TEXAS TRANSPORTATION INSTITUTE

TEXAS HIGHWAY DEPARTMENT

COOPERATIVE RESEARCH

MANUFACTURE OF STRUCTURAL LIGHTWEIGHT CONCRETE
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in cooperation with the
Department of Commerce
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BIBLIOGRAPHY (64-6)
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MANUFACTURE OF STRUCTURAL LIGHTWEIGHT CONCRETE

Compiled by
Texas Transportation Institute

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1. Use of fly ash in concrete pavement constructed in Nebraska, Charles A. Sutton
Nat'l Research Council--Highway Research Board Abstracts 33: n 12, December 1963, p 55-56.
Nebraska has an abundance of sand-gravel in streams and old lake beds that in many ways is an excellent aggregate for use in concrete. It provides a concrete that is highly workable in the plastic stage and durable with high strength after it hardens. However, certain materials in this aggregate often react with portland cements in such a manner that disruptive expansion is produced in the concrete and its useful life is considerably reduced.
Various methods for inhibiting this reaction and its resulting expansion have been investigated and one method that showed considerable promise in a series of laboratory tests was to use fly ash in the concrete. Since the laboratory tests were favorable, two experimental test roads, each approximately six miles in length, were constructed with concrete involving the use of fly ash. One road was constructed in 1950, the other in 1951.
This is a report of the data accumulated from these test roads, which indicate that the use of fly ash in the concrete presented no special problems in construction and the fly ash concrete was durable, high in strength, and did not expand because of cement aggregate reaction.

2. Experimental fly ash concrete pavement in Michigan, F. E. Legg,Jr.
Nat'l Research Council--Highway Research Board Abstracts 33: n 12, December 1963, p 56.
The Michigan experimental fly ash concrete pavement was constructed in 1955 and is 1, 750 feet long. It may be of interest primarily for two reasons: (1) Five sections are included in the project with ash contents varying from none to 200 lb. per cubic yard. Simultaneously, cement content was varied in increments from 5.5 to 4.0 sacs per cubic yard, and (2) loss on ignition of the fly ash was high (13 to 14 percent) requiring very large amounts of air-entraining admixture to maintain the air content at levels considered necessary for satisfactory resistance to severe weather and de-icing salts. Compression and flexural strength test specimens were made from the job concrete from each section and strengths are reported at ages up to 5 years. Strengths of drilled cores are also reported along with accelerated scaling tests on job-made slabs. Observations at the age of eight

years do not indicate positive superiority of behavior of any of thetest sections and the present paper will have to be considered a combined construction and progress report.

3. The use of fly-ash in construction, A. Jarrige.
<u>Ann. Inst. Tech Bat Trav Publ</u> 12: n 138, 1959, p 521-43.
(In French, with English summary).
The physical and chemical properties of fly-ash and its use for various purposes including road construction work are considered. Reference is made particularly to a special cement containing 20 per cent of fly-ash which is being produced by the French cement industry.

4. Concrete containing fly ash as a replacement for Portland blast-furnace slag cement, W. E. Grieb and D. O. Woolf.
<u>Proc Amer Soc Test Mater</u> 61: 1961, p 1143-53, Discussion 1154.
Investigations by the Bureau of Public Roads have shown that fly-ash can be used satisfactorily to replace part of the cement but the properties of the concrete are affected by the carbon content of the fly-ash, lower strengths being associated with higher carbon contents. The amount of fly-ash used should be not more than about 15 percent by weight of the CaO content of the cement.

5. The estimation of the strength of concrete made with lightweight aggregate, K. Shirayama.
<u>Mag Concr Res</u> 13: n 38, 1961, p 61-70.
The results of compressive strength tests carried out on concrete made with Leca expanded clay aggregates, produced in Norway, showed good agreement with an empirical formula. The relations between cube strength and cylinder strength and modulus of elasticity are discussed. A table of proposed mix proportions is given.

6. Determining the suitability of clays for the production of lightweight aggregates, V. S. Ramachandran, N. C. Majumdar and N. K. Patwardhan.
<u>Indian Concr J</u> 35: n 12, 1961, p 453-6.
This article discusses how an understanding of certain physicochemical processes involved in the bloating of clays will be helpful in predicting the bloating properties of a clay by simple and reliable methods for subsequent pilot plant studies. A bibliography of 15 references is appended.

7. Aggregate drier for laboratory use, G. Hondros.
<u>Aust Civ Engng & Constr</u> 3: n 8, 1962, p 37-9.
A mobile aggregate drier, designed for the concrete laboratory

at the University of Western Australia, is described and illustrated. Its use has been extended to the preparation of materials for soil mechanics investigation. A rotating drum on a steel frame is driven at 7¼ rev/min by a 3/4 h.p. 3-phase motor. Compressed gas burnt in a 2-in. Primus burner induces enough draught to dry damp aggregate completely. The results of short duration performance tests on the unit are tabulated. Maximum output of dry material is 1/3 ton/h.

8. Studies relating to the testing of fly ash for use in concrete, R. H. Brink and W. J. Halstead.
Publ Rds Wash 29: n 6, 1957, p 121-41.
This paper, which was presented at the 59th Annual Meeting of the American Society for Testing Materials, 1956, gives the result of an investigation carried out by the Physical Research Branch of the U. S. Bureau of Public Roads. The study was concerned mainly with the pozzolanic behaviour of fly-ash as shown by its effect on mortar strength and included an examination of the physical and chemical properties of fly-ash and of its effectiveness in reducing the expansion which results from the alkali-aggregate reaction. Lime and sodium hydroxide were shown to be unsatisfactory reagents for estimating the pozzolanic activity of fly-ash, but it is thought that a suitable lime-fly-ash mortar test might be developed after further study: 34 samples from 19 different sources were examined. It was found that: (1) The effect on mortar strength of replacing part of the cement with fly-ash varies with the cement used. (2) Fly-ash has the greatest proportional benefit on the ultimate strength of lean mixes, although tests at 28 days do not usually indicate this. (3) The carbon content of fly-ash lowers the strength of mortar because it increases the amount of water required to obtain a workable consistency (4) Finer fly-ashes produce higher strength in mortars: the strength was shown to be related to the amount of fly-ash passing a No. 325 sieve, but not the specific area of the fly-ash as determined by the air permeability method. (5) If the addition of fly-ash requires an increase in the amount of water needed to prepare mortar of a stated consistency, the strength of the mortar decreases. (6) Fly-ash inhibits the volume change caused by the alkali-aggregate reaction if used in sufficient amount. The testing procedures are given in an appendix.

9. Use of fly ash in concrete, A. G. Timms and W. E. Grieb. Publ Rds Wash 29: n 6, 1957, p 142-50.
The properties of concrete containing 4 types of fly-ash were examined by the Physical Research Branch of the U. S. Bureau of Public Roads. Flexural and compressive strengths at 28 days or less were lower than those of comparable concrete without fly-ash, but at one year the fly-ash concrete was at least as strong as comparable normal concrete. Fly-ash did not affect resistance to freezing and thawing of normal concrete. In air-entrained concrete, some fly-ashes gave satisfactory durability but others did not. Concretes containing higher percentages of fly-ash generally had less shrinkage than those with smaller ones. Any substitution of fly-ash for Portland cement lowered the resistance of the concrete against attack by calcium chloride. The amount of air-entraining material necessary to produce a given amount of air in concrete is said to increase with the carbon content of the fly-ash. This paper was presented at the 59th Annual Meeting of the American Society for Testing Materials, 1956.

10. The use of blast-furnace slag as a concrete aggregate, E. F. Farrington. Proc Instn Civ Engrs, Part I, 5: n 1, 1956, p 56-9.
Molten slag from blast furnaces producing basic iron is tipped into shallow pits to cool and harden. It is then dug up and processed to conform to B.S. 1047: 1952. Uses of slag in plain or reinforced concrete construction are described. Some characteristics of the aggregate and of the concrete obtained are discussed. It is suggested that slag which conforms to the British Standard should be considered on equal terms with other aggregates.

11. Studies on the suitability of expanded shale aggregate for use in cement concrete, D. H. Sawyer, C. M. Brown and L. H. Strunk. University of Kentucky, Engineering Experiment Station Bulletin 38: Lexington, Kentucky, 1955 28p.
The main purpose of this investigation was the evaluation of the physical and structural characteristics of concrete made with expanded shale aggregate in order to determine its potential use in bridge decks. It was found that concrete mixes containing expanded shale can have: (1) Compressive strengths approximately equal to and flexural strengths slightly lower than those of comparable mixes containing dense aggregate. (2) A satisfactory bond with

reinforcing steel up to the yield point of the steel, even though the relation between slip and bond stress is somewhat less favourable for the light-aggregate concrete than for comparable dense concrete. (3) An extremely poor resistance to freezing and thawing czrried out normally in durability testing. (4) An inherent resistance to resaturati on after being dried. (5) An increase in resistance to freezing and thawing by the use of air entrainment. (6) A high resistance to abrasion when measured by a modified Los Angeles type test. (7) Unit weights approximately 35 per cent less than those for corresponding mixes containing limestone aggregate.

12. Fly ash concrete for highways in Kansas, W. M. Stingley and R. L. Peyton.
Nat'l Research Council--Highway Research Board Abstracts 33: n 12, December 1963, p 56.
Although fly ash has been widely used as an admixture in mass concrete, its use in concrete highway construction has been limited. It has been used in Kansas, as a replacement for a part of the cement, in one experimental paving project that has been under traffic for 14 years. Five brands of cement with dissimilar characteristics were used in combination with a single aggregate and fly ash from a single source. Although this project has been reported previously, no detailed study of the fly ash sections, which included varying results with change in cement brand, was made.
Evaluation of effectiveness in preventing map cracking is based on the supposition that reductions in flexural strength accurately relfect increases in map cracking as here defined. Other variables, such as changing moisture content, are given consideration, but are assumed to balance out over a long period.

13. A new approach to P.F. ash concrete, A.J.W. Jackson and W. F. Goodridge.
Contract J 180: n 4263, 1961, p 1284-6, 1296.
Methods are suggested for the design of concrete mixes containing pulverized fuel ash or fly-ash and having an early strength comparable to that of ordinary Portland cement concrete. The fly-ash-cement ratio and the fly-ash sand volume replacement factor must be determined experimentally according to the source of the fly-ash, and type of aggregate and cement used.

14. Influence of various factors on sulfate resistance of concretes containing pozzolan, M. Polivka and E. H. Brown.
Proc Amer Soc Test Mater 58: 1958, p 1077-99: Discussion 1099-1100.

An investigation has been carried out at the University of California on the effects of several types of exposure and curing period on the sulphate resistance of concretes containing cements of high and very low tricalcium aluminate (C_3A) content with and without pozzolan replacements. It is concluded that: (1) A pozzolan of high quality used as a partial replacement of high C_3A cement will greatly improve sulphate resistance. (2) The use of a very low C_3A cement results in concretes with superior resistance to sulphate action. A partial replacement of this cement with pozzolan does not improve sulphate resistance. (3) Curing for more than 28 days has no appreciable effect in improving resistance of concretes to the action of a mixture of sodium and magnesium sulphate solutions. (4) Continuous complete immersion of concrete specimens in sulphate solutions appears to be a satisfactory method for laboratory investigations. (5) A mixture of sodium-magnesium sulphate attacks the exposed concrete surface, causing surface scaling, whilst sodium sulphate alone tends to penetrate into the concrete, causing swelling and cracking without scaling of the exposed surface. (6) The loss-in-weight method seems to provide the most positive evaluation of potential sulphate resistance. Twelve literature references are appended.

15. Steam curing and X-ray studies of fly ashes, M. Mateos and D. T. Davidson.
Proc Amer Soc Test Mater 62: 1962, p 1008-15; Discussion 1015-8.

Specimens made of lime and fly ash mixtures were cured in an autoclave (248F, 1 atmos), and their strengths were compared with those obtained at ordinary curing temperatures. The strengths of the mixtures after steam curing for one day reflected the pozzolanic quality of the fly ash. Strength determined in this manner may be used as a criterion for a quick evaluation of the suitability of fly ash for use in concrete or lime-soil mixtures or as a quality control test. X-ray diffractometer patterns of fly ashes are also included. The drystalline minerals present in fly ashes are quartz, magnetite, mullite, hematite, corundum, calcium carbonate, anhydrite, and calcium hydroxide.

16. Some statistical analyses of the strength and durability of fly ash concrete, T. J. Pasko and T. D. Larson.
Proc Amer Soc Test Mater 62: 1962, p 1054-67.

A systematic method is presented for determining the amount of fly ash needed to produce concrete with optimum strength and durability. An experimental factorial design was used to analyse statistically the effectiveness of a typical commercial fly ash as a partial substitute for cement in a road paving mixture. Concrete specimens made from various mixtures were tested for strength and freezing-and-thawing durability. The results of flexural and compressive strength tests showed that maximum strength was obtained when 120 lb of cement was replaced by 147 lb of fly ash per cu yd of concrete.

17. Concrete with slag aggregate.
Association Technique Pour Le Development Des Utilisations Des Laitiers De Hauts Fourneaux.
Laitiers & Tarmacadam 12: n 11, 1958, p 51-60 (In French).
Results are given of research carrier out for the Association by the Laboratoires du Batiment et des Travaux Publics on concrete containing blast-furnace slag. Tests were made of the compressive and flexural strength, capillarity, shrinkage and swelling, resistance to freezing, and modulus of deformation of the concrete.

18. The utilisation of pulverised fuel ash, S. Raymond.
Civ Engng, Lond 53: n 627, 1958, p 1013-6.
A review is given of current methods of using fly ash which eliminate the need for paying for its disposal from electricity generating stations. About 3½ million tons, expected to rise to 4 million tons by 1961-2, are dealt with annually in the United Kingdom. Consideration is given to the properties of fly ash and its applications as bulk fill, as an admixture in concrete, in soil stabilization as a filler in asphalt, as a binding material to fill aggregate voids in road base construction and as a sintered aggregate.

19. The use of pozzuolanic materials in mortars and concretes, C.K. Murthy.
Indian Concr J 31: n 6, 1957, 186-90.
This review summarizes the properties of pozzolanic materials, including chemical composition of 18 types, and discusses the theory of pozzolanic action. The use of pozzolans as replacement for some of the Portland cement in concrete increases the plasticity of fresh concrete and reduces the tendency to bleeding and segregation, the effect being greater in lean mixes than in rich ones; the extent of the improvement is affected by the type, fineness and amount of the pozzolan. Pozzolanic materials reduce the permeability of lean-mix concrete, counteract expansion due to alkali-aggregate reaction, increases volume changes which accompany

changes in moisture content, may reduce compressive strength (particularly at early ages), tend to reduce creep, may improve resistance to sulphate water, and reduce heat of hydration.

20. Sydney fly ash in concrete, G. B. Welch and J. R. Burton. Commonw. Engr 45: n 5, 1957, p 48-53; 1958, n 6, p 62-7.
A laboratory investigation is described on the effects of a limited number of typical examples of Sydney fly-ash on the properties of concrete mixes. It was found that it is slightly inferior to U.S.A. fly-ash, but that it may be used successfully in concrete as a cement replacement or as an admixture.

21. Surkhi as a puzzolana, N. R. Srinivasan. Central Road Research Institute, Road Research Papers No. 1., Delhi, 1956 (Central Road Research Institute), 74p.
An investigation into the use of surkhi (burnt clay) as a pozzolan was carried out in two parts. In the first part, a study was made of the mineralogical and crystallographic characteristics of five clays and the surkhis derived from them, a shale, a clay stone and an unknown soil. In the second part, a large number of soil samples was studied, work being concerned mainly with the preparation of surkhis at different temperatures and finding their reactivities by the lime reactivity test. As a result of the investigations, it is concluded that loamy soils which are generally used for making bricks do not yield surkhi of high reactivity. Clayey soils generally give a better surkhi but the reactivity depends largely on the type of clay minerals present and the degree of burning. Before using any soil for surkhi-making in any major work, lime reactivity tests should be carried out on surkhis derived from the soil at different temperatures to find its maximum reactivity and optimum degree of burning. It was also found that iron oxides have an important effect on the pozzolanic activity of surkhis and that red or yellow soils with free iron oxides generally yield better surkhis than black cotton soils. It is recommended that the definition of the term pozzolan given by F. M. Lea should be amended to include certain aluminous and ferruginous minerals as well as siliceous materials.

22. Time deformation studies on two expanded shale concretes, G. W. Beecroft. Nat'l Research Council--Highway Research Board Proc 37: 1958, p 90-105.

The report deals with concrete for use in prestressed members of bridges and containing two lightweight aggregates available in Oregon.

23. Lightweight concrete saves on bridge steel, Anon.
Contractors & Engrs 55: n 7, 1958, p 50-2.
Lightweight air-entrained concrete made with Haydite expanded shale aggregate reduced the weight added to the deck of the viaduct at St. Louis, Mo, from about 150 to 102 lb/cu ft and allowed a significant reduction in girder size. The 1391-ft viaduct rests on 15 reinforced concrete piers and carries four lanes of traffic and two 26-ft carriage ways with a 4-ft central reserve and 2½-ft footways. The methods of setting the forms, reinforcing and pouring are described. An electric vibrator and a steel capped vibrating screed were used; the concrete was finished by hand with aluminum floats, dragged with burlap and cured by wet cotton mats. Seven sacks of cement per cubic yard with 200 pounds of Haydite per sack gave a 7-day flexural strength of 500 lb/sq. in.

24. The use of expanded clay aggregate for the preparation of reinforced concrete bridge sections, I. G. Ivanov-Dyatlov, D. N. Ageev and M. A. Litvinenko.
Avtom. Dorogi 23: n 2, 1960, p 8-10 (In Russian)
Research by the Moscow Highway Institute (MADI) is described which confirmed that concrete prepared with expanded clay aggregate can be successfully used for the construction of reinforced or prestressed concrete bridge sections. A graphical analysis is presented of results obtained with test beams prepared in the laboratory with 500 kg/cu.m cement and expanded clay ("keramzit") with a density of 500 kg/cu.m. A saving of 60 roubles per cubic metre of concrete was obtained with almost 30 per cent reduction in weight. Clay concrete beams proved to have greater resistance to crack formation than standard concrete beams but were more liable to deformation and had a lower modulus of elasticity; flexure was 15 per cent higher but still within acceptable limits.

25. Investigation of the effect of some pozzolans on alkali reactions in concrete, A.H.M. Andreasen, K.E.H. Christensen and P. Bredsdorff.
Danish National Institute of Building Research and Academy of Technical Sciences, Committee on Alkali Reactions in Concrete, Progress Report, Series L--No. 1, Ccpenhagen, 1957, 88p. (In English, with Danish summary)

A description is given of investigations carried out up to 1956 at the Laboratory for Mortar, Glass and Ceramics, Denmark, on the possibility of us ing Danish raw materials to produce pozzolans which would prevent alkali reactions in concrete. The report includes detailed discussions of the methods employed for testing the pozzolans and the results obtained. It was found that, of the materials tested, the most suitable sources of pozzolan were limestone-opal-flint, kieselguhr, kaolin, moler, and si-stoff (a by-product in the manufacture of aluminum oxide from clays).

26. Keramzitobeton v krupnopanel'nom domostroenii, G. F. Kuznetsov, N.Ya. Spivak.
<u>Beton i Zhelezobeton</u> n2, Feb 1961, p 58-63.
Expanded clay concrete in large panelled housing; having various physical and mechanical properties, expanded clay concrete is used in Soviet Union as material for wall, panel, floor, roof, and stair construction; production of clay concrete; characteristics of clay concrete elements; tabular and graphical data.

27. Lightweight structural concrete.
<u>Concrete Construction</u> 6: n 2, Feb 1961, p 32-5.
Problems of use of lightweight concretes are discussed; facilities for manufacturing expanded slag aggregates, as Kinney-Osborne, Caldwell, and Brosius machines and also jet or pit systems, as nonmechanical means of manufacture, are evaluated; processing of shale, clay, and slate in rotary kiln or sintering on moving grate; tendency of light weight concrete to entrap air pockets and to form honeycomb can be overcome with properly designed mix and by proper vibration; curing requirements.

28. No fines concrete.
<u>Concrete Construction</u> 6: n 7, July 1961, p 196-8.
Advantages of concretes consisting of coarse aggregate, cement and water--fines being omitted entirely; portion of interconnected voids but with practically no fine capillary pores, about 1/3 less weight, reduced shrinkage, and better thermal insulation; type of aggregate and method of mixing required.

29. Vermiculite roof deck and insulating concrete.
Concrete Construction 6: n 3, Mar 1961, p 66-7.
Vermiculite, soft mica like material, is crushed, cleaned dried and sized, and resulting concentrate is exfoliated in furnaces at temperatures of 1800 to 2000 F; thermal conductivity ranges from 0.6 to 0.96 Btu/hr/sq ft depending on mix ratio; its common use if for light, structural roof decks, and for insulation fill; best mixture of vermiculite concrete for roof construction is 1:4 and for roof insulation 1:6 and 1:8; methods of mixing and handling.

30. Yacheistye betony na gipsotsementnoputstsolanovykh vyzhushchikh, A. V. Volzhenskii, A.V. Ferronskaya.
Beton i Zhelezobeton n 3, Mar 1961, p 123-6.
Cellular concrete made with gypsum-cement-pozzolan binders; method of manufacture of lightweight foam and gas concrete proposed; components if optimum mixture established; waterproof and frost resistant product obtained; graphs and tabular data.

31. Ispol'zovanie neprokalennoi alyuminievoi pudry v proizvodstve gazobetona, L. M. Rozenfel'd.
Beton i Zhelezobeton n 12, Dec 1960, p 561-3.
Use of noncalcined aluminum powder in manufacture of gas concrete; instead of heating, paraffined aluminum powder is treated by foaming products which make hydrophile surface of powder.

32. Drying shrinkage and creep of expanded shale lightweight aggregate concrete, B.J.F. Patten.
Constr Rev 33: n 11, Nov 1960, p 29-32.
Comparative investigation of drying shrinkage and creep of lightweight concrete made from expanded shale aggregate from New South Wales and of concrete made from river sand and gravel; lightweight concrete exhibits slightly greater creep strains and its drying shrinkage is considerably less; instantaneous strain is canceled out by end of 3 mo of sustained loading; test procedure and apparatus diagrams.

33. Experimental lightweight flat plate structure.
Constr Rev 34: n 1, 3,4 Jan 1961 p 21-32, Mar p 25-33, Apr p 21-6.
Jan: Structure consists of lightweight concrete slab 3½in. thick, 48 by 27 ft in area, and standing on 16 steel box columns 5 ft high; paper deals with measurements taken during construction and on sample specimens up to 28 days

after casting; results are given in tables and diagrams. Mar: Analysis of deformation in structure after removal of formwork; comparison between various methods of design analysis of structures. Apr: Long term deformations in structures.

34. Creep of lightweight concrete, C. H. Best, M. Polivka.
Mag Concrete Research 11: n 33, Nov 1959, p 129-34.
Creep data covering periods of up to 18 mo for concretes made with expanded-shale aggregates and having compressive strengths of 3000 and 5000 psi at 28 days; comparison with data for sand gravel concretes of comparable strength; creep in lightweight concrete was equal to or less than that in normal weight concrete of comparable strength; hydraulic loading equipment used in creep tests.

35. Experience is key to profitable haydite production, N. F. Mohler.
Brick & Clay Rec 137: n 2, Aug 1960, p 40-2, 67.
Methods used by Carter-Waters Corp of Kansas City for producing lightweight aggregate with rotary kilns; four-kiln plant is at New Market, Mo, and another plant has been completed in Iowa.

36. Experimental flat plate structure of expanded shale concrete.
Constr Rev 33: n 2, Feb 1960, p 22-9.
Australian experiments have shown that only important differences between expanded shale concrete and ordinary concrete are in density and modulus of elasticity; any compressive or tensile strengths can be obtained with light concrete as readily as with dense, at same cement factor and appropriate workability; there are some difference in creep; test results given for floor slab supported on steel columns.

37. Konstruktsii iz yacheistykh vetonov v zhilishchnom i promyshlennom stroitel'stve, V.V. Makarichev.
Beton i Zhelezobeton 5: n 2, Feb 1959, p 52-8.
Use of porous concrete units in housing and industrial plant constructions; 5 yr experinece in manufacturing and use of prefabricated units in Soviet Union; apecification of various types of light weight concrete aggregates and various prefabricated units as building material.

38. Lightweight concrete with sintered clay aggregate, R.H.Evans, T. R. Hardwick.
Reinforced Concrete REv 5: n 6, June 1960, p 369-84 (Discussion) 384-400.

Advantages of lightweight aggregates; test results on sintered expanded clay known commercially as Aglite; tests on reinforced beams for ultimate loads, deflections and cracking characteristics,post-tensioned columns for creep and shrinkage losses, columns for modulus of elasticity and pull-out pefformance, and prestressed concrete beams; measurement of transmission or bond lengths of columns.

39. Proizvodstvo bezavtoklavnogo teploizalyatsionnogo gazobetona, G. Ya. Polyakov.
Beton i Zhelezobeton 5: n 2, Feb 1959, p 58-62.
Manufacture of heat insulating gas bloated concrete without autoclave; scheme of manufacturing plant and scheme of mixer; 1 m^3 of aggregate consists of cement (300-400 kg), plaster (40-60 kg) hydrogen peroxide (13-16 liters) and water (190-230 liters); units for roofing are steam treated under normal atmospheric pressure.

40. Styropor-Beton, H. Eick.
Zement-Kalk-Gips 12: n 6, June 1959, p 253-7.
Styropor concrete; polystyrene foam, named Styropor, was tested for use as aggregate in concrete; foaming was achieved by hot water soaking on site; results of tests with neat cement and with cement and sand show properties of Styropor as aggregate with regard to mixing, bulk density, flexural and compressive strength, water absorption, and thermal conductivity; two suitable mixes have been formulated; use of Styropor concrete for insulating blocks and wall slabs.

41. Use of lightweight cellular screeds, P. Cable.
Insulation (Lond) 4: n 3, May-June 1960, p 127-9.
Consideration of nature of cellular lightweight concrete and distinction between this type of material and lightweight aggregates; factors governing selection and use of cellular concrete insulating material; requirements for insulating material for in situ roof screeds; use of roofing felt and asphalt when laid on lightweight concrete; cause and methods for overcoming blistering by mechanical methods; condensation prevention.

42. Use of lightweight concrete for reinforced concrete construction, A. Short.
Reinforced Concrete Rev 5: n 3, Sept 1959, p 141-88.
Comparison of research data obtained in United State, Germany, Sweden, and in some eastern European countries; corrosive effects of blast furnace slag, colliery shale,

boiler clinker, pulverized fuel ash or waste slate on embedded reinforcement; unsolved problems of structural design; adapting lightweight concrete to British standards, 33 refs.

43. Arkalite--New product of Arkansas industry, B. C. Herod.
<u>Pit & Quarry</u> 52: n Oct 1959, p 98-100.
250 cu yd of expanded clay aggregate is produced per day in rotary kiln operation at plant near England, Ark; 8 by 125 ft gas fired rotary kiln, conveyors, and 40 by 33 hammermill described; kiln discharges expanded clay pellets into clinker pit.

44. Control testing for separation of lightweight material from aggregate, E. C. Higginson, G. B. Wallace.
<u>ASTM--Bul</u> n 243, Jan 1960, p 60-8.
Method of test, developed in US Bur Reclamation Laboratories, for large scale separation; percentage of lightweight material is determined by sink-float separation in heavy liquid of suitable specific gravity; field experience with method at Glen Canyon Dam; effects of methods of removing lightweight materials, moisture content, rate of absorption of heavy liquid on accuracy, speed, and safety of test.

45. Lightweight concrete made with expanded blast furance slag, D. W. Lewis.
<u>Am Concrete Inst--J</u> 30: n 5, Nov 1958, p 619-33.
Data on strength, durability, unit weight, thermal conductivity, and other characteristics of concrete made with typical expanded slag over wide range of cement contents (4 to 8½ sacks per cu yd to include both insulating and structural concretes); based on test conducted, structural lightweight concretes having 28-day compressive strengths in range of 2000 to 4000 psi can be readily obtained.

46. Cinder as heat insulating material and lightweight aggregate in cement mortar, I. S. Uppal, S. R. Bahadur.
<u>Indian Concrete J</u> 33: n 5, May 1959, p 167-8.
Use of ground and screened cinder in cement-sand mortars, in various proportions was tested in India; chemical analysis of cinder and sand used; effects of proportions of mixing on reduction of heat conductivity and on tensile strength; other tests showed that waterproofing by soap treatment is successful also in presence of cinder in mixture.

47. If clay or shale make LW aggregate, J. O Everhart.
Brick & Clay Rec 134: n 5, May 1959, p 58-9, 86.
Report on techniques for making accurate preliminary evaluations developed at Engineering Experiment Station, Ohio State Univ, during study of Ohio materials as sources for lightweight aggregate; stages recommended are analysis by X-ray diffraction methods which may be supported by differential thermal analyses and optical petrography, time temperature density studies and pilot plant studies.

48. Les utilisations des cendres volantes dans le construction, A. J. Arrige.
Institut Technique du Batiment et des Travaux Publics-Annales 12: n 138, June 1959, p 521-44.
Industrial use of fly ash; recovery of fly ash by electrostatic method and subsequent wetting; hydraulic recovery process; characteristics of cement with fly ash admixture; density and resistance of concrete with varying quantities of fly ash aggregates.

49. Use of fly ash as pozzolan in dense and lightweight concrete, J. T. Tanner, W. M. Kenan.
North Carolina State College--Dept Eng Research--Bul n 69, Apr 1958, 26p.
Pozzolan effect on portland cement is explained and test results given; effects on fresh and hardened concrete, use of pozzolans in foam concrete and in massive concrete; autoclaving of concrete and its economic aspects.

50. Use of flyash in concrete, C. T. Wanzer.
Combustion 30: n 8, Feb 1959, p 38-46.
Present disposal cost of fly ash averages $1 per ton; cost can be greatly reduced if fly ash can be diverted to income producing use; fly ash dispensing installations and uses; table of chemical and physical characteristics of fly ash for use in concrete.

51. Goff-Kirby produces foam concrete, R. J. Crouse.
Concrete 66: n 2, Feb 1958, p 30-1, 37.
Foam concrete, which is poured into place, has average compressive strength of 750 psi, and after three days of curing provides excellent base for conventional floor topping; foaming agent in concrete is same as that used in fire equipment.

52. Le beton d'agregates legers en fondation de chaussees dans les ouvrages d'art, M. Briancourt, M. G. Manchon.
Travaux 41: n 277, Nov 1957, p 585-8.
Use of lightweight aggregate concrete for bases of roadways on civil engineering structures; application on steel bridges in Paris andLyons; composition and testing of concrete.

53. Lightweight-aggregate concrete for structural use, J.J. Shideler.
Am Concrete Inst--J 29: n 4, Oct 1957, p 299-328.
Investigation of properties of lightweight aggregate concrete; program includes tests of plain, conventionally reinforced, and prestressed concrete specimens; data reported on concrete mix proportions, compressive and flexural strength, modulus of elasticity, bond, creep and drying shrinkage.

54. Lightweight structural concrete proportioning and control, G. H. Nelson, O. C. Frei.
Am Concrete Inst--J 29: n 7, Jan 1958, p 605-21.
Physical properties and gradation of expanded shale aggregate produced in Georgia; effect of fine aggregate-coarse aggregate ratio and effect of entrained air on properties of lightweight structural concrete; optimum air content for maximum strength of lightweight concrete recommended.

55. Long-term expansion of perlite plaster and concrete, R. D. Hill.
Australian J Applied Science 9: n 2, June 1958, p 141-62.
Study of five perlite aggregates and their raw materials, and of perlite plaster and concrete made with these aggregates; principal cause of long term expansion in perlite plaster and concrete is expansion of aggregate upon rehydration, ion exchange is of minor importance; other factors influencing high rates of expansion and means to prevent this effect.

56. Manufacture and application of light-weight aggregates, T. S. Dickinson.
Junior Instn Engrs--J 68: pt 9, June 1958, p 263-71.
Review of all porous aggregates used for making them; description of aggregates commonly available and methods of production; special reference is made to Leca, (Light Expanded Clay Aggregate), prominent material in development of prefabricated units of light weight concrete.

57. Study of Missouri shales for lightweight aggregate, P.G. Herold, P. Kurtz, Jr., T. J. Planje, J. D. Plunkett. Missouri Geol Survey & Water Resources--Report Investigations n 23, 1958, 39p.
55 samples of Missouri shales, clays, and loesses were tested for bloating characteristics; 12 samples bloated at commercially feasible temperatures in oxidizing and reducing atmospheres; 10 other bloated satisfactorily in reducing atmosphere only; remaining 33 samples either failed to bloat or bloating tendency was inadequate.

58. Tips on lightweight aggregate handling, K. Nensewitz. Brick & Clay Rev 132: n 2, Feb 1958, p 53-5, 69.
Information on gradation, segregation, batch variation, moisture compensation, cement-aggregate ratio, and mixing light weight concrete. Exerpt from Materials and Methods Session of Besser School for Block Makers and Block Users.

59. Uniform structural lightweight aggregate concrete through careful proportioning and control, P. J. Fluss. Am Con Inst--J 29:n 12, June 1958, p 1059-62.
Variations in bulk specific gravity of aggregate and construction requirements make necessary careful proportioning, proper control, and adjustment of structural light weight aggregate concrete; experience on Ferry Building, San Francisco, is cited; testing by proportionally changing aggregate weights and added water; tables show proportion of mixes and performances.

60. Expanded-shale plant of material service, B. C. Herod. Pit & Quarry 50: n 8, Feb 1958, p 70-2, 74-5, 78-80, 123-4.
Expanded, coated light weight aggregate produced in plant with current daily capacity of 1500 cu yd at Ottawa, Ill; flexible design involves more than 6000 ft of conveying system, three screening and three reduction phases,and wide blending range in kiln feed.

61. Hard shell aggregate invades Chicago area, E. Meschter. Rock Products 61: n 7, July 1958, p 78-81, 128.
Synthetic aggregate, Materialite, made of laminated shale in Ottawa, Ill, plant is 50% lighter; consistent moisture is 6-8%; by burning in kilns, shale pelletizes, expands, and acquires tough "skin"; 3/4 x 3/8 in. and 3/8 x 0 in. sizes of raw material are used; concrete products made with Materialite weigh 95 lb compared with 150 lb for concrete made with natural aggregate.

62. Idealite--Great western aggregates producing 750 cu yd daily, H. F. Utley.
Pit & Quarry 50: n 10, Apr 1958, p 138-40, 146.
Production of Idealite, coated expanded shale lightweight aggregate, at plant south of Laramie, Wyo; kiln which is 12 ft in diam and 266 ft long discharges to enclosed vibrating grizzly which takes aggregate as it comes from cooler cylinders; details of screening and storage equipment; physical properties of Idealite given.

63. Mechanism of lightweight aggregate formation, E. G. Ehlers.
Am Cer Soc--Bul 37: n 2, Feb 1958, p 95-9.
Study of mechanism involved in bloating of six shales and clays for use in brick and concrete, from chemical and mineralogical viewpoints; bloating was effected and gases causing bloating were collected and analyzed by chromatographic method; relationships between firing temperature, particle size of materials fime in kiln, and effects of preheat are discussed.

64. How Trulite is made from coal refuse, K. A. Gutschick.
Rock Products 59: n 11, Nov 1956, p 70-3, 120.
New manufactured lightweight aggregate is lighter than coal cinders; manufacturing process involves burning coal refuse on 10x35 ft traveling grate stoker at 2500F, after which resulting cinder cake is colled, crushed, and sized prior to shipment.

65. Lightweight aggregate, B. C. Herod.
Pit & Quarry 49: n 9, Mar 1957, p 162-3, 166-7.
Production and use of Barlite, lightweight aggregate at Barrett Industries, San Antonio, Texas; raw material is clay which analyzes 65% silicon, 20% aluminum, and 5% iron compounds; products include light weight concrete masonry units, concrete sewer pipe and drain tile, and ready mixed concrete.

66. Lightweight aggregate from pulverized-fuel ash, W. Kinniburgh.
Concrete & Constr Eng 51: n 12, Dec 1956, p 571-4.
Blocks made with pulverized-fuel ash aggregate are within requirements of British Standard and have properties superior to clinker blocks used in tests; small part of aggregate was crushed in order to obtain required grading; structural concrete made with this aggregate; typical results obtained with various mixtures of vibrated concrete.

67. Lightweight aggregate--present and future, A. R. Rowan.
Min Eng 8: n 11, Nov 1956, p 1103-4.
Data on manufacture of lightweight aggregate and distribution

of light weight aggregate plants; development of new bituminous concrete aggregate, relative amounts of lightweight aggregate needed to supply masonry unit industry in 1975.

68. Lightweight aggregates, W. Grant.
Concrete 65: n 7, 8, July 1957, p 30-2, Aug p 28,30,32,34.
Properties and qualities of natural, by-product and manufactured aggregates.

69. Lightweight aggregates for concrete masonry units, C.C. Carlson.
Am Concrete Inst--J 28: n 5, Nov 1956, p 491-508.
Differences between light and heavy aggregates having influence in block manufacturing procedure; physical properties of lightweight aggregate concrete masonry wall construction compared to those of heavyweight aggregate; uses of light weight aggregate masonry units for precast and cast-in-place floor and roof construction.

70. Lightweight aggregates in British Columbia, J. W. McCammon.
Can Min & Met Bul 50: n 538, Feb 1957, p 88-9.
Results of laboratory tests of foamed slag, cinders, pumice, diatomite, vermiculite, perlite, and bloated clay and shale.

71. Production of lightweight aggregate by sinter-hearth process, F. Catchpole.
Brit Cer Soc--Trans 56: n 10, Oct 1957, p 519-26 (Discussion) 526-8, 2 plates.
Description of first endless grate continuous sintering machine installed in Great Britain for making expanded clay aggregate on industrial scale; raw materials and processing methods; operation of plant when sintering carbonaceous shale; aggregate produced has low bulk density and is shown to be suitable for production of concrete of high strength weight ratio.

72. Terlite--lightweight aggregate, J. Grindrod.
Pit & Quarry 50: n 3, Sept 1957, p 132-4.
British research plant product, Terlite, is expected to provide light weight aggregate for building purposes and economical disposal of power station pulverized fuel ash; full scale research plant for conversion of ash was placed in operation at Battersea Power Station.

73. Trulite--Unique lightweight aggregate, B. C. Herod.
Pit & Quarry 50: n 1, July 1957, p 200-2, 212-3.
New type of lightweight aggregate introduced by Trulite Corp, Ceredo, W. Va; Trulite weighs 1250 lb per cu yd, and 8 in equivalent concrete masonry units incorporating this aggregate, while weighing only 26 lb, test over 1000 psi; manufacture is carried out in plant which converts refuse from coal preparation plant into lightweight aggregate; operation has been raised to 12 tph.

74. Use of foam in concrete, J. L. Hanold.
Concrete 64: n 4, Apr 1956, p 32-4.
Review of various methods of producing very low density concrete; air entrainment; cellular concrete and how various textures are obtained; foaming processes including mechanical mixing and method in which solution of foam liquid is mixes with compressed air.

75. Future of structural concrete, R. F. Blanks.
Western Construction 31: n 5, May 1956, p 38-40.
Precasting, prestressing, and lightweight aggregates have made possible new uses for structural concrete; discussion of past and future of concrete, with emphasis on production and effects of lightweight aggregates as new structural materials are produced; comparison of standard and lightweight concrete; characteristics of coated expanded shale.

76. Expanded shale--many and varied uses increasing volume, S.C. Smithwick.
Rock Products 58: n 1, Jan 1955, p 136-8, 140, 155.
Use of expanded shale as reinforced concrete aggregate has important place in construction of bridges; ships of lightweight concrete; structural use in buildings; prestressed applications.

77. Factory-precast, prestressed lightweight concrete structural system, H. C. Persons.
Rock Products 58: n 4, Apr 1955, p 217-8.
Production of all major structural members for industrial buildings at plant of Geo Rackle & Sons Co. Houston, Texas; girders cast with low slump concrete have 28 day strength of 7000 psi.

78. Lightweight aggregates for structural concrete, A. Pauw.
Am Soc Civ Engrs--Proc 81: Separate n 584, Jan 1955, 14p.
Light weight concretes may be produced by formation of air voids in cement paste, formation of air voids in concrete by omitting fine aggregates, and use of light weight aggregates which owe their low density to presence of enclosed

voids in aggregate; physical properties of light weight structural concrete and their effect on design; economic considerations.

79. Production of expanded shale aggregates, B. A. Monkman.
Can Min & Met Bul 48: n 516, Apr 1955, p 204-7.
Advantages; requisites of shale; operations at Calgary plant of Light Weight Aggregates of Canada, Ltd; crushing and sizing of raw material, burning, stockpiling; production and uses of Herculite.

80. Some preliminary studies on compositions of lightweight structural shapes by foam methods, R. G. Hardy.
Kansas State Geol Survey--Bul n 109, 1954, p 1-12.
Use of pozzolanic materials for manufacture of light weight aggregates; three methods of introducing foam; whipping foam in suitable slurry, generating gases in mix, and mixing slurry and preformed foam; subsequent autoclaving is usually employed where structural strengths are desired in products.

81. Use sintering process to make lightweight aggregate.
Rock Products 58: n 6, June 1955, p 76-7.
Onondaga Brick Corp, Warners, NY, has remodeled and enlarged its plant for production of expanded shale lightweight aggregate; annual production is 200,000 cu yd; process employs Dwight-Lloyd sintering machine and involves proportioning of raw materials, mixing materials, burning out fuel to cause shale to coalesce into hard spongy mass, and primary crushing of resultant mass.

82. Automatically controlled kilns and fuel system for lightweight aggregate plant, W. B. Lenhart.
Rock Products 57: n 5, May 1954, p 83-4, 86.
Controlled lightweight aggregate, "Solite" produced in six kilns at Bremo Bluff, Va; new plant at Aquadale produces lightweight aggregate from Monroe slate; plant uses two 7x8x135 ft rotary kilns fired with powered coal; maximum temperature 2400 F; data on crushing, screening, and conveying.

83. Factors in manufacturing fired clay lightweight aggregate, R. G. Hardy.
Am Car Soc--Bul 33: n 7, July 1954, p 201-3.
Bases for establishment of new Mineral Products Co plant at Kansas City, Kan, including: market analysis, search

methods, evaluation of aggregates produced by fabricating into products, selection of aggregate gradations, and plant design, cost and construction.

84. Investigation of lightweight aggregates of North and South Dakota, W. A. Cole, J. D. Zetteratrom.
U. S. Bureau Mines--Report Investigations n 5065, July 1954, 43p.
Investigation of clays, shales, and other materials to determine feasibility of lightweight aggregate manufacture; characteristics of various types of lightweight concretes; description of bloating clays and shales; lightweight aggregate plants; laboratory testing; suitable areas for plants; transportation facilities and potential marketing areas; production costs.

85. Lightweight aggregate from certain Oklahoma shales, A.L.Burwell.
Oklahoma Geol Survey--Mineral Report n 24, Sept 1954, 20p.
Seven samples tested for reactions and results when subjected to elevated temperatures; density, porosity, and absorption recorded and influence of drying and preheating are shown; changes in product due to variation in temperature and duration.

86. Lightweight building material from waste materials.
Can Chem Processing 38: n 6, June 1, 1954, p 50, 52, 54.
New lightweight, chemically aerated concrete will be produced by Alberta Ytong Manufacturing Co at Calgary, and known as Ytong; material is manufactured in form of large block for external and internal walls, insulating and reinforced roof and floor slabs, window lintels, etc, which can be sawed and drilled like wood; strength in compression is 850 psi.

87. Livonia lightweight corporation is blueprint of economical operation.
Brick & Clay Rec 124: n 2, Feb 1954, p 51-3.
Methods used at plant near Detroit, Mich, where 600 cu yd of lightweight aggregate is manufactured daily and marketed under trade name "Beslite"; mining of clay; movement of prepared mix; wind box operation; crushing and screening.

88. Producing lightweight aggregate from slate, W.B. Lenhart.
Rock Products 57: n 3, Mar 1954, p 92-6, 98.
Two-kiln plant of Georgia Lightweight Aggregate Co, Rockmart, Ga, is mechanized throughout; dual gas and oil kiln firing unit, and dust collector followed by spray tower hold dust to minimum; product is sold under name "Galite"; flow-sheet of raw processing, calcining, and screening; illustrated description of 8x125-ft kiln, kiln firing, firing control, crusher, clinker cooler, silos and conveyors; chemical analysis of raw shale.

89. Production of lightweight aggregates, H. G. Iverson.
Rock Products 57: n 2, Feb 1954, p 110, 138, 140.
41 plants are in operation or being planned in 20 states; desirable qualities of lightweight aggregates in addition to light weight, are high strength, low absorption, good insulation, low expansion or shrinkage; raw materials are natural byproduct or manufactured aggregates; non-bloating clays and shales can be converted to bloaters by addition of proper admixtures to raw materials.

90. Sintering of shales to produce lightweight aggregate for concrete, W. C. Scott, Jr.
Pit & Quarry 46: n 6, Dec 1953, p 98-100, 116.
TVA sintering process for production of light weight concrete aggregate; most important factors in sintering noncarbonaceous shales are moisture and carbon contents of charge.

91. Some observations on expanded blast furnace slag concrete, H.E. De Weerdt.
Pit & Quarry 46: n 6, Dec 1953, p 163-7.
Porosity of slags; effect of vibration and soaking on weight of slag; cell space and colors of slags; air entraining in slag concrete; steam curing.

92. Texas industries blankets fields of concrete and aggregates, H. C. Persons.
Rock Products 57: n 2, Feb 1954, p 86-97.
Texas Industries, Inc, Dallas, largest producer of light weight aggregate made from expanded clay or shale under trade name "Haydite"; particulars of their various plant in Texas and Louisiana; operations expanded to include aand and gravel, crushed stone, ready mixed concrete and concrete pipe; illustrations and list of plant equipment.

93. Virginia clay brick manufacturer adds lightweight aggregate business, W. E. Trauffer.
Pit & Quarry 46: n 6, Dec 1953, p 108-10.
Since cinders of good quality became more difficult to obtain, possibility of making light weight expanded clay-shale aggregates from company owned deposits waa investigated; Virginia Lightweight Aggregate Corp, Roanoke, Va, has designed capacity of 400 to 540 tons of "Weblite" aggregate per 24 hr; data on manufacturing process.

94. Water granulated blast furnace slag.
Concrete 62: n 8, Aug 1954, p 32-3.
Preliminary reports of results obtained by replacing up to 35% of costly lightweight aggregates with blast furnace byproduct known as water granulate slag; method of production; key to lower production costs and greater efficiency in lightweight block field.

95. Blast furnace slag for concrete and road construction, J. L. Cowie.
Commonwealth Engr 40: n 10, May 1953, p 413-6.
Successful uses of blast furnace slag in New South Wales for reservoirs, water supplies, stormwater drains, septic tanks, concrete roads, concrete blocks and slag wool.

96. Expanded blast furnace slag for use as light weight concrete aggregate, R. W. Miller.
Blast Furnace & Steel Plant 41: n 6, June 1953, p 635-8, 645.
Operation of Brosius and Caldwell machines used in producing expanded slags; other methods and devices indicated; principal use of expanded slag as aggregate in manufacture of concrete masonry units; relationship of expanded, air cooled, and granulated slag with respect to tonnage produced and dollar value per ton.

97. From sand and gravel to lightweight aggregate, W.B. Lenhart.
Rock Products 56: n 9, Sept 1953, p 70-4.
Data on artificial lightweight aggregate plant of Ohio River Sand Co, Louisville, Ky., where "Kenlite" (derived from "Kentucky" and "Light") is produced; finished material is expanded shale relatively small in size; plant has 8x125 ft rotary kiln but it is planned to have four in operation; flow-sheet of plant operation; crusher houses, 6x14 ft and 5x15 ft respectively, contain double deck screen and cone type crusher.

98. Leichtbeton in Schweden, G. A. Rychner.
Bauzeitung 70: n 11, Mar 15, 1952, p 155-9.
Lightweight concrete in Sweden; development during last 30 yr; different types, their manufacture, properties and applications; practical examples; illustrations.

99. Lightweight aggregates--expanded shale, J. W. Shaver.
Concrete 61: n 10, Oct 1953, p 3-6, 41.
Estimate of demand for lightweight aggregates for current annual production of concrete units is 20 million cu yd; to make up ever increasing deficit, method was developed consisting of bloating of local clays and shales through burning them in rotary kilns or by sintering on grates; burning to 2000 F, shale begins to become plastic; bloated material is cooled, then crushed and graded; data on Buildex plant, Ottawa, Kan.

100. Lightweight aggregates from blast furnace slag, J. R. Wallace.
Conference on Industrial Minerals Sponsored by Nova Scotia Dept Mines & Research Foundation June 20-22, 1951, p 62-72, (discussion) 72-7.
Production of foamed slag and its properties; comparison of chemical composition of Portland cement and foamed slag; properties of foamed slag concrete; uses of foamed slag concrete in masonry units and monolithic structure.

101. Lightweight concrete blocks for housing.
Surveyor 112: n 3187, Apr 4, 1953, p 241-3.
Blocks can be made with light weight aggregate or by aeration; principal aggregates are clinker, foamed slag, and expanded clay; use of blocks as internal partitions, inner leaf of cavity external walls, or as both leaves of cavity external and cavity party walls; British specifications for blocks; design requirements; protection of blocks and walls under construction against rain.

102. New use for phosphate slag, W. C. Scott, Jr., W. D. Sandberg.
Chem Eng 60: n 7, July 1953, p 182-3.
Electric furnace smelting of phosphate rock yields about 8 tons of slag per ton of phosphorus produced; formerly this slag found use in agricultural liming and railroad ballast; development of process to expand slag into lightweight aggregate for concrete; applicability to concrete block manufacture and other concrete construction; brief process details.

103. Preliminary report on coated lightweight concrete aggregate from Canadian clays and shales--5: Quebec, H. S. Wilson. Canada Dept Mines & Tech Surveys--Memo Series n 126, Aug 1953,36p.
Definition of light weight aggregate; types of clay and shale lightweight aggregate and their desirable properties; test methods; relation of chemical properties to bloating of clays and shales; application of chemical analyses to problem of producing coated aggregate; distribution of clays and shales in Quebec.

104. Short talks on lightweight slag concrete, H. E. DeWeerdt. Concrete 61: n 7, 8, 11 July 1953, p 16, 18, Aug p 12, 14, Nov p 28-9.
Strength and surface smoothness of concrete depend on grading aggregates; comparison between pit expanded material and slag supplied by horizontal rotating disk type machine; specific gravity of slag is 2.5, hence cu ft weighs 156 lb; typical characteristics of lean and rich plastic mixes; comparison of moisture loss and strength gain of different types of slag.

105. Sydney foamed slag as lightweight aggregate, M. R. Foran, R. E. Johnson, S. Ball, J. R. Wallace. Eng J 36: n 5, May 1953, p 556-72.
Physical and mechanical properties and engineering significance of Sydney foamed slag; tests on nature of impurities, sieve analysis, durability, mortar making properties, thermal conductivity and chemical behavior for light weight concrete; data given for strength, density, thermal conductivity volume changes, resistance to impact, to concentrated loads, to freezing and to thawing moisture penetration and acoustic properties.

106. Unique rotary hearths in new plant. Brick & Clay Rec 122: n 8, Aug 1953, p 50-1.
Equipment and operation of new Cinder Concrete Products plant, Denver, Colo, to produce lightweight aggregate from clay; two Stearns sintering hearth units are circular in form and are rotated in horizontal plane on rollers supported by heavy steel frame; each hearth is divided into 24 pie-shaped compartment, which are rotated under loading point, inverted furnace, and finally to discharge point.

107. Field practice in lightweight concrete, J. A.Murlin & C. Willson.
Am Concrete Inst--J 24: n 1, Sept 1952, p 21-36.
Properties of expanded shale and clay aggregates produced in Texas; economy of light weight structural concrete members as compared to heavy concrete; design and control of light weight structural concrete, both ready and job mixed; methods of mixing, placing, finishing and use of admixtures; economy of expanded clay or shale structural concrete.

108. Lightweight building units of autoclaved lime and siliceous material, E. Ahlstedt.
Rock Products 55: n 6, June 1952, p 107-10.
70-80% of new home units in Sweden built of chemically aerated light weight concrete; manufacturing process; material characteristics; roof slabs; floor construction.

109. Lightweight concrete aggregates from clays and shales, J. G. Matthews.
Can Min & Met Bul 44: n 471, July 1951, p 489-92.
Characteristics of low density and high density concrete aggregates; advantage in using light weight concrete is 30% to 40% decrease in dead load in structural concretes and 80% decrease in dead load for insulating concrete; rotary kiln process and sintering machine process for producing clay and shale aggregates.

110. Preliminary report on coated lightweight concrete aggregate from Canadian clays and shales, J. G. Mathhews.
Canada Dept Mines & Tech Surveys--Memo Series n 117, Feb 1952, 68p, supp map, n 120 Apr 50p, supp map, n 121, June 48p, n 122 Aug 47p.
Feb: Types of clay and shale aggregate found in Alberta; physical properties; relation of chemical properties to bloating of clays and shales; application of chemical analyses to problem of producing coated aggregate; locations; test results. Apr: Types of clay and shale aggregate found in Manitoba and Saskatchewan. June: Types found in Province of Ontario. Aug: Types found in New Brunswick, Nova Scotia and Prince Edward Island.

111. Sources of lightweight aggregates in Colorado, A. L. Bush.
Colorado Scientific Society--Proc 15: n 8, 1951, 368, p 6 supp plates.
Materials in Colorado suitable for use as light weight aggregates are pumic, scoria, perlite, obsidian, vermiculite,

welded tuff, clay, shale, slate, diatomite, fuller's earth, slag, and cinders; deposits of suitable aggregates shown on maps; characteristics. Bibliography. Paper prepared as part of program of Interior Dept for Development of Missouri River Basin.

112. Variation in density of lightweight concrete aggregates, H. S. Sweet.
Am Soc Testing Matls--Bul n 184, Sept 1952, p 44-7.
Tests of specific gravity, absorption, and concrete properties of different gradations of light weight aggregates; influence of variation in specific gravity for different particle sizes on problem of specifying sieve analysis limits on weight, basis, and on design of concrete mixes for workability; it is concluded that certain modifications should be made in grading specification for aggregates.

113. Development of large lightweight structural clay building units, W. C. Bell and D. H. McGinnia.
Am Cer Soc--Bul 30: n 10, Oct 15, 1951, p 333-40.
Aggregates studied using Dwight-Lloyd type sintering machine; aggregates were crushed, grain sized, blended with clay, and formed into building tile by means of concrete block machine, then dried and fired; clay building tiles without bloated aggregate also developed by block machine; data on physical properties.

114. Development of lightweight aggregate from Florida clays, A. F. Greaves-Walker, S. L. Bugg, and R. S. Hagerman.
Fla Univ--Eng & Indus Experiment Station--Bul Series n 46, Sept 1951, 23p.
Historical background; unit weight of various aggregates and resulting concretes; chemical analysis of several Florida clays; pilot plant tests; physical properties of lightweight aggregate and resulting concrete; manufacture of lightweight aggregate.

115. Herstellung und Anwendung von Ytong-Leichtkalkbeton, A. Laubenheimer.
VDI Zeit 93: n 22, Aug 1, 1951, p 718-9.
Manufacture and use of Ytong light weight lime concrete; method, originating in Sweden, uses mixture of blast furnace slag, lime and cement; plant at Salzgitter, Germany, produces annually 100,000 cu m of Ytong blocks and slabs; unit weight from 400 to 650 kg per cu m; compression strength 20 to 60 kg per sq cm; possibilities of application.

116. Nation's most modern haydite plant.
Rock Products 53: n 10, Oct 1950, p 163-5, 171.
Haydite plant in Portland, Ore, contains 8x100-ft rotary kiln, operating at 2200 F; oil for fuel is stored in 27,000-gal underground storage tank; hot air that has derived its heat from clinker is used for secondary combustion in rotary kiln; plant is entirely dustless; data on crushing operations and raw material excavation; examples of use of haydite for concrte.

117. Neuer Leichtbaustoff aus Hochofenschlacke, F. Schmidt.
Stahl u Eisen 71: n 7, Mar 29, 1951, p 351-3(discussion)353-4.
New light structural material from blast furnace slag; characteristics and procedure for manufacture of porous concrete developed in Sweden, called Siporex; properties and application of material.

118. Poston brick and concrete products co. finds profit opportunity in L-W clay aggregate plant.
Brick & Clay Rec 117: n 5, Nov 1950, p 44-6.
To insure reliable, nearby source of low cost, light weight aggregate for its concrete block production units was original intent of company when plans were being made to construct and operate aggregate plant on firm's Springfield, Ill, property; aggregate is bloated shale, marketed under trade name "Shalite".

119. Processi ng tailings into lightweightaggregates, W. B. Lenhart.
Rock Products 54: n 9, Sept 1951, p 94-5, 107-8.
Story of manufacture of Lelite at Lansford, Pa, plant of Lehigh Materials Co; material, made from shale recovered from mine tailings, is expanded in endless grate type of furnace, into cellular, light weight aggregate which has excellent insulating and heat resisting properties.

120. Production of lightweight aggregate, T. C. Miller.
Rock Products 53: n 10, Oct 1950, p 104-8, 138.
Historical development of light weight aggregate; aggregate classification; data on perlite, vermiculite and blast furnace slag; production of light weight aggregate from clay, shale or other similar material is accomplished with rotary kiln or sintering machine; photomicrographs.

121. Pumic-lightweight aggregate, L. I. Neher.
Am Concrete Inst--J 23: n 1, Sept 1951, p 65-75.
Chemical and physical properties, mix design, presaturation of aggregates and application of pumice aggregates in lightweight tilt-up and masonry construction are discussed.

122. Sintering clay into lightweight aggregates, W. B. Lenhart.
Rock Products 54: n 8, Aug 1951, p 108-11.
Application of Dwight-Lloyd sintering process to manufacture of lightweight aggregate from clay at plant in Salisbury, NC; data on raw material, tests and test results.

123. Tennessee lightweight aggregate plant, W. B. Lenhart.
Rock Products 54: n 6, June 1951, p 103-5.
Product made by Lake City Lightweight Aggregate Corp, Briceville, Tenn, is expanded shale, marketed under trade name La-Lite; two 6x7x70 ft Vulcan rotary kilns with 6-in. lining of firebrick are fired with pulverized coal; data on operating cycle; screening analysis; concrete block using La-Lite, strength of 1050-1075 psi and weight of 25 to 26 lb.

124. For aggregate production consider several manufacturing processes,
Brick & Clay Rec 117: n 1, July 1950, p 56.
Variety of methods have been successfully used in production of light weight clay aggregates; manufacturers contemplating aggregate production should consider merits of all processes before selecting plant equipment; brief summary of those light weight aggregates which can be made by industry; description of processes for manufacturing Haydite, Aglite and lighter aggregate; sizing aggregate; note on pellets made from clay.

125. Konnyu-Beton, E. Bereczky and J. Becz.
Magyar Technika 4: n 5, 7 , 8, May 1949, p 66-71, July p 79-89, Aug p 47-54.
Light weight concrete; properties of light weight concrete manufactured in Hungary; rigidity, specific weight and hardening qualities; prefabricated sections of buildings such as roofings, processed from light weight concrete; only cheap raw materials of inland origin are used.

126. Lightweight aggregate concrete, R. W. Kluge, M.M. Sparks and E. C. Tuma.
Am Concrete Inst--J 20: n 9, May 1949, p 625-42, (discussion) v 21: n 4, pt 2, Dec p 644 (4p); see also Ice & Refrig 117: n 3, Sept 1949, p 24-6.
Studies made by Nat Bureau of Standards; aggregates studied were expanded clay, shale and slate, expanded blast furnace slag, expanded vermiculite and perlite, sintered diatomite, fly ash and pumice; test results summarized.

127. Lightweight aggregate from expanded slate, D. Mocine.
Rock Products 52: n 7, July 1949, p 101-3, 116.
Production of aggregate "Solite" at plant of Southern Lightweight Aggregate Corp, Richmond, Va; primary crusher, 17x42 in. set for 2-in discharge; secondary crusher, 10x30 in. set for 1½-in; both of gyratory type; oversize conveyed to surge pile as kiln feed; schematic flow sheet of plant; capacity of plant with two kilns is 200 to 300 cu yd finished material per day.

128. Lightweight aggregate from mine shale.
Utilization 3: n 4, Apr 1949, p 27-9.
Utilizing breaker slate reject from anthracite preparation plants, Lehigh Navigation Coal Co has developed process from which light weight aggregate of special quality is manufactured at its new plant at Tamaqua, Pa.

129. Lightweight aggregate industry in Oregon, N. S. Wagner and R. S. Mason.
Min Eng 1: n 11, Nov 1949, Sec 3 (Trans) p 385-7.
Pumice; volcanic cinders and scoria; haydite; volcanic tuff; diatomite.

130. Light-weight pumice concrete, A. E. Niederhoff.
Am Soc Civ Engrs--Proc 75: n 6, June 1949, p 743-57, (discussion) n 9, Nov p 1387.
Because of its light weight and insulating qualities it has been found feasible and economical to ship pumice as far as 300 mi for use in building construction; material weighs about one half as much as conventional concrete, has strength up to 3500 psi, low heat conductivity and is nailable.

131. New lightweight aggregate, W. M. Avery.
Pit & Quarry 41: n 11, May 1949, p 158-60.
Lelite is produced by expanding metamorphic, carbonaceous shale, which is mined along with anthracite coal at plant near Lansford, Pa; manufacturing process; about 360 tons are produced daily.

132. Production of lightweight concrete aggregates from clays, shales, slates, and other materials, J. E. Conley, H. Wilson, T. A. Klinefelter and others.
U. S. Bur Mines--Report Investigations n 4401, Nov 1948, 121p. supp plates.
Industrial Research and Development Division of Office of Technical Services, U. S. Department of Commerce, has entered into contract with Bureau of Mines to assist in research aimed at stimulation of industrial production of larger quantities of light weight concrete aggregates; results of investigation under contract to date.

133. Results of research on lightweight concretes, E. G. Molander.
Agric Eng 30: n 3, Mar 1949, p 129-30, 133.
Discussion of porous concretes, foam and gas concretes, and organic filler concretes; their use for agricultural purposes.

134. Solite aggregate, W. M. Avery.
Pit & Quarry 43: n 7, Jan 1949, p 129-31, 134.
Solite (combination of "Southern" and "light") bears close resemblance to haydite; it weighs 57 lb per cu ft; silica 35 to 60%, alumina 25 to 30%, carbonates and other oxides 10 to 15%; at Southern Lightweight Aggregate Corp plant, Bremo Bluff, Va, average shot consists of about dozen holes charged with 40% dynamite; 100-ft rotating kilns, fired with pulverized coal, operate at 2600 F.

135. Story of pumice.
Concrete 56: n 10, 12, Oct 1948, p 8-10, 34, Dec p 3-5, 37.
Oct: Application of pumice concrete to Jackson County Memorial Hospital at Altus, Okla; deadweight reduced to 50% thus making possible saving of 45% of reinforcing steel; high thermal insulation value eliminated need for roof insulation; cost of typical bay of school building was $963.29 with normal concrete against $822.64 with pumice concrete; proportioning. Dec: Manufacture and tests of concrete masonry units; facilities and products of Harter Marblecrete Stone Co, Oklahoma City, Okla.

136. Story of pumice--progress to date on structural design, J.E. Counts.
Concrete 56: n 11, Nov 1948, p 20-2, 35.
Chart showing relationship between weight of pumice, modulus of elasticity and compressive strength; shear strength, bond strength, resistance to low temperatures, and fire; sand pumice concrete can be obtained with compressive strengths as high as 4500 psi at weight of 100 lb per sq ft with sand pumice mix.

137. Wood-wool concrete, S. Gèleff.
Indian Concrete J 22: n 12, Dec 1948, p 271-4.
Material consists of wood wool chemically treated and mixed with cementing agent, e.g., magnesite, plaster, or portland cement, and thereafter pressed into final shape; specific weight varies between 0.25 and 0.50 for fully dried slabs; resistance to water, frost, rot and fungi; data on flexural strength, thermal insulation power, raw materials and manufacture.

138. Aggregates for David Dam, W. B. Lenhart.
Rock Products 52: n 6, June 1949, p 101-3.
Gravel plant in Colorado uses shale pozzuolan in mix to improve durability of concrete; typical concrete mix and strength; storage bins for cement and pozzuolan; stacker belt for coarse aggregates; conveyors; photographs.

139. Marietta concrete has first aglite plant, J. W. Shaver.
Concrete 57: n 10, Oct 1949, p 3-6.
Traveling grate system of manufacturing light weight concrete aggregates at plant of Marietta Concrete Corp, Marietta, Ohio; flow chart; manufacturing operations require 30 electric motors having total of 625 hp; sintering machine.

140. Mechanics, techniques and economics of expanded clay-shale aggregate production, W. G. Bauer.
Pit & Quarry 41: n 6, 12, Dec 1948, p 91-5, June 1949, p87-90.
Dec 1948: Factors which affect clay handling; mining, transportation crushing, sizing, conditioning and clay drying; diagram gives list of equipment for raw material preparation. June 1949: Use of rotary kiln in sintering and floating process of gas containing clays and shales; kiln design factor; shortcomings of present installations; mechanical and thermal kiln capacity factors, heat exchange and draft factors, heat requirements and role of moisture.

141. Design and control of pumice concrete mixes, W.K. Wagner.
Rock Products 51: n 9, Sept 1948, p 125-7, 136-8.
Chemical analysis of pumice; tests made to determine strength relationships in mixes of workable and plastic consistencies; water cement ratio and relation of modulus of elasticity to compressive strength for pumice mixes plotted in alignment charts; study of effect of air entraining.

142. Haydite production, W. M. Avery.
Pit & Quarry 42: n 3, Sept 1948, p 158-62.
Pictorial description of plant at New Market, Kan, with data on crusher, double deck vibrating screens, shale storage silo, kilns, oil burners, cooling pit, conveyor and grinding; plant designed for output of 160 cu yd per kiln per day; removal of 18 ft overburden and truck loading are handled with Traxcavator shovel; rotary kilns driven by 25 hp GE slip ring variable speed motor.

143. Lightweight aggregates win new atteation.
Arch Rec 104: n 1, July 1948, p 143-5.
Examples of use in recent building construction; physical properties, formation and mode of occurrence of volcanic aggregates, including pumice, vesicular glass andperlite; vermiculite; clay, shale aggregates including Airox, Rocklite and diatomite; byproduct aggregates such as expanded slag, cinders and fibers.

144. Lightweight concrete aggregate from phosphate waste, A. F. Greaves-Walker and P. P. Turner.
Rock Products 51: n 6, June 1948, p 185.
Investigations conducted by Eng & Indus Experiment Station of Univ of Florida for finding practical uses of wastes at phosphate mines in central part of Florida, which contain clay, aluminum silicate and calcium phosphate suitable for light weight concrete aggregates.

145. Properties of some lightweight-aggregate concretes with and without air-entraining admixture, P. H. Petersen.
U. S. Bur Standards--Bldg Matls & Structures--Report EMS112, Aug 16, 1948, 7p; see also Am Concrete Inst--J 20: n 2, Oct 1948, p 165-75.
Aggregates made with burned shale or expanded slag; three grades of concrete using each aggregate were made; air entrainment of greater than 20% is reported for mixtures leanest in cement; compressive, transverse, and bond strength; coefficients of thermal expansion, shrinkage, and values for change in length due to wetting and drying.

146. Studies of lightweight concrete mix design and strength, E. L. Howard.
Rock Products 51: n 6, June 1948, p 189.
Report on studies of concrete made from natural aggregates; comparative unit weights, compressive strengths and physical and chemical analysis of scoria and pumice from Siskiyou County tabulated; comparative mix and compression data of concrete using scoria (pebbled) aggregate.

147. First sinter-lite plant is making lightweight aggregate from fly ash.
Pit & Quarry 29: n 7, Jan 1947, p 199-200.
Illustrated description of manufacture of concrete products from fly ash supplied by power plants; use of fly ash necessitates certain procedure that changes dust-like fly ash into clinker which can be crushed and graded; data on crushers, screens, sintering machine, storage bin and mixer.

148. Fly ash teams up with Portland cement to make better concrete, W. M. Avery.
Pit & Quarry 39: n 11, May 1947, p 157-9.
Fly ash used as substitute for portland cement either by intergrinding or by addition to concrete mixer; its puzzolanic property enables it to form stable, insoluble compounds in presence of moisture; tests show that fly ash may replace portland cement up to 30% by weight.

149. Aluminum-treated concrete cuts building costs, J. G. Wurtz, Jr.
Construction Methods 28: n 3, Mar 1946, p 94-5, 158,160, 162-3.
Light weight expanded concrete is made by addition of aluminum powder to mix, which reacts in same manner as bread dough to yeast; such concrete may be field cast in place or used as precast slabs; besides reduction of weight, expanded concrete has unusual sound deadening properties; data on mixing, use and properties; illustrations.

150. Lightweight concrete opens up new markets.
Rock Products 49: n 1, Jan 1946, p 265-7.
Description of specialty products made of lightweight vermicullite concrete by Pacific Bldg Material Co, Berkeley, Calif, including portable incinerators, precast outdoor barbecues, vent tiles, ornamental fences, safes and burial vaults.

151. New lightweight aggregate from fly ash, R. F. Leftwich.
Concrete 54: n 1, Jan 1946, p 14-5, 39.
Illustrated description of plant for manufacture of lightweight aggregate of fly ash for concrete masonry units in Bronx, NY; data on material, operating process, machines and equipment given.

152. Applications of haydite widen with advances in production techniques, W. M. Avery and H. F. Utley.
Pit & Quarry 37: n 12, June 1945, p 60-3, 68.
Production and uses of Haydite outlined, and equipment and operation at Western Brick Co, McNear Brick Co, and Haydite Concrete Products Co, described.

153. New California plant produces light-weight aggregates for cocnrete ships and barges, H. Utley.
Pit & Quarry 37: n 8, Feb 1945, p 108-8, 116.
Airox Co of Los Angeles produces new type of aggregate made by burning diatomaceous shale at deposit; process consists of making sized aggregate which is vesiculated by expansion of gases generated within material by heat and then sealed by fusing surface of each pellet.

154. Recent developments in lightweight concrete, T. W. Parker.
Roy Inst Brit Architects--J 52: n 2, 4, Dec 1944, p 43-7, (discussion) Feb 1945, p 100-2.
Properties of concrete made with light weight aggregates such as clinker, pumice, shales, clays and expanded vermiculite; strength, water absorption and heat insulation discussed. Bibliography.

155. Effect of curing conditions on compressive, tensile and flexural strength of concrete containing haydite aggregate, E. B. Hanson, Jr., and W. T. Neelands.
Am Concrete Inst--J 16: n 2, Nov 1944, p 105-14.
Results of tests on lightweight concrete used in barges to determine cause of extensive cracking of concrete experienced in similar structures.

156. Washington haydite co. uses local material for lightweight aggregate, W. E. Trauffer.
Pit & Quarry 36: n 12, June 1944, p 71-2.
Notes on activities of producer near Bothell, Wash, 16 mi northeast of Seattle; typical analysis of clays; about ½ cu yd of Haydite is obtained from each cubic yard of clay mines; mix for concrete blocks contains about 55% of fines and 3/16-in. material and 45% of ½-in; these products weigh about 60 lb per cu ft.

157. Properties of porous concrete of cement and uniform sized gravel, P. H. Petersen.
U. S. Bur Standards--Bldg Matls & Structures--Report n BMS 96, Mar 18, 1943, 15p.
Physical properties of porous concrete consisting solely of portland cement, water, and uniform sized gravel were investigated; compressive, transverse, shearing, and bond strengths, are reported as well as resistance to heat transfer; water penetration by capillarity, and rain penetration.

158. Waste slate as raw-material source of lightweight aggregates, J. E. Conley.
Am Inst Min & Met Engrs--Trans (Indus Minerals Div) 148: 1942, p 161-66. Indexed in Engineering Index 1942 p 243, from Tech Publ n 1512 for meeting Oct 1941.

159. Lightweight aggregates for concrete, E. T. Moyer.
U. S. Bur Mines--Information Cir n 7195, Jan 1942, 26p; see also Cer Age 40: n 5, Nov 1942, p 152-4.
Comment on need for and advantage of light weight building materials; kinds of aggregates; properties and uses; natural aggregates; by-product aggregates; processed aggregates; market summary.

160. Waste slate as raw-material source of lightweight aggregates, J. E. Conley.
Am Inst Min & Met Engrs--Tech Publ n 1512 for meeting Oct 1941, 6p.
Reference made to literature on light weight concrete industry; requirements for raw materials; type of furnace used for production of Haydite, Gravelite; etc, from clays or shales; preparation of waste slate for expanding treatment; illustrated description of expanded pellets produced; estimate of manufacturing costs; patent data.

161. Design of light-weight zonolite concrete mixes, G. P. Tschebotareff.
Am Concrete Inst--J 12: n 4, Feb 1941, p 509-15.
Results of tests, illustrating pecularities of such mixes which necessitate special approach to problem of their design; determination of advisable water content.

162. Creep of portland blast-furnace cement concrete, A. D. Ross.
Instn Civ Engrs--J n4, Feb 1938, p 43-52.
Analysis of series of original laboratory tests; stresses induced by creep.

163. New plant produces lightweight slag, G. F. France.
Pit & Quarry 30: n 10, Apr 1938, p 63-8.
Way in which Hudson Valley Fuel Corp, Troy, NY, decided to utilize slag from existing blast furnace operations in production of light weight concrete aggregate.

164. Experience with light aggregate in concrete construction, R. S. McLean.
Eng News-Rec 118: n 13, Apr 1, 1937, p 484-5.
Experience with exclusive use of five types of light weight aggregates in 2-story Commerce Building constructed on new campus of Junior College in Fullerton, Calif; concrete weighed only 115 lb per cu ft; absorption rate of coarse light weight aggregate; strength and slump tests.

165. Lightweight concrete aggregates, F. M. Lea.
(Great Britain) Dept Sci & Indus Research--Bldg Research--Bul n 15, 1936, 13p, 4d net.
Uses of light weight concrete aggregates; description of materials available; properties of light weigh concretes; precautions in use.

166. "Foamed slag"; new light-weight aggregate.
Concrete & Constr Eng 31: n 2, Feb 1936, p 148-51.
Properties of cellular aggregate produced by cooling rapidly molten blast-furnace slag of suitable chemical composition by patented process; foamed slag concrete; tests on building units; crushing strength; heat transmission; shrinkage.

167. Lightweight aggregate produced from slate waste, E. H. Coleman.
Concrete Bldg & Concrete Products 11: n 3, Mar 1936, p 47-8 and 50; see also Concrete & Constr Eng 31: n 1, Jan 1936, p47-51.
Results of analyses and tests made by Building Research station of Great Britain; use of slate-waste aggregate in construction of partition slabs.

168. Review of construction and materials. Foamed slag; new structural material.
Roy Inst British Architects--J 43: 3rd series n 7, Feb 8, 1936, p 376-9.

169. Aspectos da utilizacao das escorias basicas de alto forno na industria dos cimentos, V. L. Martins Coimbra.
Ordem des Engenheiros--Boletim 5: n 9, May 1, 1956 (Memo 174) 9p.
Aspects of utilization of basic blast furnace slags in cement industry; manufacture and structure of Portland clinker; hydraulic capacity of granular slag and its advantages.

170. Carolina tuff-lite triples production, plans expansion.
Brick & Clay Rec 129: n 3, Sept 1956, p 62-5.
Procedures for raw material preparation and sintering operation in manufacture of light weight aggregates; aggregate and coarse material handling; loading set-up; equipment list.

171. Iron blast-furnace slag as building material, S. K. Chopra, N. K. Patwardhan.
India Central Building Research Institute, Roorkee--Bul 3: n 2, Dec 1955, p 42-57.
Use of slag as aggregate in concrete production; use in granulated form in cement production; foam slag application in making light weight concretes. Bibliography.

172. New slag processing plants show levy company five-year expansion, R. L. Peck.
Pit & Quarry 48: n 7, Jan 1956, p 182-3, 186-7, 190.
Dix No. 2 Plant, processes expanded slag produced at three Ford blast furnaces, into lightweight concrete aggregate; operations at other new slag processing plant of company in Trenton, Mich.

173. Properties of lightweight aggregates and lightweight concretes, G. W. Washa.
Am Concrete Inst--J 28: n 4, Oct 1956, p 375-82.
History of use of lightweight aggregates; lightweight concrete is divided into: cellular or foam, no-fines or "popcorn", and lightweight aggregates concrete; lightweight aggregates, both mineral and vegetable, are enumerated; desirable properties of mineral aggregates discussed.

174. Raw materials for lightweight aggregate production in New Jersey, W. Lodding.
Rutgers University--Bur Mineral Research--Bul n 7, 1956, 160p, 2 maps.
Physical and chemical properties; preparing sinter charge and sintering tests; properties of sintered aggregate; kiln expansion tests and procedure for concrete testing.

175. Sintering and lightweight aggregates, A. F. Leitner.
Pit & Quarry 48: n 8,9, Feb 1956,p 94-6, 105, Mar p 104-6, 110.
Feb: Essentials of sintering. Mar: Planning commercial sintered light weight aggregate manufacturing operation.

176. Structural lightweight-aggregate concrete, R. W. Kluge.
Am Concrete Inst--J 28: n 4, Oct 1956, p 383-402.
Proportioning and control of concrete mixtures containing lightweight aggregate; some of physical characteristics of plain concrete, as well as certain structural properties of reinforced lightweight concrete with comments on their relation to design of structural elements.

177. They've expanded to meet growing demand.
Brick & Clay Rec 127: n 5, Nov 1955, p 47-50.
Report on Hydraulic Press Brick Co's Ohio light weight aggregate plant, where production has been boosted to 500 cu yd daily by adding kiln and modernizing line; processing methods.

178. Use of blast-furnace slag as concrete aggregate, E. F. Farrington.
Instn Civ Engrs--Proc 5: pt 1, n 1, Jan 1956, p 56-9, 2 plates.
Use of slag as aggregate in reinforced concrete work at works of Appleby-Frodingham Steel Co; slag from Company's own blast furnaces conforms to BS 1047:1952; practical characteristics; results are evidenced by plant itself, which is built of slag aggregate concrete.

179. Arizona volcanic cinder concrete, a comparative study, A. W. Ross, K. K. Kienow.
Engineering Experiment Station Bulletin No. 9, The University of Arizona, Civil Engineering Series No. 4, May 1959, 32p+.
Since very few studies have been made with comparable types of material, this program has entailed investigations relative to the basic aggregate properties, the relation of the aggregates to concretes of several different designs, appropriate testing methods, and the establishment of design criteria for general field use.

180. Lightweight aggregate--the modern building material. Papers delivered at the annual meeting--Expanded Clay and Shale Association, Inc.--Chicago, Illinois, February 15-16, 1958.
The Future of Lightweight Concrete, William W. Karl.
A Study of a Sintering Process, Ronald G. Hardy.
A Report on the Mackinac Bridge, Melvin Cruzen.

181. The tensile strength and diagonal tension resistance of structural lightweight concrete, J. A. Hanson. Research and Development Laboratories, Portland Cement Association, January, 1961, 6 lp.

This report describes the tests employed and the results obtained in an extension of a previous study of diagonal tension resistance reported by the author; This extension of the original program involves lightweight concrete beams of longer span and lower steel percentages. An important conclusion, that diagonal cracking load should be considered as the ultimate load for non-web reinforced beams, has been confirmed.

A large number of 6x12-in. cylinders from the beam concretes were broken by the "split-cylinder" tension test. Good correlation was established between this indirect tension measurement and the shear resistance of the beams at diagonal cracking. This correlation shows that the diagonal tension resistance of lightweight concretes varies from approximately 60 per cent of that of the similar normal weight concrete to nearly 100 percent, depending upon the particular lightweight aggregates used.

Proposed ultimate load design recommendations are made for structural lightweight concrete. These are in general accord with the recommendations of the ACI-ASCE Committee 326 on Shear and Diagonal Tension for normal weight concrete. It has been found that diagonal tension strength of the lightweight concretes is affected by the same variables as affect the resistance of normal weight concrete. The difference between the two types of materials is one of magnitude of diagonal tension resistance and not of fundamental difference in behavior.

The proposed design recommendations also provide for the fundamental differences in tensile resistance that exist between the various lightweight aggregates. A combination of compressive strength and split-cylinder tension testing provides a convenient and safe measure of the ultimate diagonal tension resistance to be associated with each of the various aggregates.

182. Determining the suitability of clays for the production of lightweight aggregates, V. S. Ramachandran, N. C. Majumdar and N. K. Patwardhan.
Indian Concr J., 1961, v 35, n 12, p 453-6, p 223.

183. Nomograph for control of lightweight constituents in blended sand for concrete.
U.S. Dept. of Interior, Concrete & Structural Branch, Lab Report No. C-1046, Feb 25, 1963, 7p+.
In the past few years, the decreasing quality of aggregate sources has emphasized the need for expansion and improvement in gravel plant design and operation to provide better quality concrete aggregate. One method of accomplishing this is by heavy media separation at the aggregate plant by which unsound, lightweight particles of gravel and coarse sand are separated from the sound aggregate particles. This method of aggregate beneficiation was first used by the Bureau on Twitchell Dam when low strengths and poor durability were encountered in concrete containing the available unprocessed aggregate. Currently, certain size fractions in the aggregate for use in exterior concrete at Glen Canyon Dam and all concrete at Flaming Gorge Dam are additionally processed by this method. This additional processing requires close control to assure compliance with specifications requirement of a maximum of 2 percent lightweight material in the processed aggregate used. Such control, as described in this report, is applied to the No. 8 to No. 4 sand fraction only as this particular size alone is obtained from two sources, (1) the heavy media separation plant and (2) as oversize in the minus No. 8 through pan size sand processed through the sand classifier, either of which can, through poor control or improper operation, provide sufficient light-weight material to exceed the specification maximum of 2 percent in the blended sand.

184. Behavior of volcanic soils in highway construction, Jorge Ernesto Erdmenger.
ASCE Proc 88: J of Const Div No. CO2, Sept 1962, p 1-24.
Scope and magnitude of highway construction work in Guatemala has led to analysis, studies, and research of several construction problems. Guatemala has abundant volcanic soil sources. Main volcanic soils studied were volcanic cinder and pumice sand. Present report analyzed forty-three different samples of pumice sand, taken from eleven departments (Provinces, geopolitical subdivisions).

185. An Investigation of diagonal tension resistance in beams made with a lightweight aggregate, George M. Upton, Jr. and Jack R. Clanton.
Trend in Engineering (Univ. of Wash.) 14: n 3, July 1962, p 18-23, 32.
Materials, fabrication, and test procedure.

186. Production of hollow lightweight aggregate by controlled preheating, Hristo Stamboliev.
American Ceramic Society J 44: n 12, Dec 1961, p 577-583.
A study made of bloating mechanism in two clays which contained large amounts of organic carbon, alkalis, and sulfates.

187. Utilization of improved lightweight aggregate, Kenichi Hiraga and others.
Semento Gijutsu Nempo 15: p 189-93, 1961.

188. Properties of portland blast-furnace slag cements for use in mass concrete, Kazuo Goto, Keisuke Enoeda and Yoshibumi Sakamoto.
Semento Gijutsu Nempo 15: p 156-8, 1961.

189. Perlite as fine aggregate for use in lightweight concrete, Shin Nakamura, Koichi Yano, and Seihachi Osawa.
Semento Gijutsu Nempo 15: p 184-9, 1961.

190. Some special hydrothermal processes in the production of lightweight concretes using porous clay aggregates, S. Kh. Mironov and A. V. Talisman.
Materialy Ob'edin. Nauchn. Sessii Inst. Stroit. Materialov i Sooruzhenii Zakavkask. Resp., Akad. Nauk Gruz. SSR, Inst. Stroit. Dela 1958, p 71-80, Publ. 1961.

191. Properties and formation of swelled three-layered clay minerals in soil clays derived from sediments, Udo Schwertmann.
Beitr. Mineral. Petrog 8: 199-209, 1962,

192. Roadside picnic and rest areas.
Int Road Safety & Traffic Rev (Great Britain) 12: n 1, Winter 1964, p 18-24.
Pleasant and safe stopping places off main road.