The Invention employs direct use of ground quicklime with pozzolans according to its own principles for attaining highest compressive strengths with a determined optimum content (rate) by binding more amounts of active calcium oxide to pozzolan(s) and obtains higher strength cements compared to the known ones and by inclusion of portland products, calcium sulphates resources, activators, chemical additives and other materials enhances higher strengths and properties. With Invention's quicklime based methods, 18%-38% more active calcium oxide compared to hydrated lime practices can be bound in the reaction for developing stronger ties to reach to compressive strengths and properties that could satisfy almost all market needs expected from general purpose cements in more economically and most environmentally friendly manner.
DESCRIPTION

POZZOLAN-QUICKLIME BINDER

The Invention is related to binder cements in powder form composing of pozzolan(s), quicklime and other materials to be used for all needs of construction sector and industry which are not requiring very high physical strengths, where pozzolan(s) are used in excess of 50% as primary ingredient among others. The invention covers all pozzolans natural or artificial and is based on hundreds of tests and observations related to many of them. It is applicable to all materials having pozzolanic reaction capability. It is well known that the cements of various pozzolans with hydrated lime are being used by various civilizations since neolitic era through thousands of years, Roman and Egyptian practices being most differentiated. It is also well known that, today also, in countries like India, binders composed of calcined clays and hydrated lime are still being used. The Invention uses the non hydrated quicklime directly, which have only been used as activator agent in some practices and not been used directly as one of major components in the mix. With this kind of use, the most apparent measure of binder evaluation, the compressive strength, are attained at far higher levels. The other fundamental evaluation criteria like water absorption, water-binder ratios, porosity are also obtained in far more favorable values. The Invention, primarily assess the theoretical facts behind these and building on these strong findings, reveals how proportioning of major ingredients of Invention’s binders can be determined. The Invention is in a coverage that can remove all the reasons that are limiting pozzolan(s) -hydrated lime binders extensive use and market preference. These reason are, delayed early strengths and late serviceability and longer protection requirement, further deterioration of strength gaining under high humidly or as water soaked and loss of strength at many events under such conditions, high water-cement ratios, higher porosity, decrease of durability, non sufficiency of final compressive strengths for too many of the uses. For these reasons, almost all practices are realized with portland cements or mixes of portland cements with hydrated limes.

Use of pozzolan(s) in practical real life, are being left to the definitions and limits that are used in portland cements (as blended cements). Like this, minimum fifty percent of portland cements are being used for practices like mortars, plasters, block making, lean concrete etc which does not require the strengths that portland cements already are capable of providing inherently. This fact is stated in UN Habitat publications also. The studies and tests implemented has proven that the new cements are capable of providing sufficient compressive strengths, excellent workability, sticking, placing, water retention, sufficient set time like many of the already marketed recepies. Eg, the market ready mix plasters are involving 25-30 % by weight cement-hydrated lime mix while our new cements use 25-30 % binder also, whose 65-70 are substituted with pozzolans. Ie, they realize same task by using cement and lime only as 30-35 % of the existing practices. The results obtained as such are not like the ones obtained from the ones by adding pozzolans and hydrated lime to portland cements, although such
products might also be considered as important. The new binder cements according to the Invention are capable of involving generally only 9-12 % of portland cement by weight in total binder cement weight, in binders where portland cements are used. This creates a large area of advantages. Many kinds of cements for various applications can be obtained and used.

Portland cement sector solely is held responsible for creating 7-8 % of world's total carbondioxide emissions and also held responsible for very high energy consumption. Further, negative impacts of half of its raw materials being lost or wasted as gases and wastage should be stated. The binder cements as per the Invention, shall have very considerable contribution to this great environmental problems and further, have cheapest solutions for raw materials for production and for obtaining the production sets or plants and for energy consumption. It shall facilitate lowest cost use of binder products reaching to a complete sustainability. These facts shall facilitate easier reach to cement of the poor who cannot obtain it even for basic shelter-housing needs. The Invention provides production of products filling an important gap in fully industry applicable manner beginning from the underlying theoretical aspects, to mix proportions, to explaining of distinctive aspects and benefits, their applications to industry and its limits, for the first time.

Also for the first time, provides product formation in plannable, calculatable and applicable manner. With the Invention, the quicklime is being used as a major component and given a main role instead of known secondary raw material or an activator material position in the known practices. Many of these known works are related to use of 3-5 % quicklime for fly ash systems activation. There are very rare works in literature, where quicklime is used as one of the major components.

These mostly consider a single pozzolan and assign assumptional or random calcium oxide ratios or portland cements or other ingredients ratios and over these data they try to measure effects of some chosen variables. In some other studies, hydration reactions, pozzolanic reactions, portland cement reactions kinetics' products and results of these are being tried to be explained and solutions are being derived with many axiomatic and hypetetic approaches for designing inputs and products formulations. Many times, systems are build on existing applications based knowledges that are being accepted as valid data or assumptions. The invention points to such a bias or mistake and assigns correct practice with their experimental basis. In all the above three situations, the products obtained could not be sufficient to meet existing usages physical strength and functioning requirements. For example, studies show influence of decreasing or increasing of portland cement or lime content but a binder system involving 30 % portland cement and 20-30 % lime can attain a 28th day compressive strength which can easily be attained by 10-15 % portland cement involving pozzolan (strength being only 1OMPa!! ). What function or use in practice to be obtained from this product in real life is not mentioned. In all three cases other results also not suitable to industry or practice are being obtained and such studies and activities take place as sole scientific studies.
A binder cement in the context of the Invention, can reach up to compressive strengths of 25 Mpa. Indeed, this is a strength that might satisfy many of the structural strength requiring functions. One should not forget that till few decades ago, these kinds of strengths were considered to satisfy all structural strength requirements and had been applied as such. Indeed, these strengths are sufficient to construct buildings which are not high rise. When it is considered that each and all kinds of pozzolans are not examined in our studies, the probability of obtaining better results from other pozzolans still exists also.

There is no knowledge of existence of a cement which is not portland cement and been produced in an fabrication industrial process. This negative fact alone can explain that a product applicable to industry and which is commercialized does not exist while an huge commercial area and extensive environmental protection continues to exist.

The Invention proves that the existing theoretical frame involves some defects and deficits and shows ways of obtaining higher strengths, applicable to industries which are economic, enviromentally protectionist non portland cements whose majority content are pozzolans. As shortest summary as per an Invention Description text; What was known and accepted till now was that, lime converts to calcium hydroxide with the addition of water and its hydration is completed prior to beginning (initiation) of the pozzolanic reaction and the formed calcium hydroxide initiates and forms the pozzolanic reaction defined in related literature. Very rare studies considered the quicklime and at maximum they explain a difference by only stating that reason that quicklime of same CaO content attains better strength results is that it is fresh and as such it is more reactive. According to theoretical basics of the existing understanding and to their application, the amount or rate of hydrated lime in reaction with any pozzolan for reaching to maximum strength by providing maximum of binding and by remaining least amount of non bound calcium hydroxide in terms of Calcium Oxide in hydrated lime, is considered the optimum rate in the total weight of the binder. This optimum rate or proportions (CaO) are determined on basis of hydrated lime and same rate is applied to quicklime and quicklime involving samples obtains higher compressive strengths. This is considered as a general optimum rate for the said pozzolan. As a result, in a sense, the rate based on hydrated lime which provides the maximum pozzolan(s) -lime binding is believed or considered as the optimum rate forming the highest compressive strength at the same time. But indeed, obtaining product with use of quicklime is completely separate concept and at the result of it more of calcium oxide has been put into reaction with pozzolans comparatively, as to form stronger ties that yields much higher compressive strength for pozzolans weightage binder cements. If the Inventions reasons for obtaining better results with quicklime be explained by beginning from its results; In the application with quicklime, the amount of active calcium oxide that shall react the pozzolans based mix to its maximum strength, ie optimum calcium oxide content or rate to perform this, is apparently higher than
optimum active calcium oxide rate of the hydrated lime involving applications. With this approach, definition of optimum lime content can be converted in a plain manner to "the rate which is providing the maximum compressive strength". The pozzolanic reactions provided by quicklime and hydrated lime are being completely different from each other. In case of using quicklime, same amount and same kind pozzolan(s) are becoming capable of to enter more of active calcium oxide to the pozzolanic reaction. This positive and active (case) happens by forming of calcium oxide more and stronger reactions and ties with pozzolans in this kind of reaction forming. Benefits obtained are more than the CaO increase. If expressed in a concrete way, defining according to their own optimum rates, the quicklime applications occupies (uses) 18%-38% more of active calcium oxide compared to application with hydrated lime. This means, 18%-38% more of active calcium oxide is being bound to same quantity of puzzolan(s) compared to the hydrated lime introduced pozzolan(s). The rate of increase in compressive strengths against this, are bigger figures like 50%-300%. I.e., the marginal contribution is immense. We also made samples by using the same chosen active calcium oxide proportions of some chosen hydrated lime applications (samples), the same proportion CaO quicklime samples' compressive strengths attained still higher values. This means, same amount of active calcium oxide attains higher physical strengths with the same pozzolan(s) when used as quicklime instead of hydrated lime. By using less content of active CaO, they can reach to same strengths obtained by hydrated lime application. This points to use of less industrial raw material, to less cost and to environmental protection impacts. Some of this effect is being tried to be explained with factors like freshness of quicklime but main difference, as described above, is existence of stronger reactions beginning with higher heats and it is distinctive from its beginning on. Factors which increase the impacts are being explained below.

The limes used in the Invention can be obtained from primitive kiln processes, industrial fabrication production (vertical shaft kilns, horizontal kilns etc.) or as industrial by products and laboratory reagent type calcium oxides, i.e. any kinds of limes notable can be used. In some cases, positive effects of inclusion of hydrated lime to quicklime to an extend max of 35% have been observed. The hydrated limes can be obtained from the above quicklimes through primitive slaking, fabrication dry slaking and in forms as paste, slurry or slaked and industrial by products or reagent laboratory types calcium hydroxides. As pozzolans, natural pozzolans (tras, volcanic rocks, tuffs, ashes, scorias and others) and their mixes, artificial pozzolans (fly ashes, iron-steel slags, calcined clays, burnt plants, silica fume, aluminum red mud and others) and their mixes and mixes of all natural and artificial pozzolans can be used. Using wastage type pozzolans like aluminum red mud and bringing value to them shall also be an additional contribution. When all kinds of pozzolans are mixed with portland cements, portland cement clinkers and calcium sulfate sources or only with calcium sulfate sources and also with other additives, the compressive strength that shall be acceptable to the market expectations and needs are being obtained in a dependable manner. By use of activations and other
additives and inputs, ideal products are being targeted. The most compressive strength increasing contributions are provided by additions of portland cements or with portland cement clinkers and calcium sulfate sources. For the second case, use of calcium sulfates calcined under very high heat are yielding improved better strengths and properties for many times. But these all has limits. In the studies made with portland cement 42.5 R addition and with its clinker’s additions to highest strength obtaining pozzolan(s) - quicklime basic binder in an amount up to 12 % in general or 15% in some cases proves, considerable compressive strength increases has been obtained. If it is generalized; optimum rate of introduction of portland products are 7%-16%. Further introduction’s marginal contributions show a decreasing trend and especially after 22%, it becomes negligible and loses economy. Prior to optimum rate, each incremental increase makes increasing contributions and reaches an optimum. Inclusion of portland cements and portland products both assists to the specific pozzolanic reaction and by its own reaction also produces further strong ties to reach to obtaining of stronger products. For finding the optimum inclusion rate that shall provide the maximum compressive strength to the mix, the basic maximum strength pozzolan(s)-quicklime mix is considered and variations products are obtained by adding maximum 15% or by decreasing maximum 10% of active calcium oxides.

Based on these alternative products, different portland product inclusion rates to these maximum possible numbers of alternative cements are implemented and optimum rate is found in an assured manner. The optimum proportioned quicklime-pozzolan(s) mix are not always appearing as the highest compressive strength attaining solution. The effects of calcium sulfate sources inclusion also are investigated in the same manner and found that primarily inclusion of 450°C-550°C and 850°C - 950°C calcined gypsum and/or anhydrites and natural and artificial calcium sulfates and industrial by product calcium sulfates in a rate of 1%-4% develops higher compressive strengths. For example, a 17.5% active CaO involving tras mix having 10Mpa compressive strength, increased to 11.5-12.0 Mpa with inclusion of 1.5% of calcined gypsum at 500°C. The high heat calcined anhydrites as above can be used up to the extent of 3.5%. Similar observations have been done for fly ashes also and this aspect is also one of the important contributions of the Invention. Method of optimum proportion determination is similar to that applied to portland cements. Case can be extended and improved by including portland cements also. As portland cements, all portland cements including white cements can be used. But use of composed pozzolan involved portland cements basically and logically does not bring an economical logic and essence. If pozzolans be needed to be used as per the new system, it should be preferable to consider pozzolans in pozzolans portion and be considered in the total pozzolans content of the system. Use of portland clinkers with calcium sulfate resources is a very suitable choice. Most of the highest compressive strength samples were obtained with use of 500°C calcined gypsums in the portland clinker. Sole use of these kinds calcined anhydrites were also tested and was observed that 1-2 % of their inclusion provides considerable higher compressive strengths. Other
calcium sulfate resources like ground natural gypsum and/or anhydrites also can be used along with clinkers. Depending on the kind of pozzolan, it was determined that the optimum active calcium oxide rate that would carry the pozzolan(s)-quicklime mix to maximum compressive strength were by weight in range of 11% to 23%. I.e., the remaining 77-89% are pozzolans or pozzolans mixes and non active part of the quicklime remained from CaO. In applications with hydrated lime same optimum active lime proportions are as 8.5% - 20%. In both cases of quicklime or hydrated lime applications, surpassing of the optimum rate or remaining under it gives decreasing effect on the obtained compressive strength. But, application of heats (45°C - 50°C) decreases this effect to some extent.

The limes which were employed in this study were market type fabricated, EN 459-1, 90 microns, 80% active calcium oxide bearing quicklime and 85% active calcium hydroxide (CL 80 5) bearing hydrated lime. As pozzolans, among others, most of the experiments were implemented with Western Anatolian tras, Middle Anatolian tras, Libyan and Turkish basaltic scoria, natural and calcined clays, pumice, fly ash obtained from three different plants and silica fume. All pozzolans and the quicklime were ground to same fineness of 42.5 R cement. The effects of finer grinding were also measured. Basically all tests were implemented under normal ambient heat circumstances, cured under water after demoulding, using 450 dosage (450 kg/m³) binder and 0-5 mm calcium carbonate based mineral aggregates. The effects of change of curing heat, dosage, aggregate size, curing conditions as protected from direct water contact has all independently been observed also. Expansion and shrinkage has been studied. These studies are being summarized at shortest. Experiments always included comparisons of quicklime employing versus hydrated lime employing. While the existing literature based on experiments with hydrated lime does not give detailed explanations; it was found out that, samples obtained by employing hydrated lime were more sensitive and biased against conditions of the circumstances, especially showing much delayed strength development under water or in full humid conditions compared to their protected conditions. Even 28* day strengths were far ahead to reach. These are important disadvantages for a market product and final users. Final strength attained being also low, it becomes to be difficult to attain satisfaction and preference.

In contrary, the Invention's binders are suitable to all climates and conditions of use. Important differences obtained by employing quicklime have been explained as a fundamental finding. The contents, percentages of uses of pozzolans, quicklime and portland cements has been studied including the limits to them. Using activators or additives for arranging hydration heat might increase early and final strengths for obtaining shorter serviceability times. As another advantage; use of quicklime might reduce the overall binder consumption amount. All these comparative increase in productivity against lower costs attained, points to use of less raw materials and to decreased environmental harm.

Water cements ratios have been studied carefully. It was found out that, for same fineness category pozzolans based binder cements, the ones employing quicklime required 7%-1 1% less water compared
to the cements employing hydrated lime, and this leads to less porosity and provides support for higher compressive strengths and physical properties. This was the second finding on the way for higher strengths. Although the decrease in water might seem to be minor, outcoming effects are important when rate of increase in strength are considered. At this point, it should be mentioned that the hydrated lime’s particule shape structure (its geometry) as being irregular and it’s being very fine by themselves also contribute to their being more porous. Increasing cement content (dosage) leads to not properly linked lime quantity and leads to drop of strength followingy. For quicklime also increasing lime content over optimum do not provide gains. In case the quicklime content is decreased, the water cement ratio does not provide a direct parallel drop due to similar fineness of pozzolans also, and strength decreases occurs. When ultra fine pozzolans like some fly ashes be used, it was observed that, even 20% more water was required the strengths were very sufficient and higher in many cases.

The durability and advantages against different natural conditions of the new binder cements were mentioned previously. The samples done with hydrated lime developed much higher 28th day strengths when cured in enveloped (water tight) conditions, instead of being soaked to water directly. This kind of difference is not that much apparent when quicklime were employed. The durability and behaviors of new cements in open air circumstances are excellent. Under increased heat (45°C- 50°C) strengths for 7th day and followingly 14th day were apparently higher while this difference slows down afterwards. Same applies to the samples employing hydrated lime under higher heat conditions. In some samples, cracks were observed but their characteristics were as non-connected to each other and short in length. But since these binders shall not be used in high dosage and in structural works requiring very high physical strengths, these cracking conditions could be ignored. The 45th day strengths were 10%- 25% higher in general. In most cases a slower increase for 90th day also has been observed. For portland cement sector, expansion because of free calcium oxide is a very crucial factor, due to cracks and strength loss that could be encountered. The expansion behavior were observed in our studies also by using very thin glass moulds in which different samples of the new binder cement were poured. In general, 1%-2% expansion by volume has occurred but no cracks were observed. In some cases micro and non connected cracks occurred but this was evaluated as no harm to the use and functions in their own limited area and micro cracks contributed to the plasticity of the mix also. All formations were monolithic and robust. The very thin glass moulds did not crack and expansion developed towards the open top of glass moulds. Behavior resembles, in a sense, the expansive cements (portland). When thin applications like renderings or plasters were implemented, no cracks or no release from the base were observed, and their curing was much similar to those of ready mix products of the market. But, these products failed against the Le Chateliere test as per portland cement norms although they were usable, robust and durable. Expansion reducing agents might provide benefits. It might be thought that, upon market acceptance and spreaded use of these new binder cements, their own specific norms can be established.
Increasing the dose (content) of the binder cements possess positive effect on compressive strengths. But very high doses combined with increased curing heats might cause cracks. Increasing aggregate size also makes positive contribution to compressive strengths. Increasing the fineness of the binder cements also is an effective factor. Increasing the fineness of the pozzolans is more influential compared to lime fineness increasing. Fineness increasing effects are more apparent for fly ashes compared to that trases. It was assessed for many cases that inclusion of calcium carbonate or others based fillers does not make notable contributions for many cases. Use of micronized minerals at limited content might make a positive contribution to compressive strength increase where maximum economical (marginal contribution making) rate being 6%. For lower cost and lower strength binder cements, it is possible to include more of micronized mineral fillers.

Inclusion of activators is an important element for obtaining Invention’s final products. The preliminary reason for employing activators is for improving the early strengths and provides the serviceability of them in parallel times to the market expectations and providing to them the property of being left to the natural circumstances without need for extra protection. The activators have provided notable improvements in 1st and 7th day strengths and products attaining 11 Mpa at 7th day were obtained. Activators provided strength increase without deteriorating the monolithic structure. Products reaching to 20 Mpa at 28th day and to 23 Mpa at 45th day were obtained. It can be presumed that, these strengths might satisfy many of the structural strength requirements also. Depending on the kind of pozzolan(s), Na2S04, NaOH, NaC03, CaCl and others can be used as activators. The observation in the context of the Invention, related to effects of curing heat, has proven that increased curing heat improves strength development directly. For this reason it might also be favorable to employ additives to increase curing heat or to prolong the higher heat period, like set fasteners, salts, some plastifiers, calcium sulfate and others. Among these, the ones that begin their task after the preliminary heat increase of quicklime itself and preferably have longer duration effects are more preferable. It can be assumed that these types of additives could be developed further specific for this task. These additives chemically effect the hydration reaction positively, increase the amount of active calcium oxide bound, increase heat or increase higher heat period duration. They perform one of many of the said functions. It is preferable that these materials should not initiate a reaction in the conditions of an air or humid protected packing conditions of the final binder product. Like this, the most practical solution, which is the one component mix could be obtained, where otherwise second component would be needed. When it is considered that quicklime itself is an activator material, negative effects like crack formation should be investigated when further activators are used. As a method for determining the activator additive content, preparing alternative contented combinations samples by decreasing the quicklime, portland cements and portland clinkers and calcium sulfates by 15% or by increasing them by 5% parallely or in varied proportions and applying alternative activator rates to these new binders yields most suitable and permanent results. It is possible to use activators
and heat related additives in combination also. Other additives’ effects are considered also. So, the list of tests (experiments) as above gets longer. Importance of approach gets clearer when combined use of activators and heat related additives under quicklime based binders are conceived and the possibility of introducing more of active calcium oxide to reaction is considered. Numerous experiments implementation seems to be the most dependable method based over or supported by calculation methods of chemical science. As such, specific, direct to the point, realistic approach could be obtained. A product that shall be commercialized and be industrially produced requires an underlying robust study and experiments that considered every factor sensitively for obtaining the optimum products. Many of the chemical additives like water cutters (extenders or plastifiers), water repellents, air entrainers etc has positive contributions. Expansion reducing additives also have positive effects. But this requires a thorough control of risk of compressive strength reduction. As a general statement, we say that additives related to cement and lime industry yields the results expected from them with the new binders also in various levels. Additive contents as high as 5% has been possible. But for the new cements, to be in the economical range or limits, it seems that excessive use of additives would not be a realistic or required case. It must be noted that without any additives, but with portland cement inclusion of 10%, it has been possible to obtain strengths in range of 13.5-19.0 Mpa. Many uses could be satisfied with these binders by substituting portland cements. If the above 10% portland cement not included, strength shall be in 10-14 Mpa range. Even this is sufficient for some uses. Also, it should be considered that strength development confirms after 28th day also and up to 25% increases at 45* day might be reached. At 90* day strength increase shall be in 20-35%, range. This is an expected but notable result for pozzolanic reaction and shows that they get more dependable in time.

The basic pozzolanic binder cement composed of pozzolan(s)-quicklime only, and it underlies all the studies, are themselves also good binders. The strength distribution range in natural pozzolans based binders are narrower compared to artificial pozzolans based ones and the upper strength values for the previous is higher than the latter in most cases. Optimum active calcium oxide also behaves parallely. As a generalization, the maximum content of pozzolans in the binder by weight, has been 89% at maximum, while optimum active calcium oxide content has been 23% at maximum. One of the critical findings of the Invention has been related to basaltic or volcanic scoria which was not mentioned as a valuable or notable pozzolan in literature. The Invention proves that this is also valuable and usable pozzolan. For example, buy introducing only 13-4% active calcium oxide to Libyan origin basaltic scoria compressive strength of 11 Mpa is obtained. By including only a 10% portland cement to this, 14 Mpa is attained. As such many groups of binder cements were obtained. If classified to main groups; 1. Pozzolan(s) - quicklime - portland cement products (and/or portland clinkers+calcium sulfates), 2. Pozzolan(s) - quicklime - Calcium sulfate resources-activators, 3. Pozzolan(s) - quicklime - activators. Categories 4,5,6 are versions of above where activators are not used. Categories 7,8,9 are versions of above 1-6 categories, which are strengthened by addition of chemical
and/or mineral additives. Also non-activated but additives strengthened versions can be and with inclusion of minerals fillers various product categories can be formed.

Most differentiated properties of the Invention's new binder cements are, distinctive workability, sticking, placing and taking form, perfect water retention and plasticity. These benefits are from the lime factor which is inherently present in their mix. As was stated previously also, many economical and environmentally protectionist substitutions of portland cements can be done especially in rendering-plastering, mortar, screed cements at first hand could be substituted. A typical new binder cement with 30% lime and portland content could not provide strengths as high as the sole 30% portland cement introduced pozzolans-portland cement combination but it is hardly usable for any duty because it is not workable, does not place etc. For an instance one can think that the hydrated lime based pozzo-lime binders also would be workable and usable but it should be remembered that they are considerably (up to 50%) weaker than he Invention's binder cements and their taking into service times are sometimes unbearably long. With the Invention, binder products which have large function area and which are not portland cements has been obtained for the first time. Its being plastic and durability against micro cracks creates additional area. By blending these binder cements with high alumina cements, refractory cements, natural cements and others up to 50%, it is possible to obtain other cements.

According to Invention's logic, the studies involve making direct experiments for determination of the compressive strengths. For observing the effects of content level of a component or components, arranging a number of experiments by decreasing that component(s) by 15% at maximum or by increasing by 7% at maximum, provides a dependable set of measurements and observations. Although it might be thought that this is difficult and time consuming, it should be stated that obtaining a product over pozzolan(s) itself is a time consuming study and in that context all experiments could be implemented. For obtaining results in short duration, heat (45°C-50°C) could be applied to come to result at 7th and/or 14th days. For example, a 7th day result can show the tendency and direction to be chosen, and numbers of experiments could be decreased in an elaborate manner. Computerized modeling involving statistical methods also could be employed. The high reactivity of the binder products points to due care to their shelf life. Drying of the pozzolans at the beginning, should be considered from the beginning. These require simple techniques like aeration, drying etc. Beneath humidity, CO₂ also is an influential factor where packing might be required to be air tight and compressed. For all these, minor improvements or adoptions in portland cement packing and delivery and similar to that of construction chemicals handling shall be sufficient, indeed, many of the portland products do not require shelf lifes prolonging to many months. When considered from occupational health and labor safety, the active calcium oxide content of 15% and 20% at maximum and with addition of portland products a total of 30% should not be considered as hazardous comparatively.
The techniques for production of the new binder cements are the known and settled techniques and applications; crushing, screening, calcinations, heating, drying, grinding, separation, mixing (blending), clinker and granules obtaining, mineral-chemical additive systems' processes' various or different combinations shall provide the needed production process for any need. The plants for these comparatively are less costly and generally more compact and can be installed in shorter time duration. The mixing-blending can be enforced direct mixing or can be as blending with others at defined phases of the processes could be arranged. As such, for plants which are already settled for a production, it is probable to find rearrangement solutions.

The consumption span of the new binder cement(s) is very large and in some known areas it permits application of some new techniques; In aerated concretes area, and especially for gas forming or air gap providing materials using ones, it permits use of large numbers of additives or chemicals (hydrolised proteins, amins, amino acids, naphtaline sulfate formaldehyde, butyl carpitol, glycol ethers, keratin-casein) derivatives, aluminum powder, hydrogen peroxide and others. This provides flexibility permitting to move out of limited area of aluminum powder and hydrogen peroxide. In the same manner, it permits substitution of the costly silicate mineral input with cheaper calcium carbonate mineral aggregate in production of aerated products. Without using autoclave or by partial use of autoclave and by just moulding and ordinary curing, it becomes possible to reduce the costs. For production of other types of light weight products as in-situ or precast concretes like diatomite, pumice, perlite, polystyrene, expanded clay aggregates and others the new binder cements can be used in most economical and flexible manner. It is obvious that they can be used for any of concreting needs with normal concrete aggregates (precast or in-situ). They can be used as economic and environmentalist binders for production of any thickness or any dimension concrete panels, reinforced or laminated or plain. As a result their usage area covers that of portland cements fully. Further, they are economical, perfect, efficient alternatives for soil and base stabilization works.

The Innovation obtains incredible pozzolime cements of high strengths and workability by including new calcium sulphate resources obtained under another innovation(........) . These new calcium sulphates are obtained under much lower heat compared to the known processes (ie 100-135°C) and ground to same sizes of the cement. Their reactivity power in Portland cement hydration is much higher and they can yield strong gypsum products in sole use also. These new sulphates also can be employed with similar ways like the other calcium sulphates as described in the previous text as complete or partial substitution to them. As a typical strong sample; 76%tras + 22% quicklime + 2% new calcium sulphate hemihydrate type yielded 17 Mpa and when this was supported with 3% NaOH and % 3 polycarboxilate type water cutter, outcome was a great 24 Mpa. Many percentages have been used and exceptional usable products have been obtained.
CLAIMS

1. According to the previous knowledge and applications about pozzolan(s)-lime binders, the second main component lime’s contact with water shall form the calcium hydroxide and if this is obtained from quicklime or hydrated (slaked) lime, this calcium hydroxide shall establish (reaction) links with the first main component pozzolan(s), where the maximum quantity (rate) of active calcium oxide to attain the highest compressive strength is accepted to be the same for both sources (ie quicklime or hydrated lime) and while it has been agreed like that, the Invention is powder binder cements with high weightage of pozzolan(s) which provides binding of higher percentages of calcium oxides and it is consisting of direct use of quicklime in the mix, introduction of 18%-38% more of active calcium oxide to the lime content and to pozzolanic reaction and instant (fast) initiation of pozzolanic reaction.

2. The percentage by weight of lime to pozzolan(s) in pozzolans-lime based binders according to the previous applications were either determined by estimation or by employing experiments which use hydrated lime to determine the quantity of lime that shall bind maximum of pozzolan(s) by measuring least amount of unbound pozzolans quantity and accept this lime percentage as the optimum lime content and on basis of molecular mass calculation the same content is accepted to be applicable to experiments employing quicklime indirectly, and being apart from above, the Invention is powdered pozzolan(s) quicklime binder cements that are capable of binding more of active calcium oxide under ambient (normal) heat and circumstances and consists of direct use of ground quicklime in higher percentages as per claim 1 and direct determination of optimum active quicklime content by employing experiments to attain and determine the highest compressive strengths of related content rates.

3. It is pozzolan(s) weightage, ground to powder pozzolan(s)-quicklime binder cements which comprises direct inclusion of second main component quicklime to the first main component pozzolan(s) in a way to determine quicklime optimum content by employing direct experiments to determine the highest compressive strength attainable and include 18%-38% more of active calcium oxide than the known, inclusion of up to 23% of active calcium oxide to the pozzolan(s)-quicklime mix.

4. It is pozzolan(s)-quicklime powder binder cements with pozzolan(s) weightage, using quicklime directly in higher rates as per claims 1-3 in contrary to previous pozzo-lime cements in which quicklime can be used as activator material only and for further activation and reactivity, for increasing of hydration heat and increasing introduction of higher active
calcium oxide rate, and it comprises of employing chemical activator materials (Na$_2$S$_0$_4, NaOH, NaC0$_3$, CaCl$_2$, NaCl and others).

5. It is pozzolan(s) weightage powdered pozzolan(s)-quicklime binder cements with capability of binding higher rate of active calcium oxide as per claims 1-4 and for enhancing their properties and increasing their reactivity, it is employing of chemical additive materials (set agents, calcium sulphates, plastifiers, water cutters, water repellents, salts and others).

6. It is use of materials in claims 4 and 5 in combination.

7. It is pozzolan(s) weightage powdered pozzolan(s)-quicklime binder cements capable of binding higher rate of active calcium oxide as per claims 1-6 and for increasing of their compressive strengths and for further strenght increasing, it comprises inclusion of portland cements or portland clinkers and calcium sulphate resources to the mix.

8. For calculating the optimum rate (amount) of portland products as per claim 7 and for determination of the highest compressive strength sample, it is introduction of different alternative proportions of portland products whose proportion calculations are obtained over the range of mix many samples whose active calcium oxide contents has been increased up to 10% as decreased down to 15%.

9. It is the optimum rate by weight of portland products as per claims 7-8 in the total pozzolan(s)-quicklime and portland products weight be 7% to 16%.

10. It is, portland products as per claims 7-9 does not exceed 22%.

11. It is pozzolan(s) weightage ground to powder pozzolan(s)-quicklime binder cements as per claims 1-3 and claims 7-10 where total weight of pozzolan(s) among the total mix is minimum 55%.

12. It is pozzolan(s) weightage binder cements as per claims 1-3 and claims 7-11, where content of active calcium oxide that shall yield the highest compressive strength for any mix, consist of 11%-23% of the weight of that pozzolan(s)-quicklime mix.
13. It is the percent by weight of active calcium oxide in pozzolan(s) weightage pozzolan(s)-
quicklime binder cements' total weight as per claims 1-3 and claims 7-12 be maximum 23% in
the pozzolan(s) - quicklime content.

14. It is, the percentage of pozzolan(s), including weight of non active part of quicklime, by
weight, be minimum 77% in the pozzolan(s) - quicklime content.

15. It is pozzoJan(s) weightage binder cements as per claims 1-14 and includes that sources for
obtaining the needed active calcium oxide component from quicklime consists of quarry kiln
quicklimes, factory quicklimes, industrial by product limes and mixes of previous items as
ground and mixed or ground and mixed during grinding of others.

16. For designed ends, it is substitution of quicklimes as per claim 15 by hydrated lime at a
maximum 35% rate.

17. It is obtaining of hydrated limes as per claim 16 by fabrication dry or putty or slurry slaking
or by primitive techniques or using industry by products.

18. It is pozzolan(s) weightage binder cements as per claims 1-17 where, additional to quicklime
component, it includes use of another component as portland cements varieties including
white cements but excluding pozzolans blended ones or portland clinkers and calcium
sulphate resources (high or low heat calcined natural gypsumstones and/or anhydrites and
industry by product calcium sulphate resources and mixes of those).

19. It is inclusion and calculation of pozzolans portion of pozzolan blended cements as per claim
18, among total pozzolan(s) of the mix.

20. It is pozzolan(s) weightage binder cements as per claims 1-19, and it includes use of calcium
sulphate resources consists of dehydrated gypsums and/or anhydrites calcined at 450°C -
550°C or 850°C - 950°C, low heat calcined hemihydrates and others, natural gypsum stones
and/or anhydrites or industry by product calcium sulphate resources or any mixes of the above
as ground and mixed or mixed while grinding of other components.

21. It is pozzolan(s) weightage binder cements as per claims 1-20 and it is calculation of calcium
sulphate content in pozzolan(s)-quicklime calcium sulphate cements with same method as per
claim 8 for calculation of portland products and it includes optimum inclusion rates are in
range of 1%-5%.
22. It is pozzolan(s) weightage binder cements as per claims 1-21 where in case of sole use of 450°C - 550°C or 850°C - 950°C high heat calcined calcium sulphate resources it is use of some calculation method for portland products as per claim 8 and optimum inclusion rate be 1%-3.5%.

23. It is pozzolan(s) weightage binder cements as per claims 1-22, although second main component quicklime and other components like portland products and calcium sulphate resources also are activating materials, for further activation it includes use of activator materials (Na₂SO₄, NaOH, Na₂CO₃, CaCl₂, NaCl and others) at a rate of maximum %5.

24. It is pozzolan(s) weightage binder cements as per claims 1-23, where for higher and longer continuation of hydration heat and for enhancing properties it includes use of additives (set increase, calcium silicate, salts, plastifiers, water cutters and others) and their mixes and also as mixes with material as per claim 23 in a maximum percentage of 6%.

25. It is pozzolan(s) weightage binder cements as per claims 1-3 and 12-14 and includes enhancing of their properties by inclusion of portland products as per claim 18 and claims 7-9 and/or inclusion of calcium sulfate resources as per claims 20-22.

26. It is pozzolan(s) weightage binder cements as per claim 25 and includes enhancing of its properties by inclusion of activator materials and/or set optimising materials or mixes of these.

27. For determining the optimum rate of use to yield the maximum compressive strengths to be attained by use of materials as per claims 23 and 24, it is preparing experiment sets by reducing them or their mixes at stages up to 15% or increase similarly up to 5% and determine the maximum compressive strength yielding alternative as the optimum rate.

28. It is pozzolan(s) weightage binder cements as per claim 27 and includes use of natural pozzolans (tras, volcanic tuff-ash-scoria, clays and others) and their mixes.

29. It is pozzolan(s) weightage binder cements as per claims 27 and 28 and includes use of artificial pozzolans (flyash, iron-steel slag, silica fume, calcined clays, aluminum red mud, burned plantation and others) and their all mixes.

30. It is pozzolan(s) weightage binder cements as per claims 1-29 and includes use of any kind of mixes of pozzolans as per claims 28 and 29.
31. It is the minimum proportion by weight of pozzolans as per claims 28-30 in total weight of binder cements as per claims 1-30 is 55%.

32. For increasing compressive strengths of pozzolan(s) weightage binder cements as per claims 1-31, it is inclusion, by incremental increase and test, of micronised mineral fillers up to 6% by weight in total weight.

33. In case where increasing of compressive strengths are not targeted, it is use of mineral fillers in desired quantity for obtaining various purpose binder cements as per claims 1-32.

34. It is pozzolan(s) weightage binder cements as per claims 1-33 and includes obtaining of other binder cements by inclusion of high alumina cements, refractory cements, and natural cements and their mixes up to 50% by weight.

35. It is pozzolan(s) weightage binder cements as per claims 1-34 and for increasing their compressive and enhancing their properties, it includes addition of chemical and mineral additives (water reducers, water repellents, air entrainers, expansion reducers and others) to them.

36. It is pozzolan(s) weightage binder cements as per claims 1-35 and includes use of basaltic scoria (or volcanic scoria), which were not found as valuable pozzolanic raw materials in previous literature, along with quicklime solely or in mixture with other pozzolans as per claims 28 and 29 and in mix with materials as per claims 4-7.

37. For obtaining the binder cements as per claims 1-36, their components, or in processing and combining them with addition of other materials, it is use of processes and techniques of crushing, screening (seiving), calcination, cooling, heating, aeration, grinding, separation, mixing (blending), clinker or granules obtaining, establishing of chemical or/and mineral additive systems as and when needed.

38. Beneath use of mechanical mixing for forming the binder cements as per claim 37, it is combining the components during process of a component or components for joint processing and parallel mixing.

39. For removing or remedying the disadvantages of the known pozzolan-lime applications like long set time, weak early strengths, high porosity and water absorption, insufficient final
strengths, weak resistance to water soaked conditions, it is pozzolan(s) weightage pozzolan(s)-quicklime ground/powdered binder cements which are capable of binding more active calcium oxide and it includes methods of direct use of quicklime in the mix, determination of optimum active calcium oxide content originated from quicklime directly by determining maximum active calcium oxide rate providing the highest compressive strength, inclusion of an additional 18%-38% of active calcium oxide to the pozzolanic reaction and enhancing binder properties by employing the materials and methods as per claims 1-43.

40. In cases of hydrated lime use in pozzolime cements and when elevated heats like 50°C are employed and also enveloped curing might be employed and other measures favorable conditions be created, the comparative compressive strength might get more closer to that of ground quicklime as expressed as per claim 39 but it is puzzolan(s) - ground quicklime based cements that provides real life use at acceptable take into service time and with simple protection measures and always yields measurable higher compressive strengths of all ages.

41. It is substitution of silica mineral at planned level in the known autoclared aerated concrete production by economical calcium carbonate minerals by using the binder cements as per claims 1-40.

42. It is partial of full substitution of autoclare system with typical moulding and curing systems by using the binder cements as per claims 1-41 for production of aerated concrete elements.

43. It is use of hydrolised proteins, amins, amino acids, naphtalene sulfate formaldehyde, butyl carpitol, glicol ethers, keratin and kazein derivatives, aluminum powder, hydrogen peroxyde and others as gas (air) making materials for products as per claims 41 and 42.

44. It is production of lightweight concrete elements by using lightweight materials (pumice, perlite, diatomite, polystrene, expanded clays and others) and employing binder cements as per claims 1-43.

45. It is implementing of in situ or precast concrete works, mortar, renderings, screeds, fillers and readmix products and other in situ products by using the binder cements as per claims 1-43.

46. It is production of thin or thick reinforced (glassfiber, pp, cellulose and others) or non reinforced panels of any dimensions by using the binder cements as per claims 1-43.

47. It is implementation of soil or base stabilisation by using binder cements as per claims 1-43.
48. It is use of binder cements as per claims 1-43 for introduction of higher content of pozzolans to the cement content.

49. Whenever a source of calcium sulphate be considered to be employed in the context of cement and methods as per claims 1-47 it is use of cements and methods as per claims 1-47 it is use of new ground calcium sulphate sources obtained under lower heat (90-135°C) compared to that of the known marketed ones as full or partial substitute with similar methods as per claims 1-47.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. C04B28/18

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>X</td>
<td>AT 410 Q89 B (KNOCH KERN &amp; CO [AT]; WOPFINGER BAUSTOFFINDUSTRIE cm [AT]) 27 January 2003 (2003-01-27) page 2; 1 lines 1-4 page 2; line 25 - page 4; line 55; claims 1-11; figures 1-3; tables 1,2,10</td>
<td>1-49</td>
</tr>
</tbody>
</table>

* Special categories of cited documents :

"A": document defining the general state of the art which is not considered to be of particular relevance

"E": earlier application or patent but published on or after the international filing date

"L": document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O": document referring to an oral disclosure, use, exhibition or other means

"P": document published prior to the international filing date but later than the priority date claimed

"T": later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X": document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y": document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"Z": document member of the same patent family

Date of the actual completion of the international search

9 May 2014

Date of mailing of the international search report

15/05/2014

Name and mailing address of the ISA/Authorized officer

European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk
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Buscher, Olf
<table>
<thead>
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<td>X</td>
<td>ANTIOHOS ET AL: &quot;Influence of quicklime addition on the mechanical properties and hydration degree of blended cements containing different fly ashes&quot;, CONSTRUCTION AND BUILDING MATERIALS, ELSEVIER, NETHERLANDS, vol. 22, no. 6, 26 March 2008 (2008-03-26), pages 1191-1200, XP022558719, ISSN: 0950-0618 chapters 1-4; tables 2, 3</td>
<td>1-49</td>
</tr>
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</table>
## INTERNATIONAL SEARCH REPORT

### Box No. II Observations where certain claims were found unsearchable (Continuation of Item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☑ Claims Nos. 1-49 (partially)
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
   
   **see** FURTHER INFORMATION sheet PCT/ISA/21Q

3. □ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box No. III Observations where unity of invention is lacking (Continuation of Item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☑ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. □ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.
Continuation of Box 11.2

Claims Nos.: 1-49 (partially)

Claims 1-49 do not fulfill the requirements for clarity and conciseness of Article 6 PCT (PCT-Guidelines, Part II, 5.02 (i) and (ii)).

The wording of claims 1-49 is so vague and unclear that a clear understanding of the subject-matter for which protection is sought is prevented.

The categories of the claims 1-49 is not directly and unequivocally derivable from the claim wording (PCT-Guidelines, Part II, 5.12).

The dependencies of the dependent claims are referring back to multiple independent claims, so that the subject-matter and a specific embodiment for which protection is sought is rendered unclear (Article 6 PCT; PCT-Guidelines, Part II, 5.15-5.17; Rule 6.4 (a) - (c)).

In addition, the description lacks representative working examples, which could be used to interpret the subject-matter of the claims.

As consequence, the claims where interpreted on the basis of the passages of the description and embodiments which clearly and unambiguously define the subject-matter for which protection is sought.

The ISA identified the following subject-matter and a fair generalization thereof to be searchable:

A binder comprising:
- a pozzolan component, chosen from natural pozzolan, like trass, volcanic rocks, tuffs or artificial pozzolan, like fly ashes, iron-steel slag, calcined clays, burnt plants, silica fume, aluminium red mud (page 4, line 29-33);
- quicklime (page 4, line 23-29; page 3, line 18 - page 4, line 22; page 6, line 2-5);
- other components, such as:
  - calcium sulphate (page 5, line 17-26),
  - Portland cement, up to 9-12% (page 2, line 1-2; page 5, line 27-35)
  - activators such as NaOH, Na2SO4, Na2CO3, CaCl (page 8, line 1-19).

Claims 1-49 do not comply with the provisions stipulated in Article 6 PCT, Rule 6.4 (a) - (c); Part II, 5.02 (i) and (ii); PCT-Guidelines, Part II, 5.12; PCT-Guidelines, Part II, 5.15-5.17.

Consequently, the provisions of Article 17(2) b) PCT and the PCT-Guidelines, Part III,
9.01, 9.25, 9.27, 9.41 apply.

This International Search Report and the Written Opinion are based exclusively on the subject-matter which has been searched.

The applicant’s attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EP0 policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EP0, the applicant is reminded that a search may be carried out during examination before the EP0 (see EP0 Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.
<table>
<thead>
<tr>
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