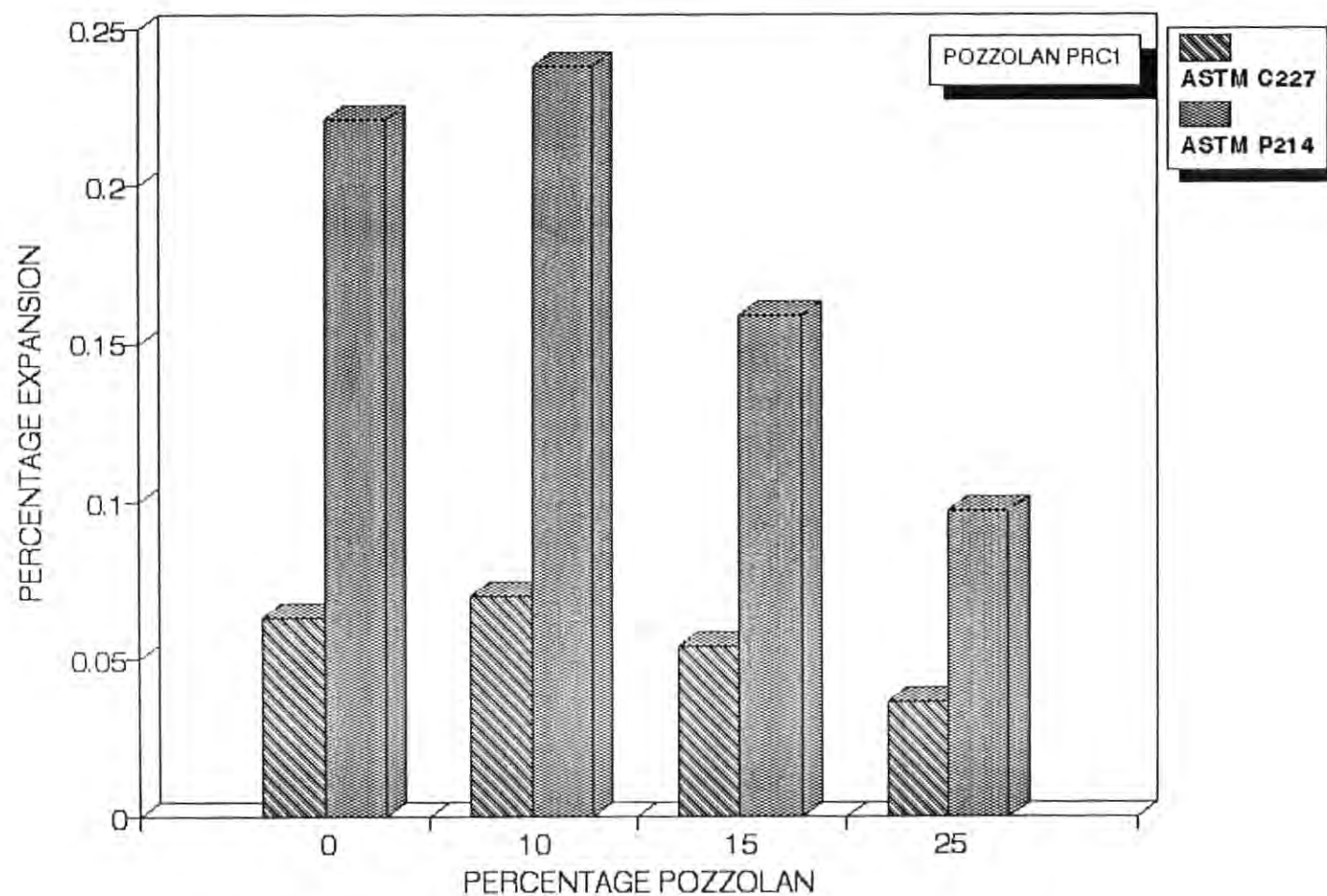


FIGURE 47 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

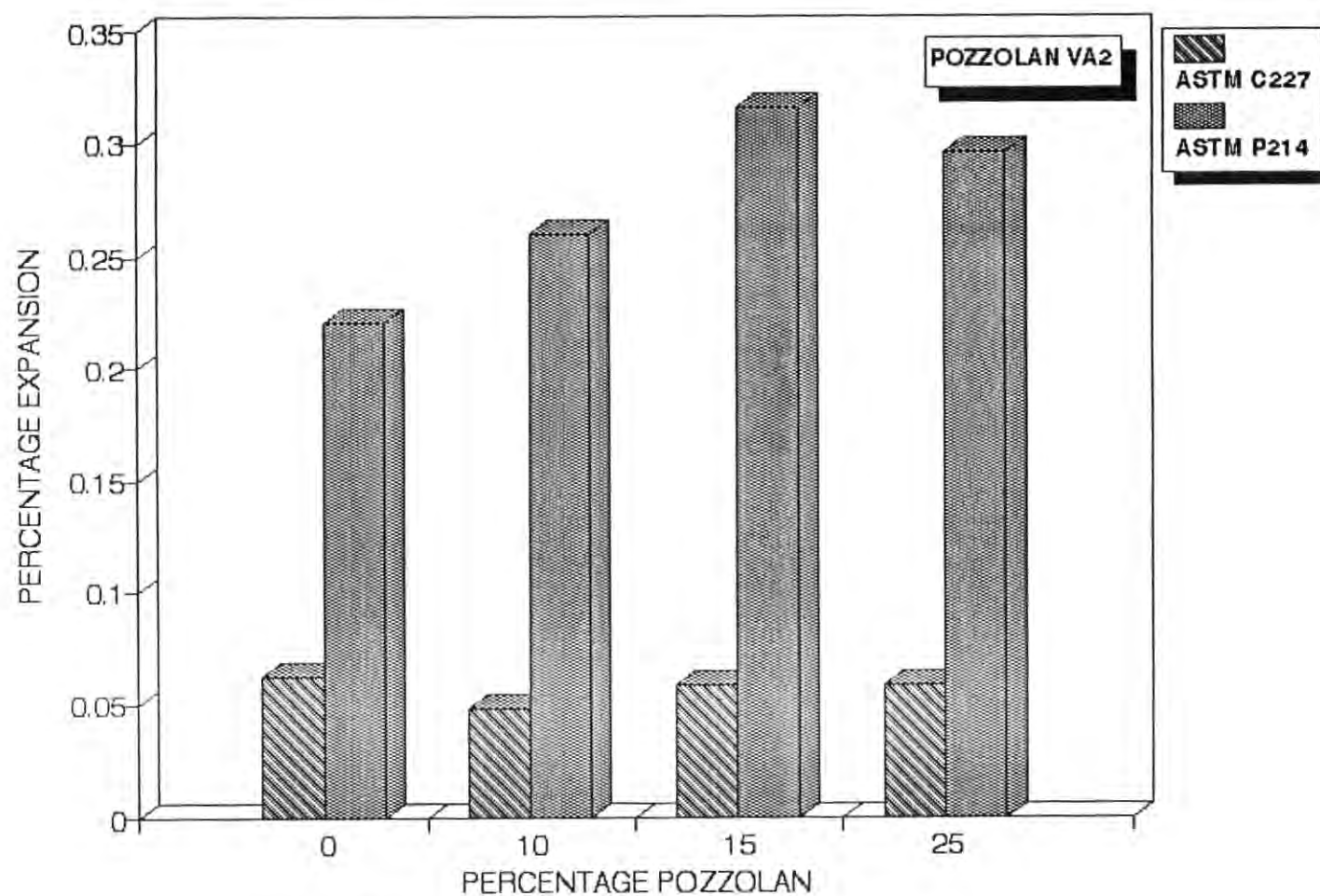


FIGURE 48 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

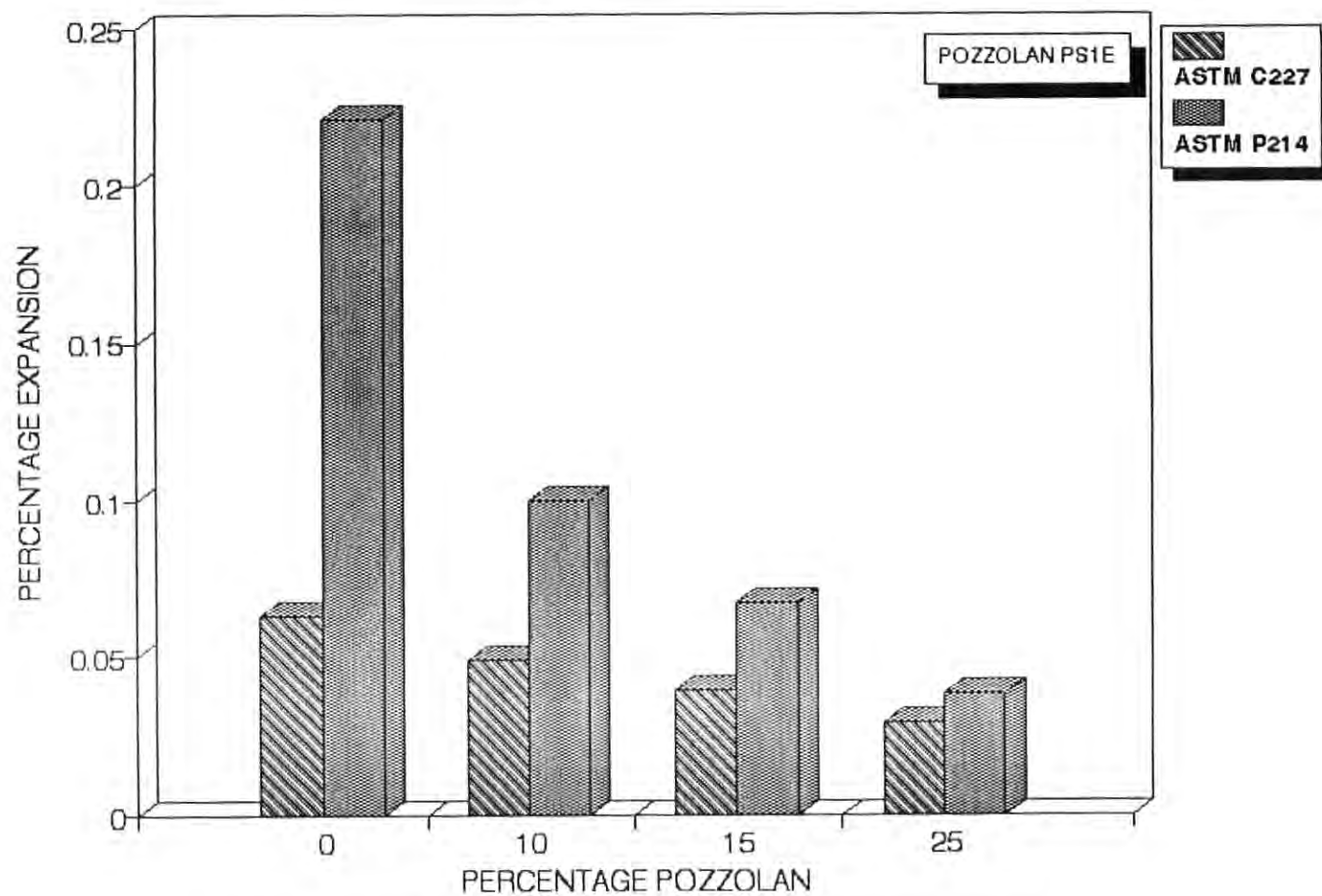


FIGURE 49 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

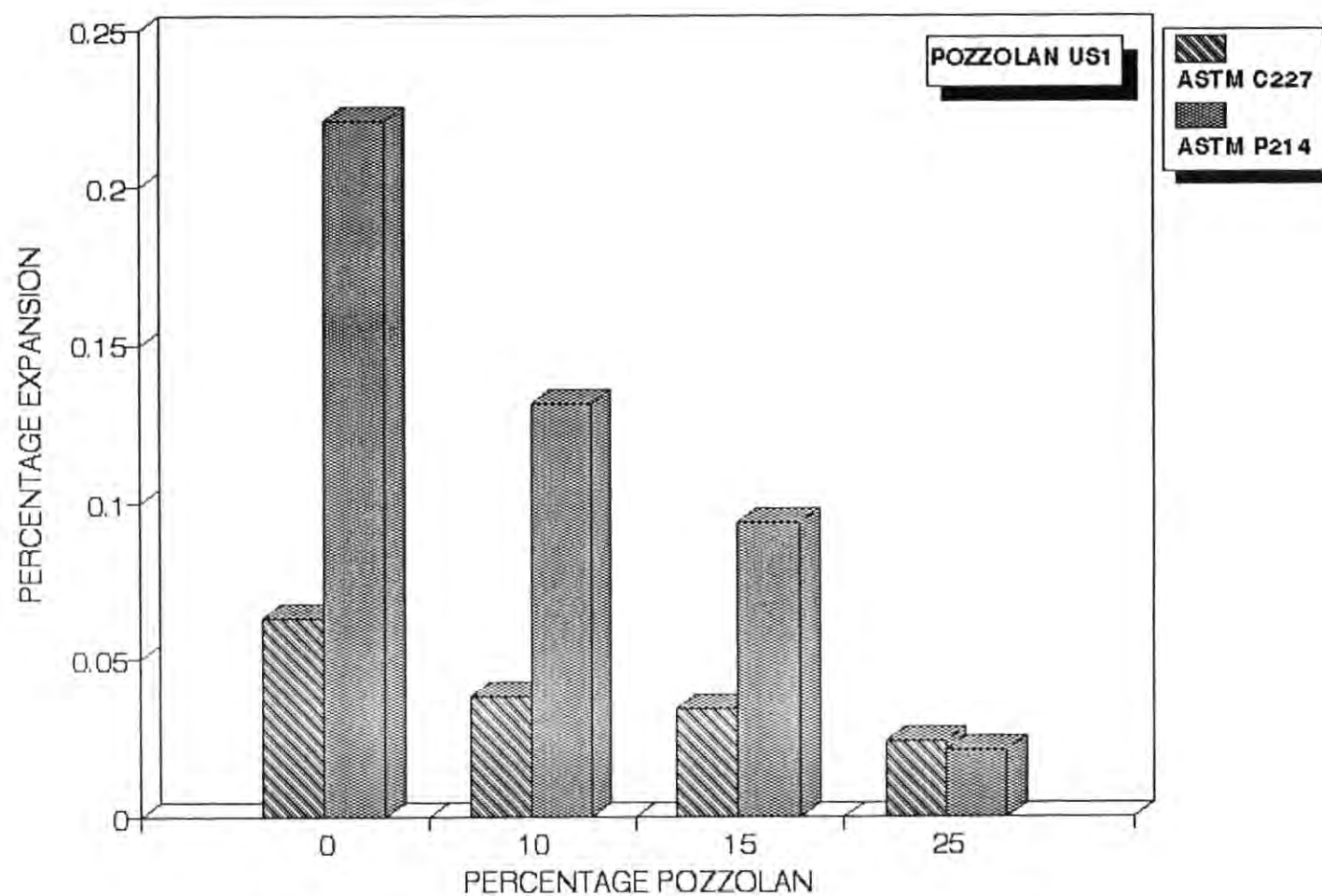


FIGURE 50 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

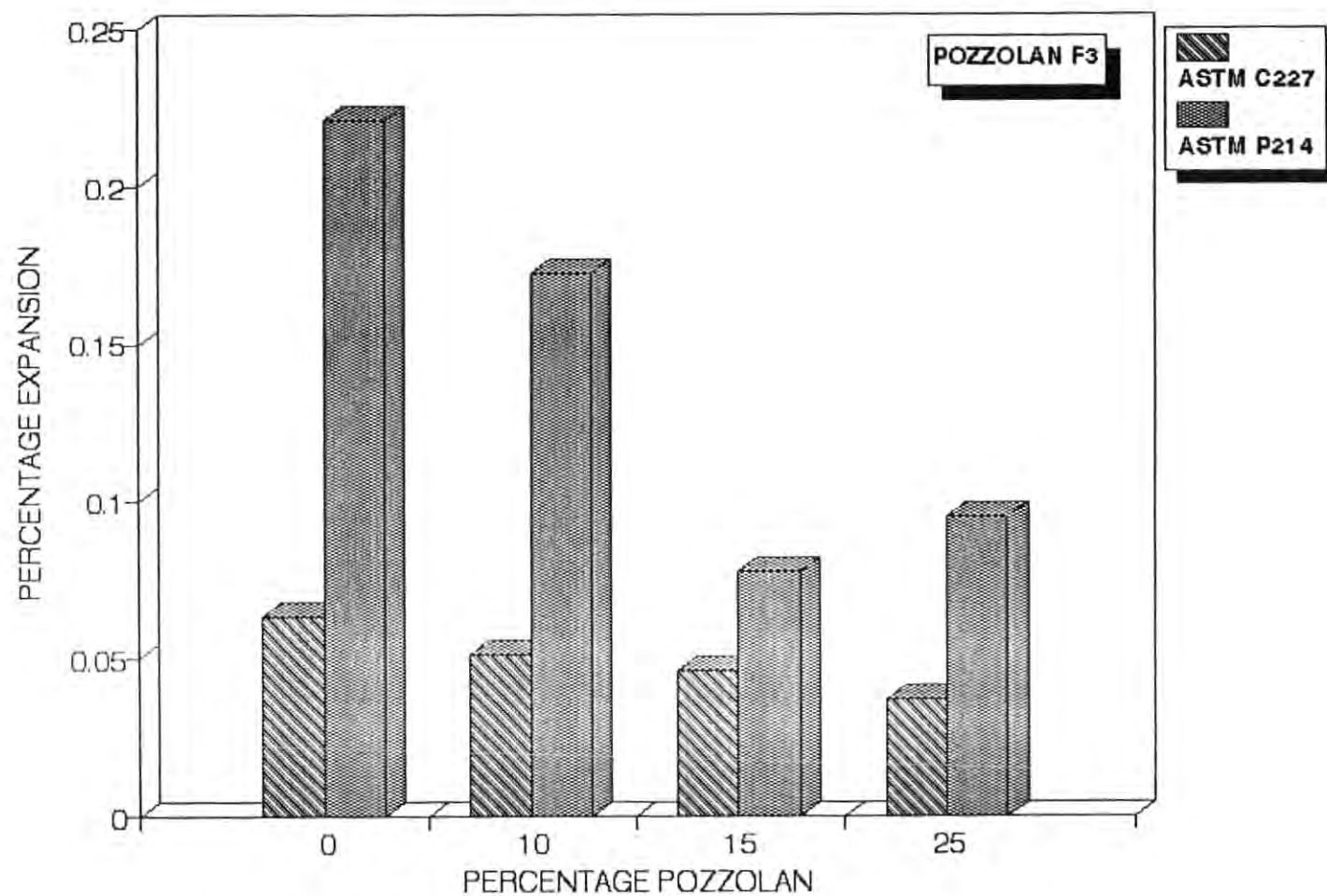


FIGURE 51 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

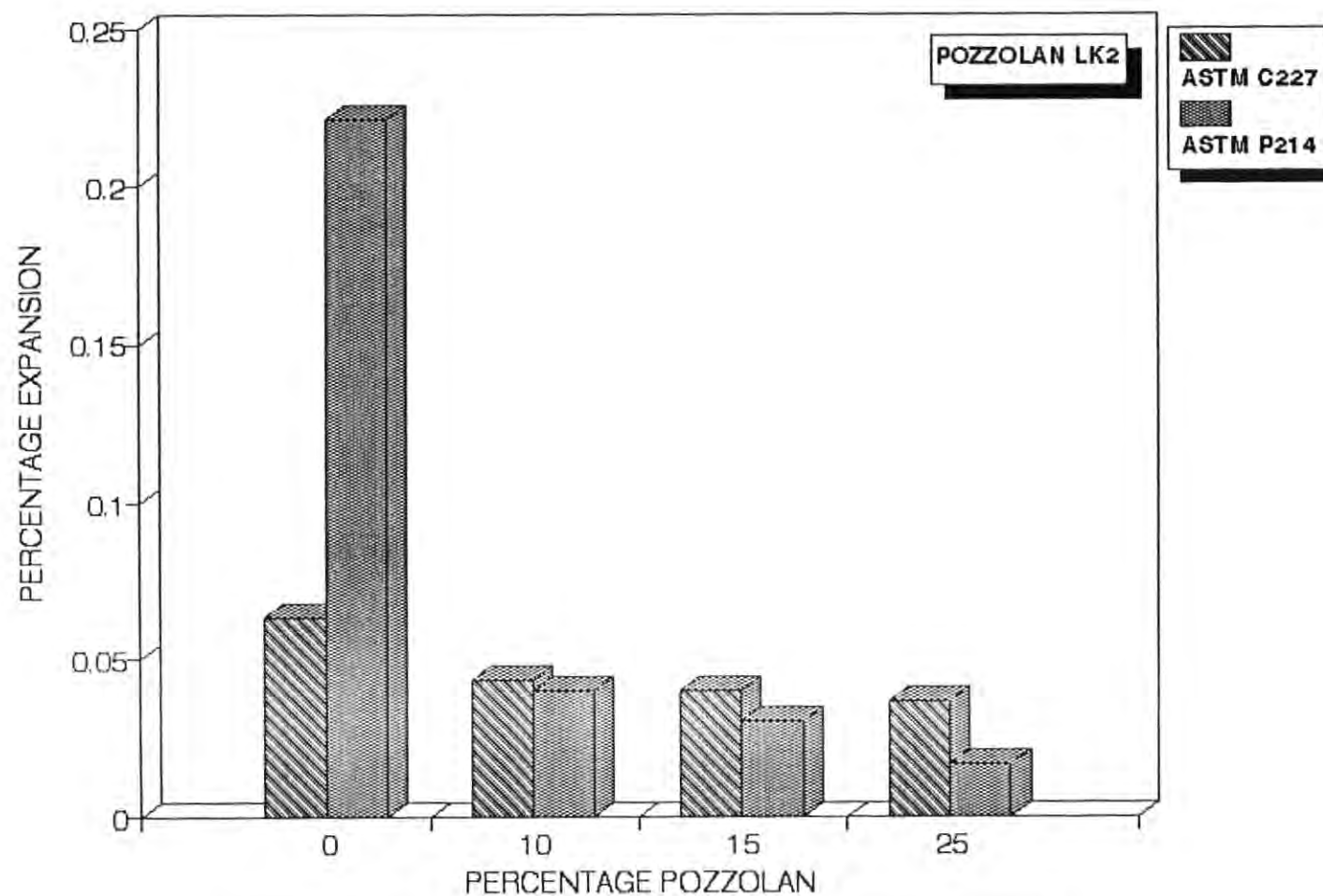


FIGURE 52 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

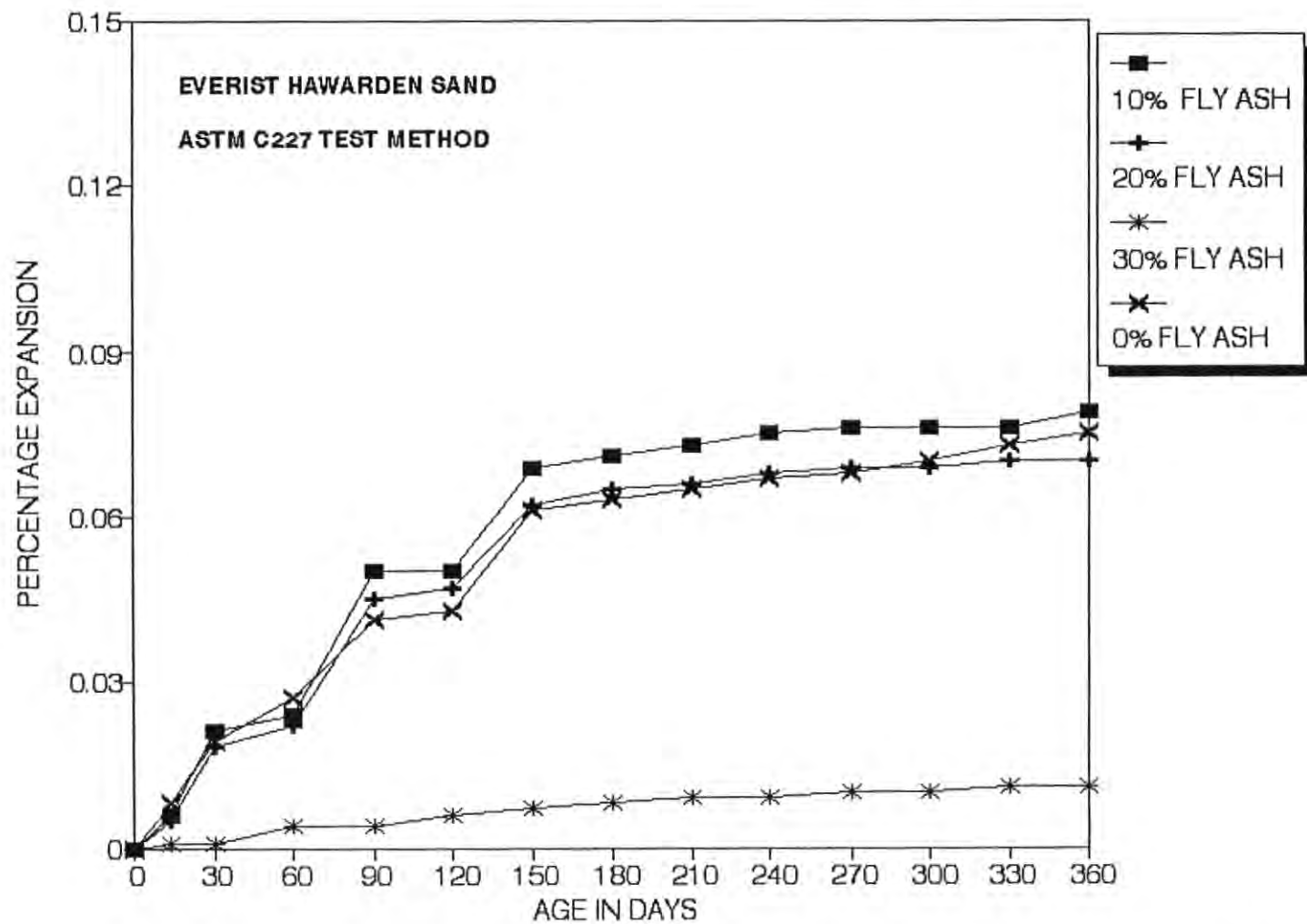


FIGURE 53 COMPARISON OF EXPANSIONS WITH AND WITHOUT FLY ASH

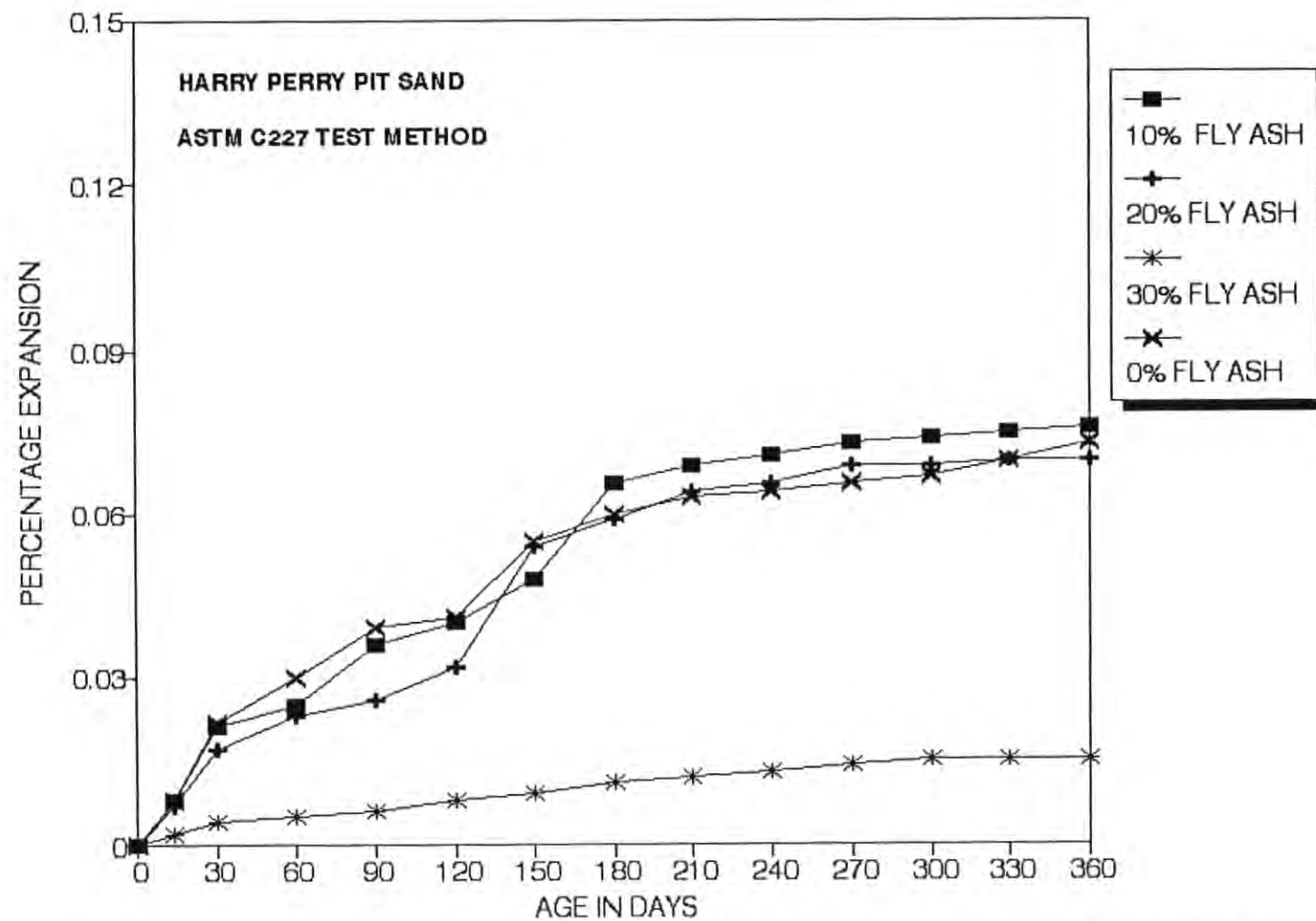


FIGURE 54 COMPARISON OF EXPANSIONS WITH AND WITHOUT FLY ASH

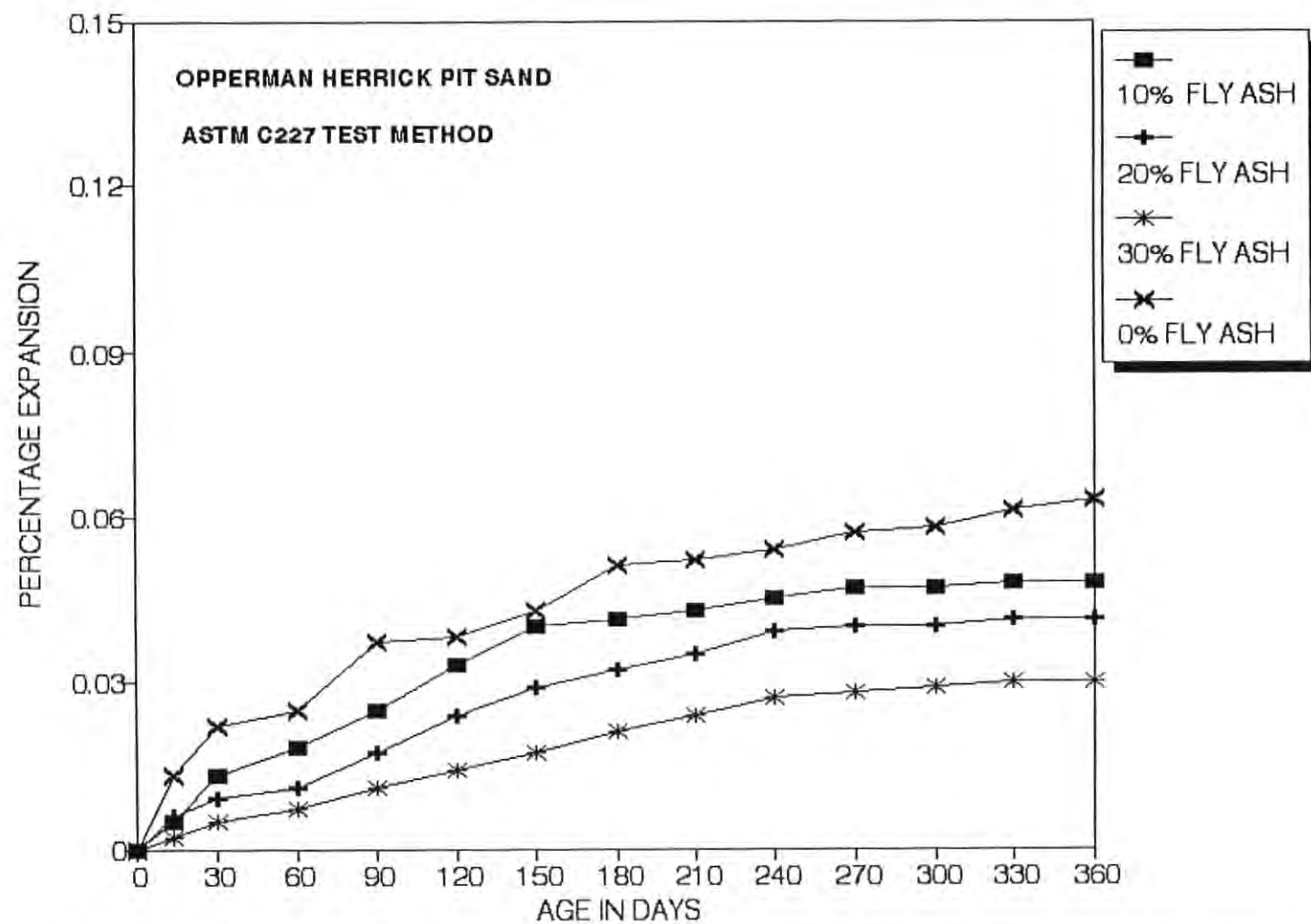


FIGURE 55 COMPARISON OF EXPANSIONS WITH AND WITHOUT FLY ASH

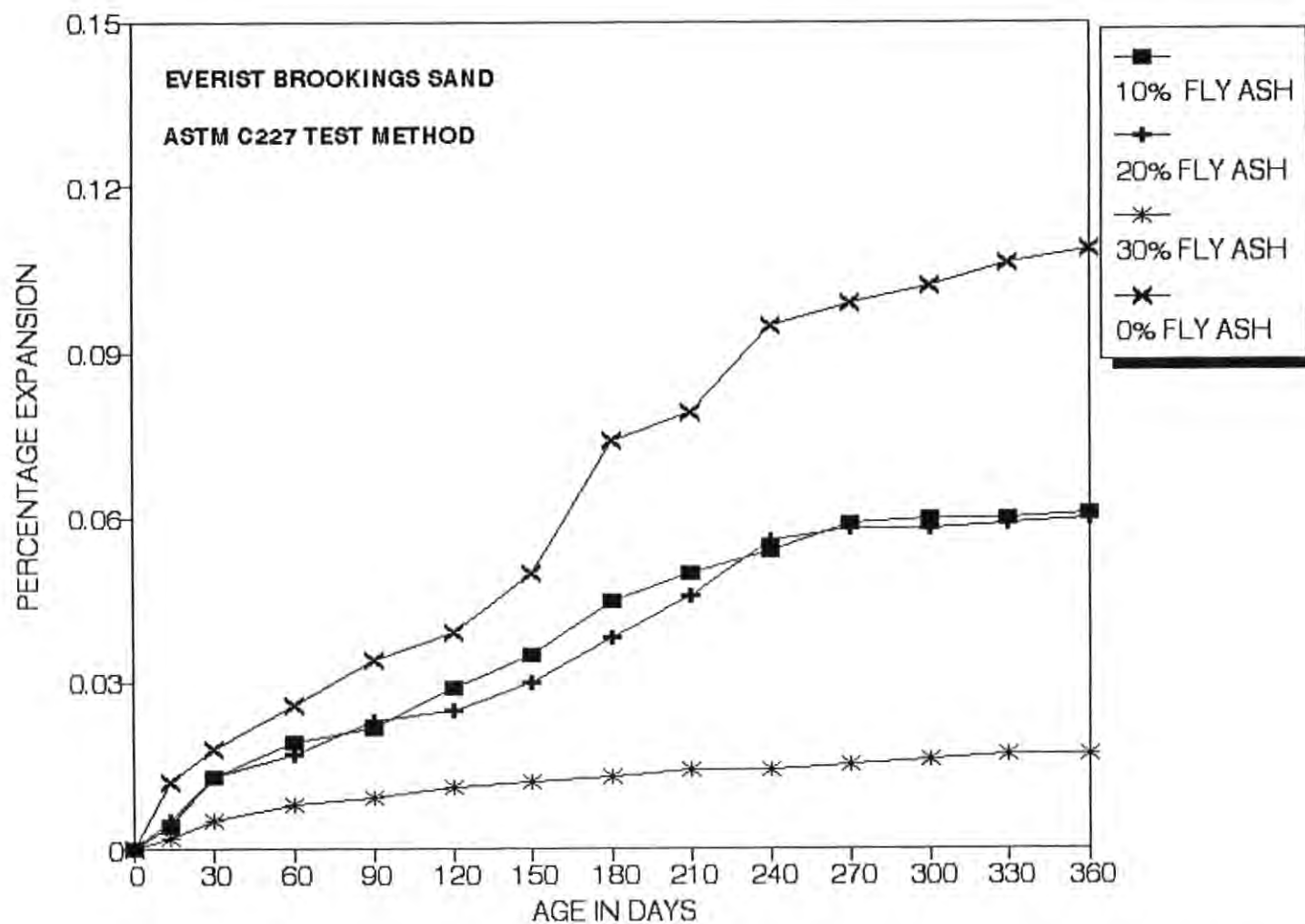


FIGURE 56 COMPARISON OF EXPANSIONS WITH AND WITHOUT FLY ASH

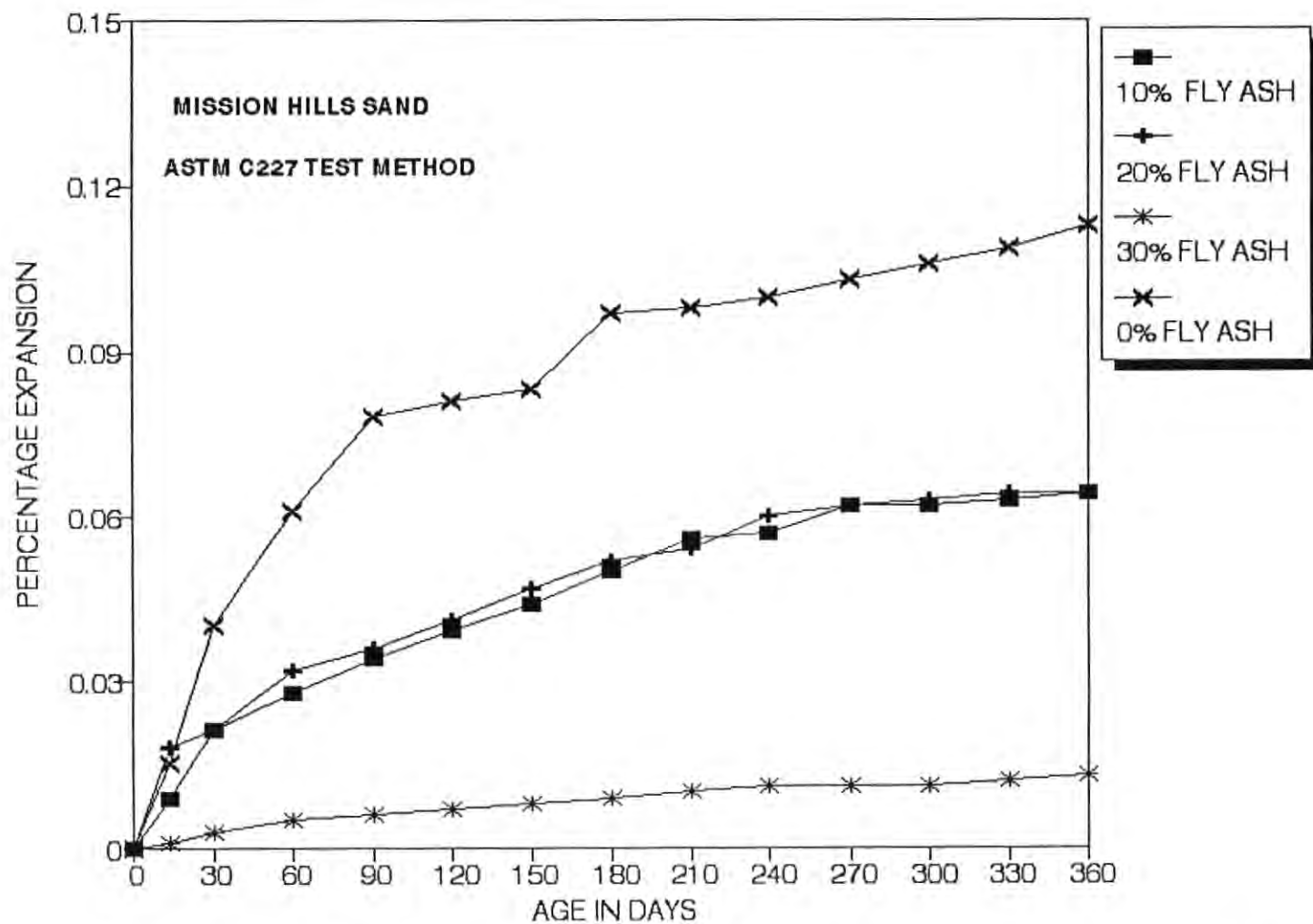


FIGURE 57 COMPARISON OF EXPANSIONS WITH AND WITHOUT FLY ASH

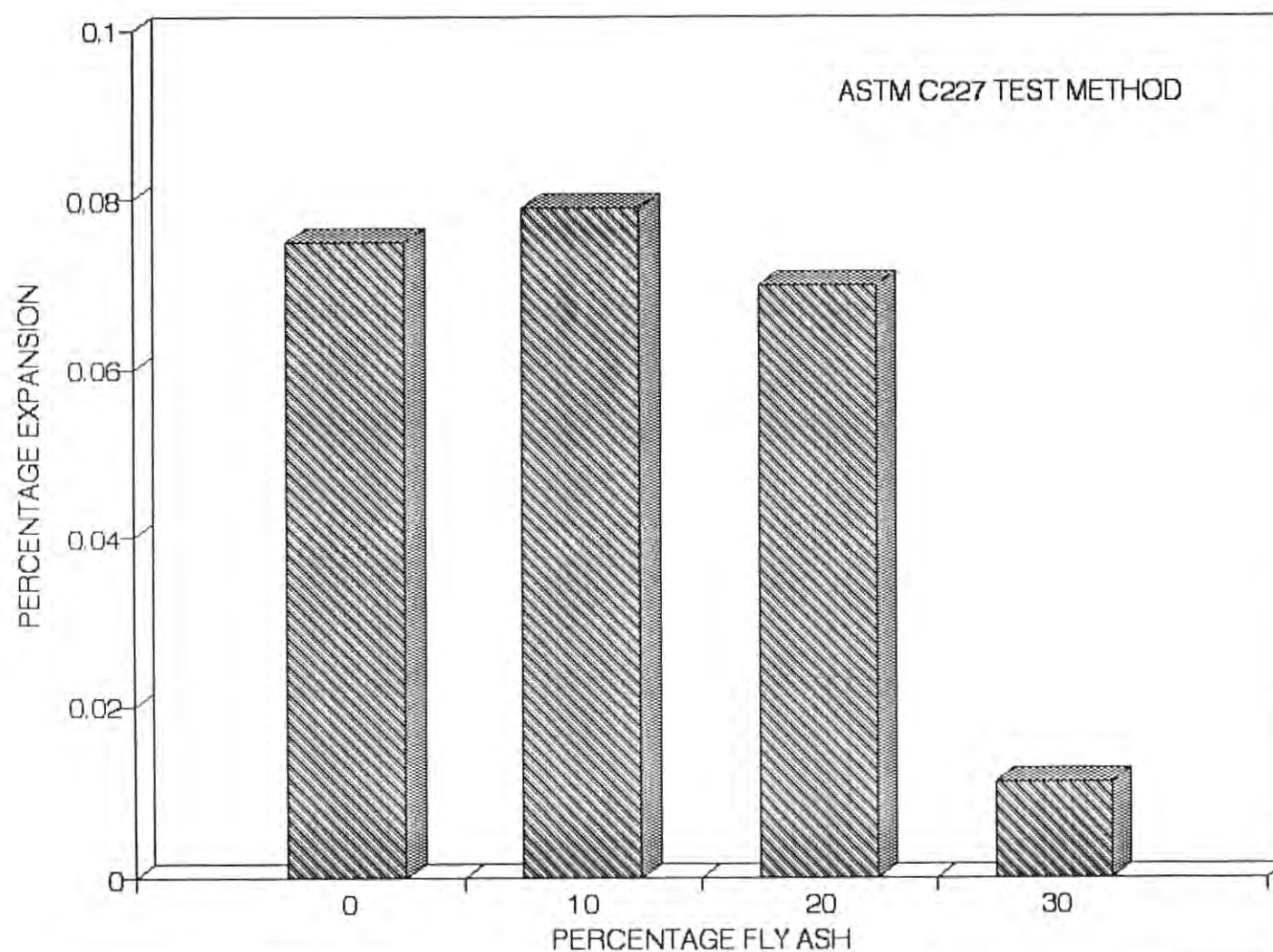


FIGURE 58 COMPARISON OF EXPANSIONS FOR EVERIST HAWARDEN SAND

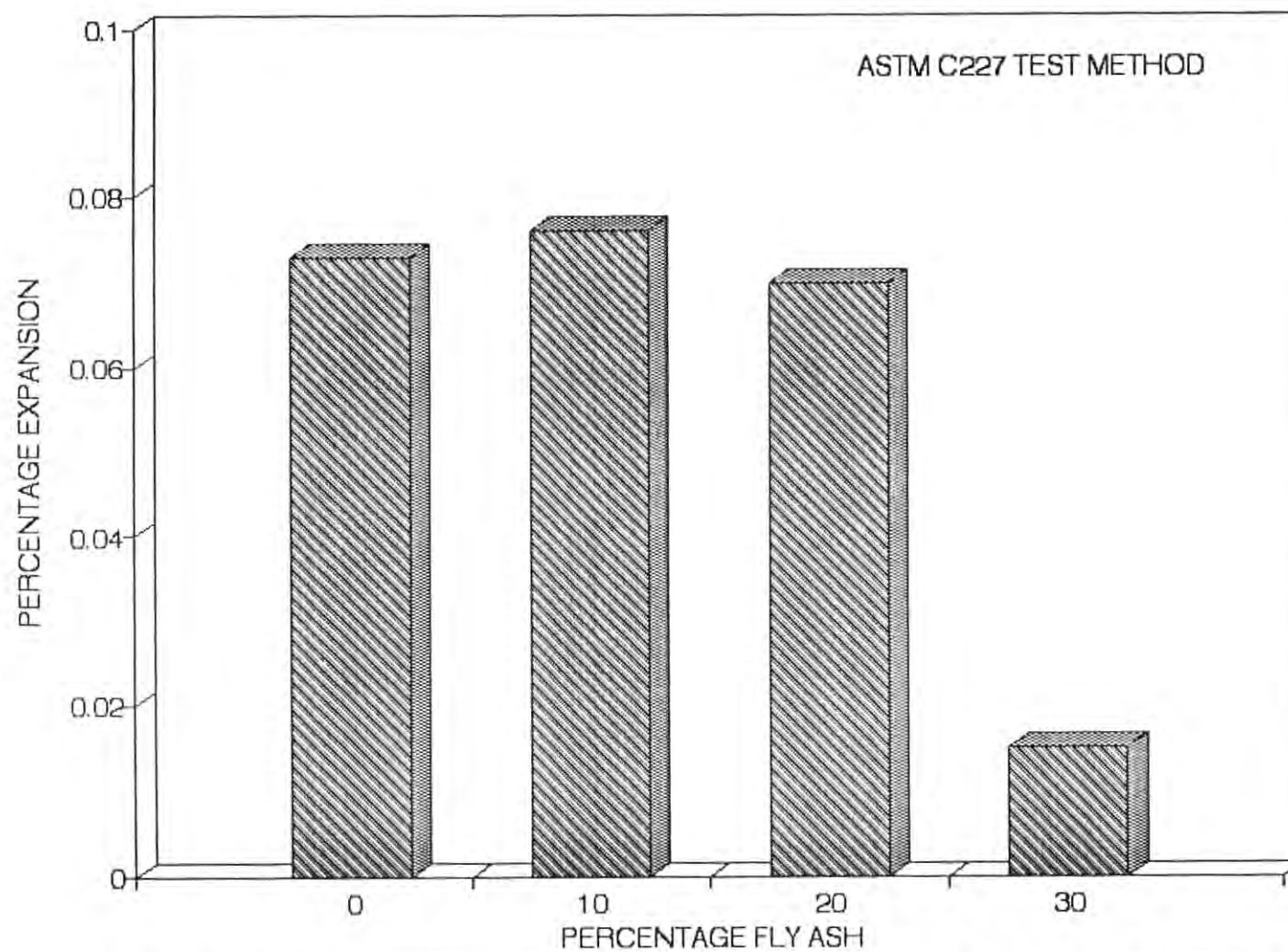


FIGURE 59 COMPARISON OF EXPANSIONS FOR HARRY PERRY PIT SAND

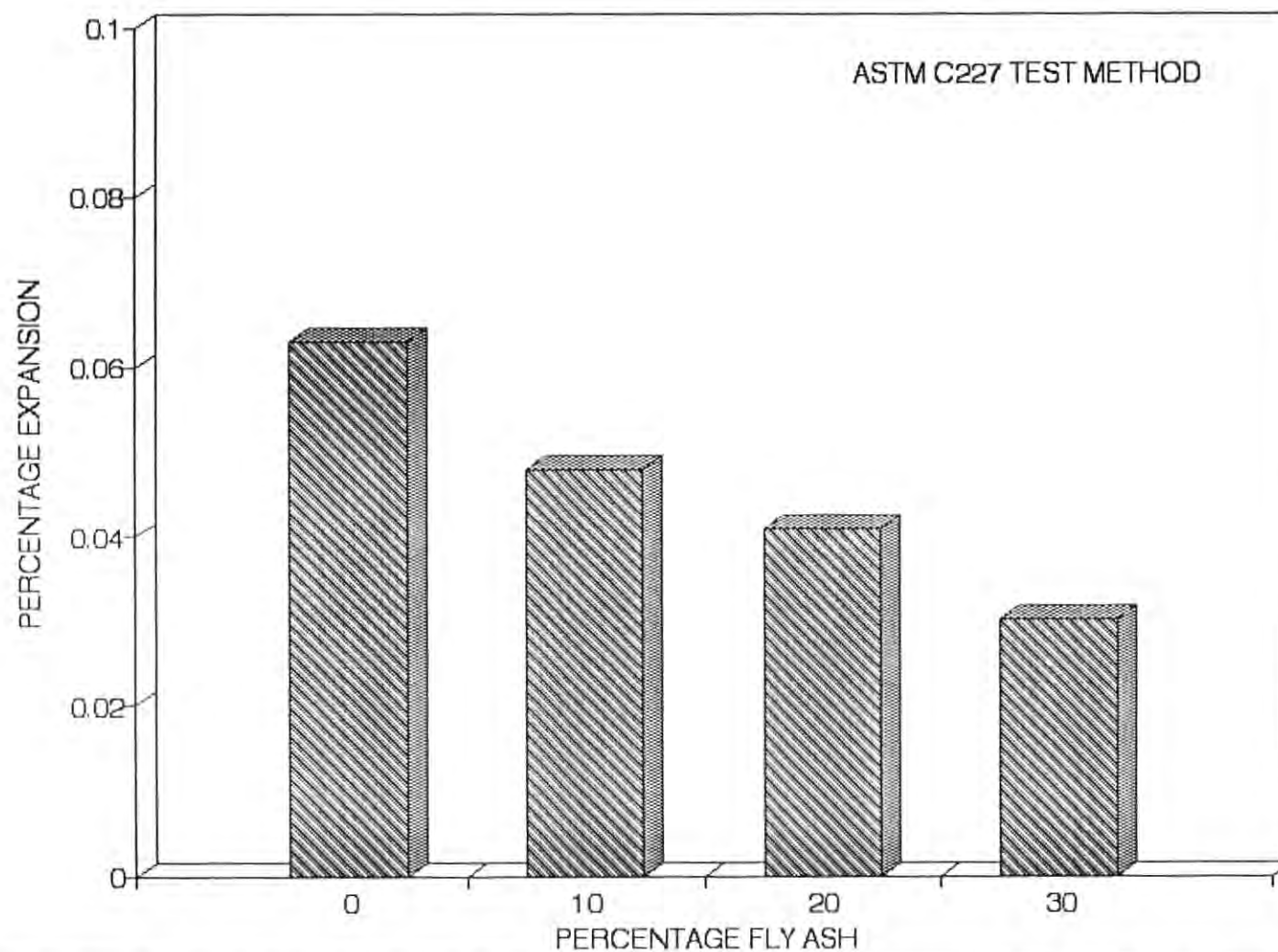


FIGURE 60 COMPARISON OF EXPANSIONS FOR OPPERMAN HERRICK PIT SAND

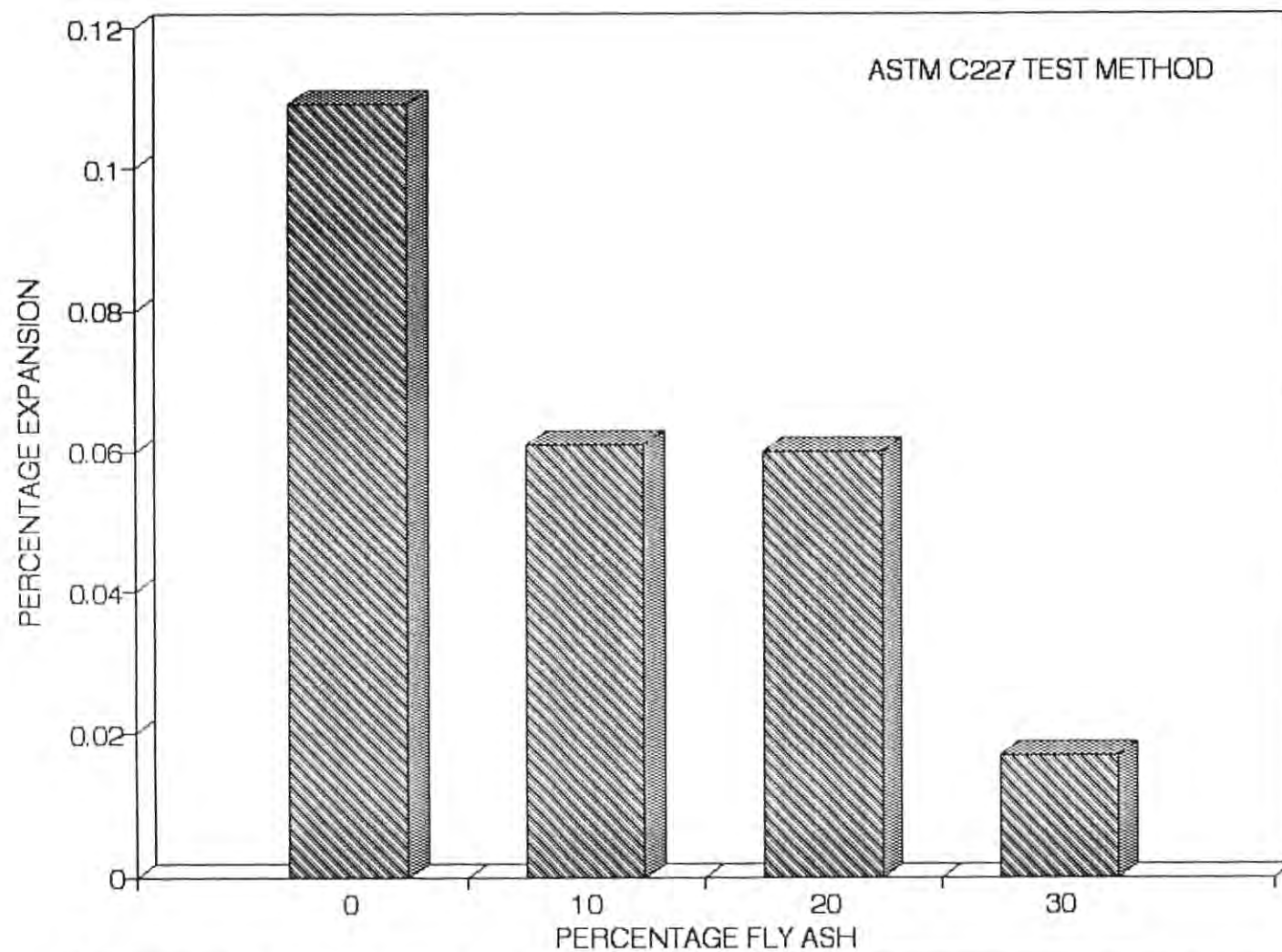


FIGURE 61 COMPARISON OF EXPANSIONS FOR EVERIST BROOKINGS SAND

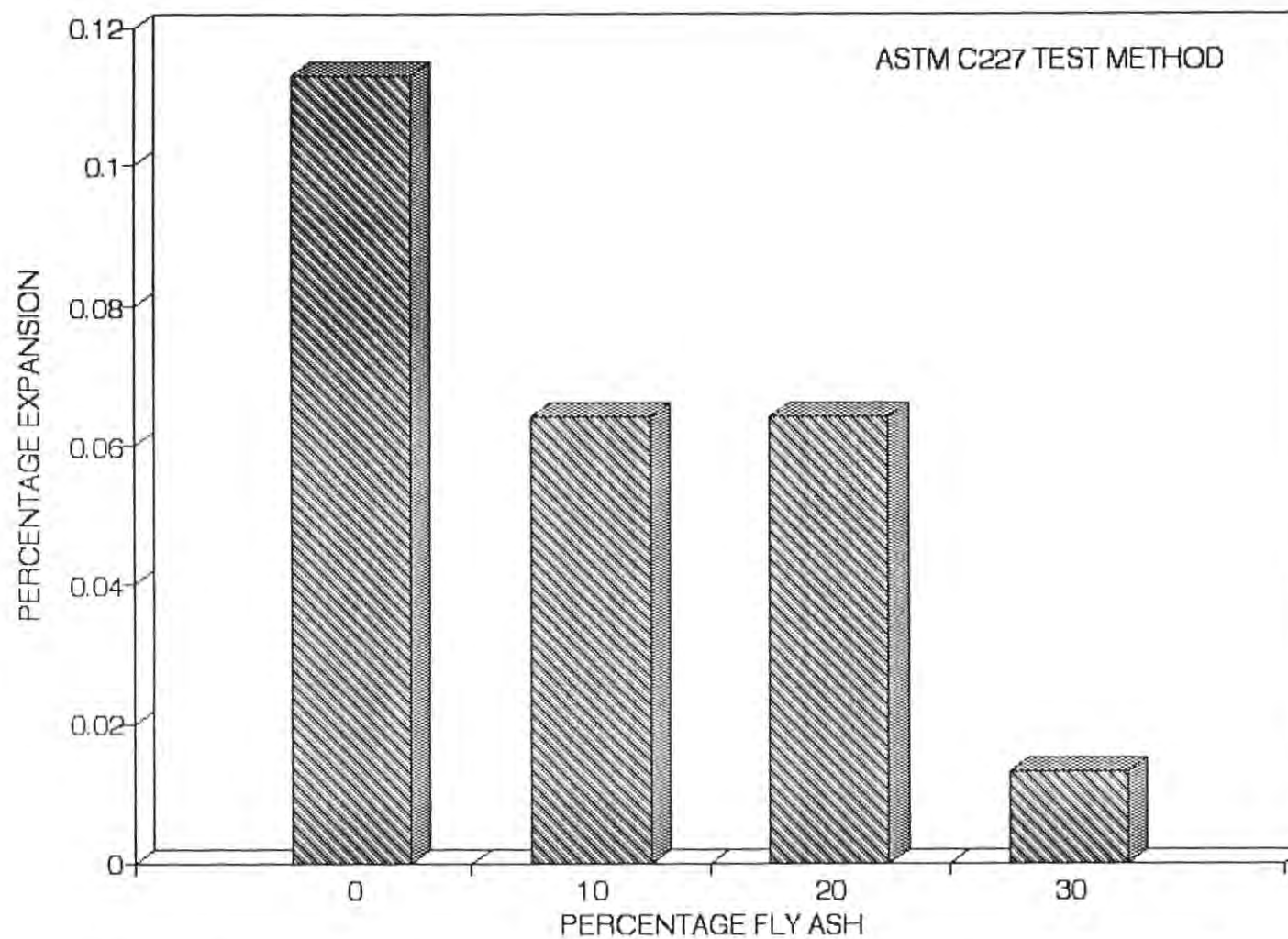


FIGURE 62 COMPARISON OF EXPANSIONS FOR MISSION HILLS SAND

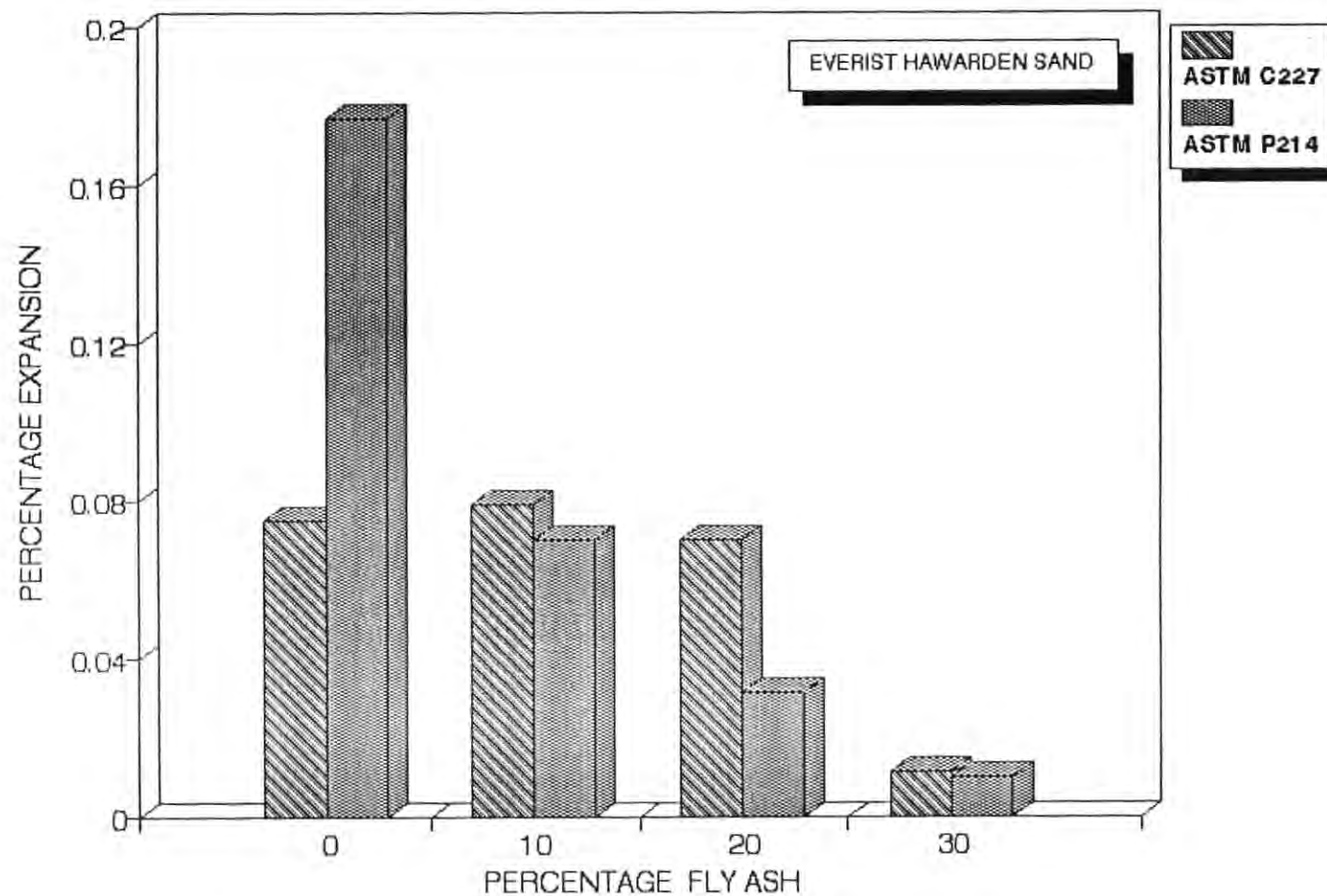


FIGURE 63 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

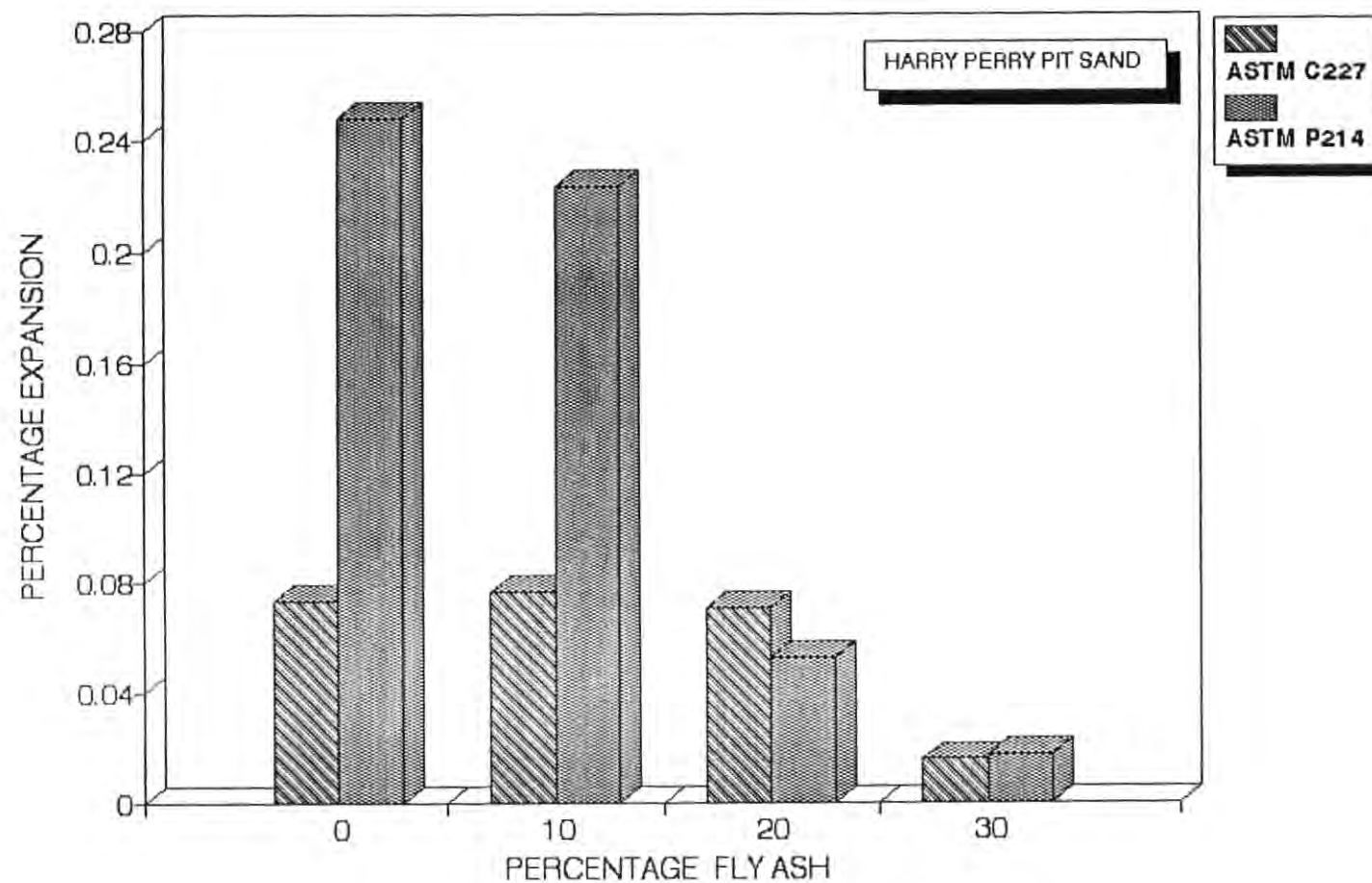


FIGURE 64 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

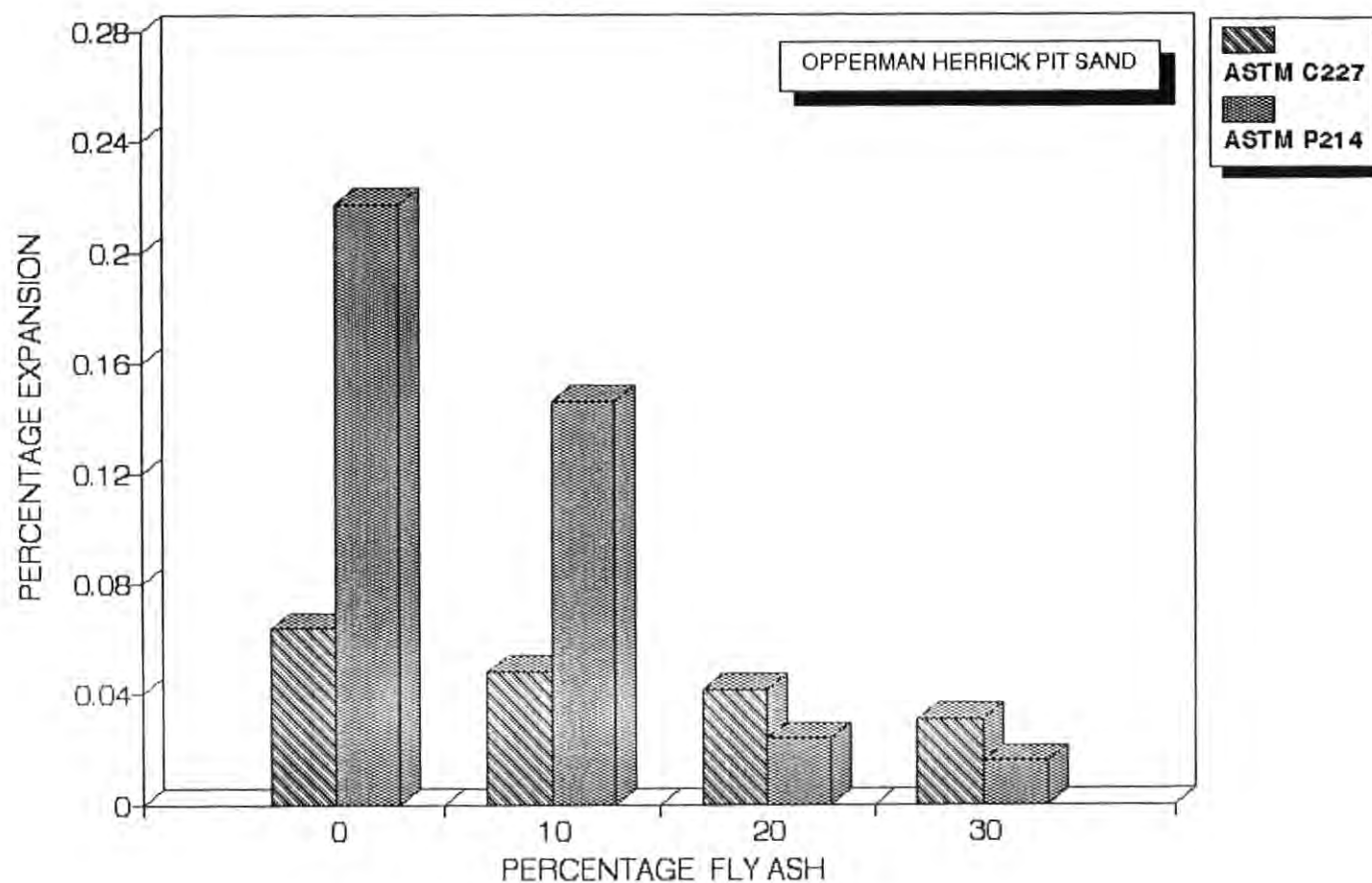


FIGURE 65 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

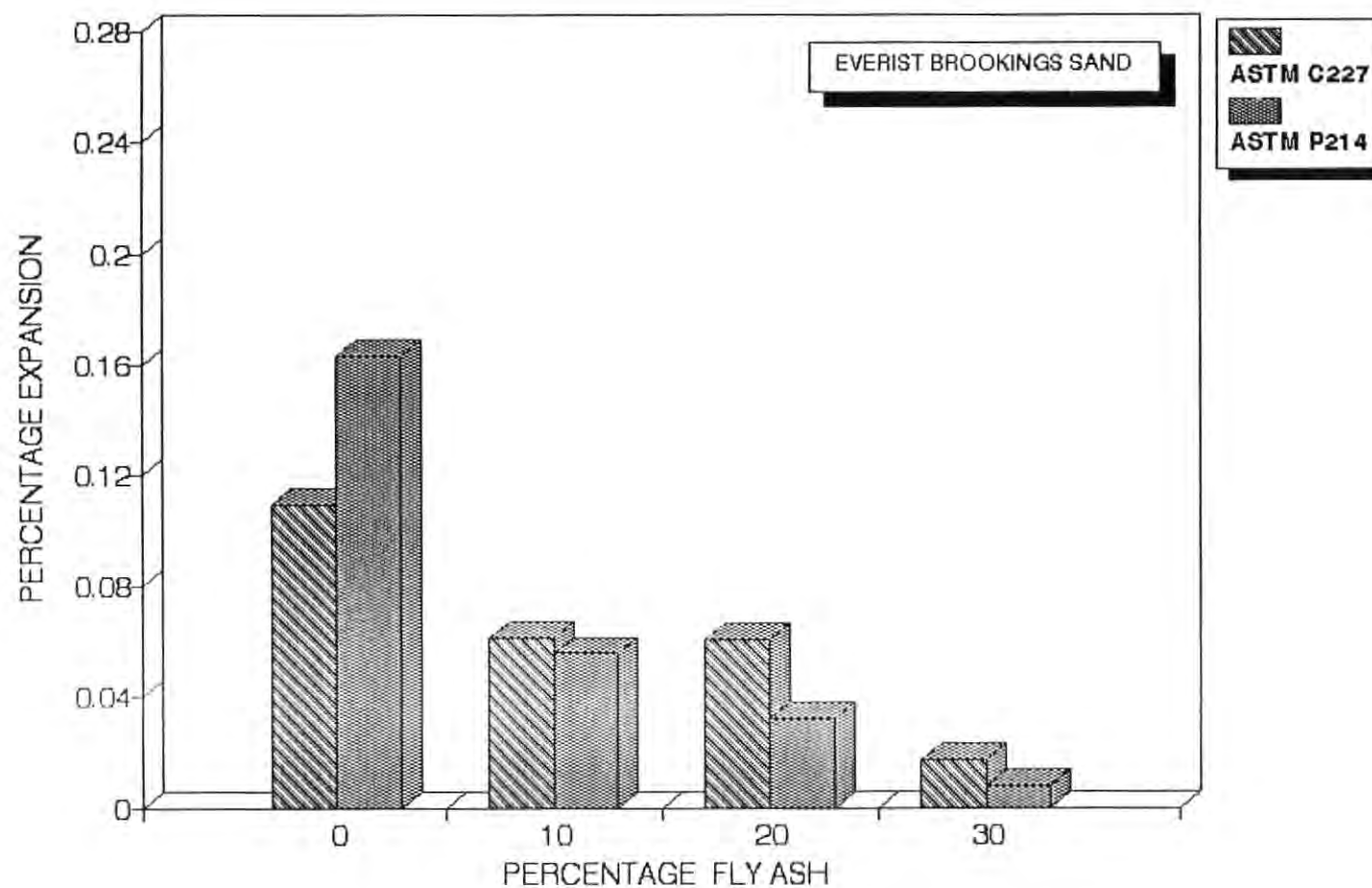


FIGURE 66 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

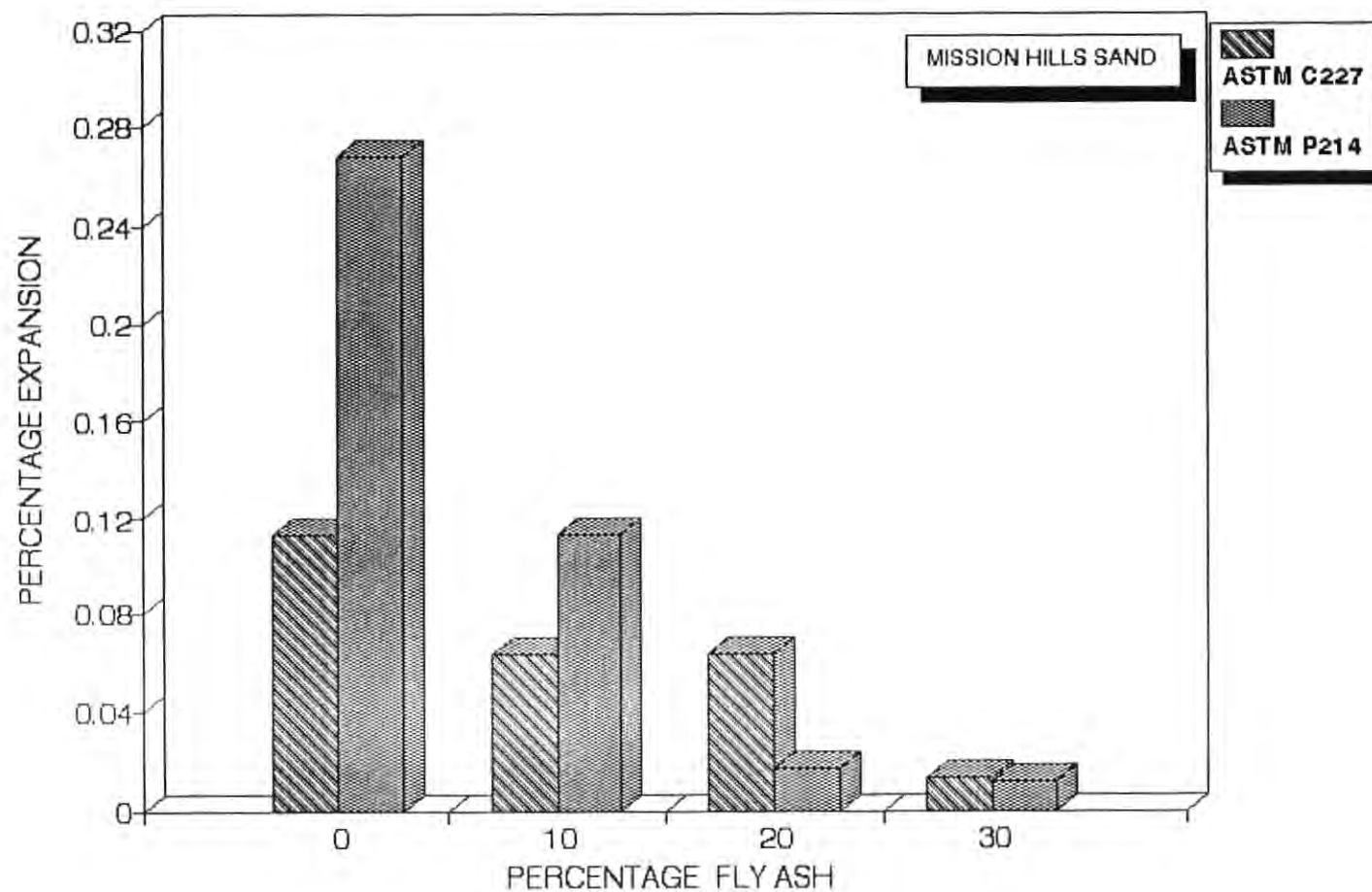


FIGURE 67 COMPARISON OF EXPANSIONS FROM
ASTM C227 AND ASTM P214 TEST METHODS

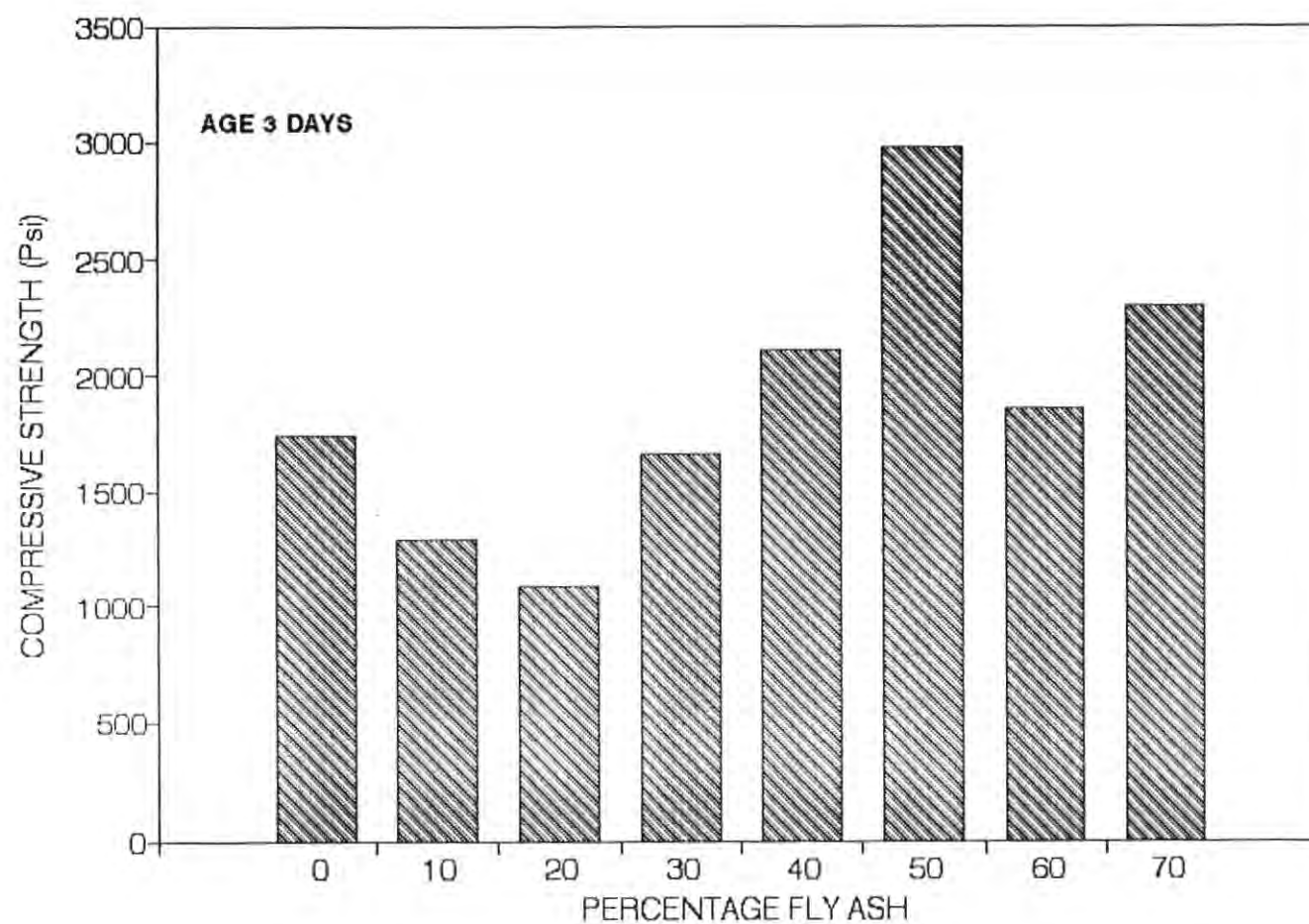


FIGURE 68 COMPARISON OF CUBE COMPRESSIVE STRENGTH WITH AND WITHOUT FLYASH

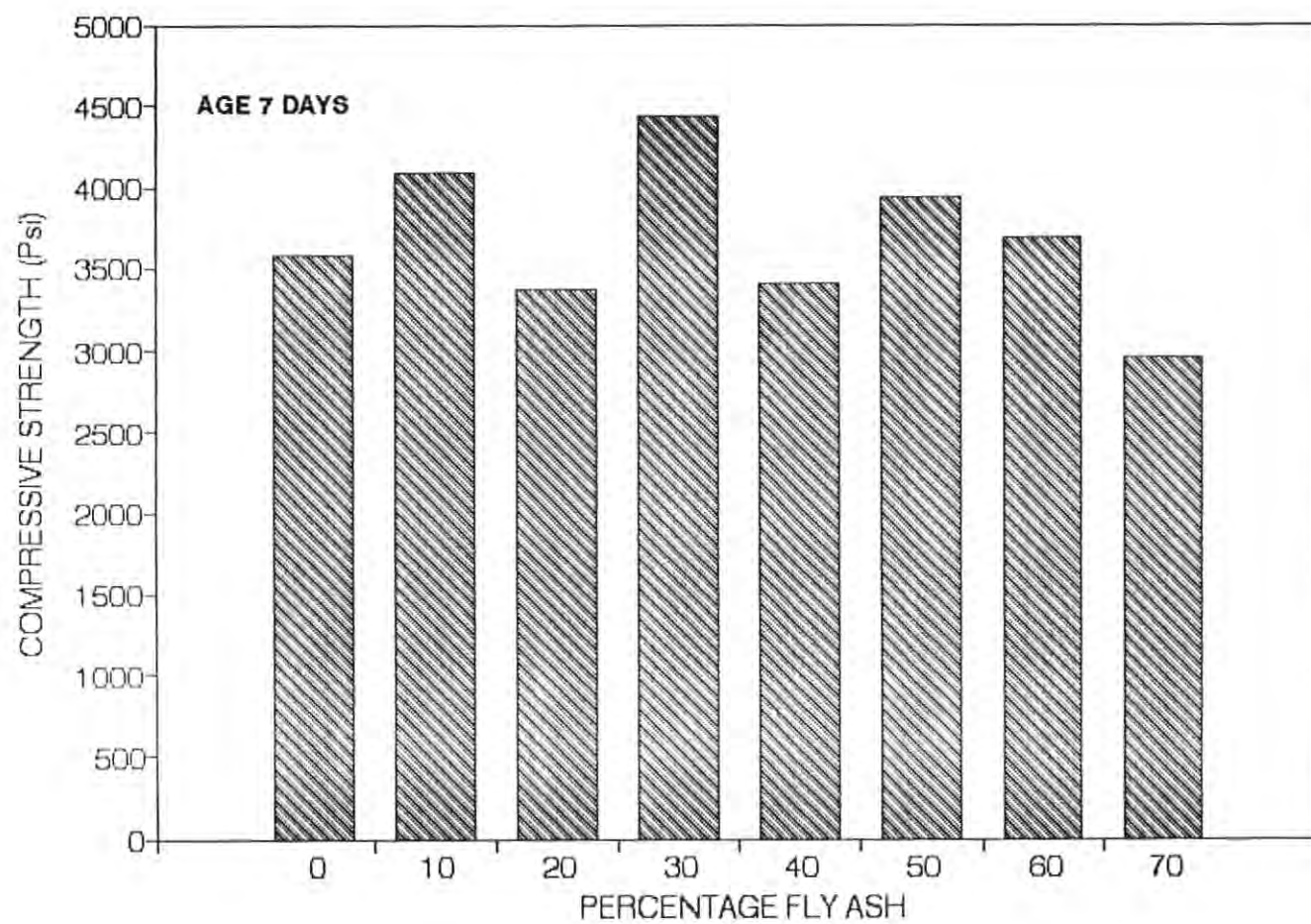


FIGURE 69 COMPARISON OF CUBE COMPRESSION STRENGTH WITH AND WITHOUT FLYASH

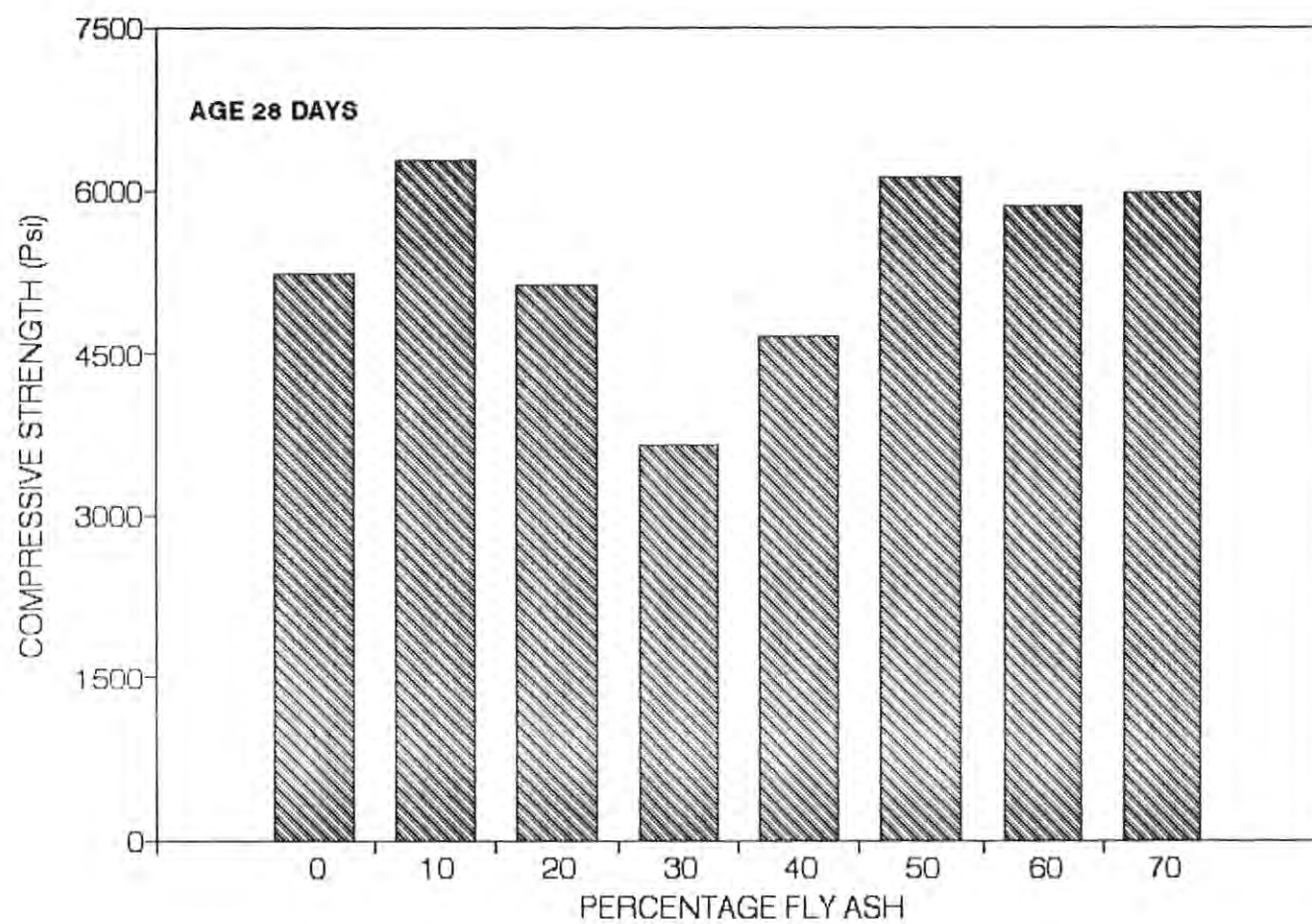


FIGURE 70 COMPARISON OF CUBE COMPRESSIVE STRENGTH WITH AND WITHOUT FLYASH

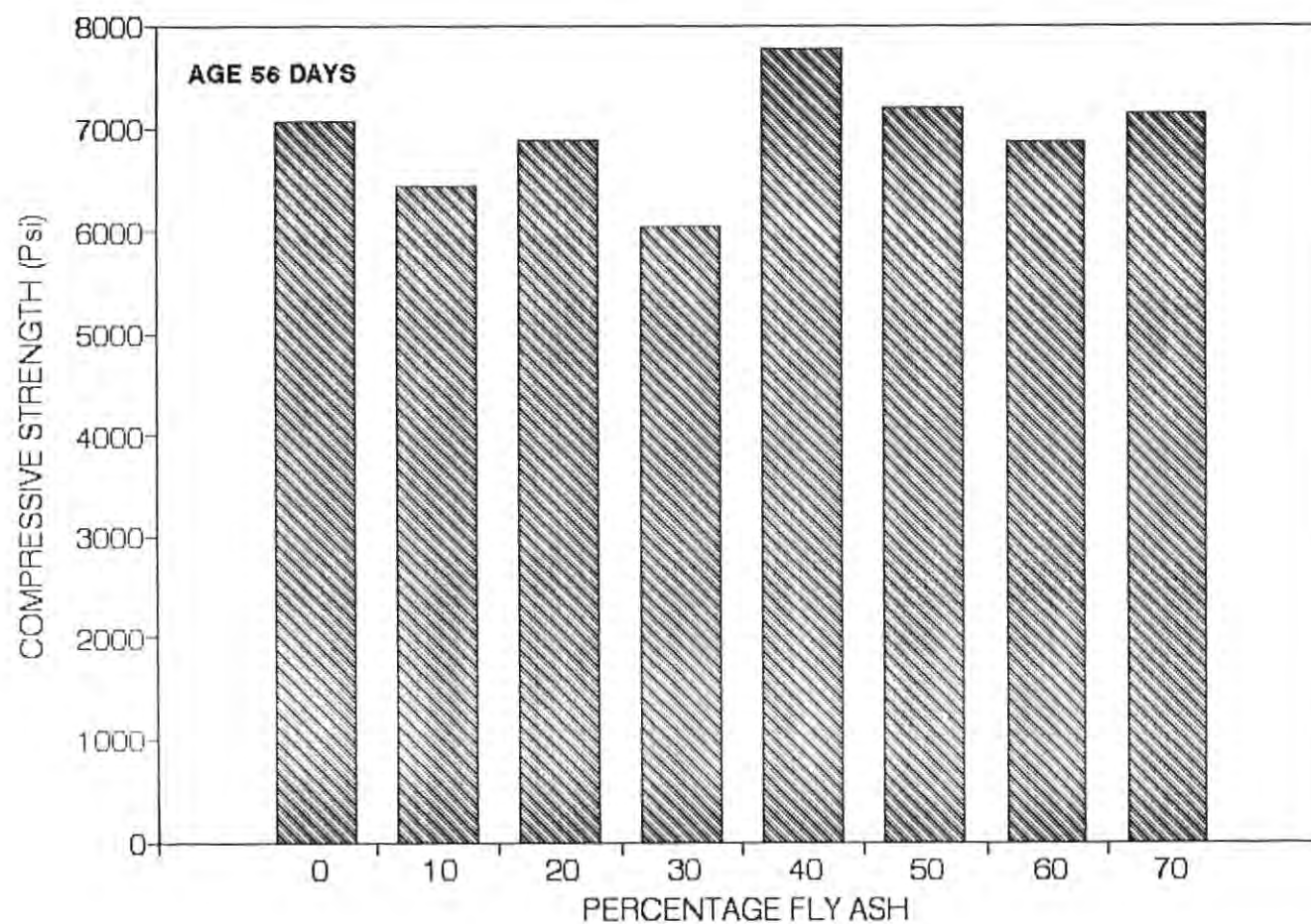


FIGURE 71 COMPARISON OF CUBE COMPRESSIVE STRENGTH WITH AND WITHOUT FLYASH