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TEXAS TRANSPORTATION INSTITUTE

TEXAS HIGHWAY DEPARTMENT

COOPERATIVE RESEARCH

CLAY AS A LIGHTWEIGHT AGGREGATE
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BIBLIOGRAPHY (63-7)
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CLAY AS A LIGHTWEIGHT AGGREGATE

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1. Bloated clay aggregate--its production and marketing potential in Florida, M. J. Roberts.
Florida Univ--Eng & Indus Experiment Station--Bul n 98, v 12, n 6, June 1958, 51p.
Survey of Florida's lightweight concrete aggregates; types, limiting factor; production costs; mining, preparation of material, and bloating are described; use of traveling grate and rotary kiln methods; crushing, screening, and storage.

2. Cinder as heat insulating material and lightweight aggregate in cement mortar, I. S. Uppal, S. R. Bahadur.
Indian Concrete J 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.

3. Evaluation and selection of aggregate for concrete construction, G. C. Price.
Roads & Eng Construction 96: n 10, Oct 1958, p 88,90,92,94, 96,100,102,104.
Significant characteristics of concrete aggregates used in western Canada; outline of research by Prairie Farm Rehabilitation Administration in aggregate evaluation; special emphasis placed on visual appraisal; results show increased water requirements due to silt and clay is of significance since this factor is directly related to drying shrinkage.

4. Fly ash sintering, A. J. Kantor.
Pit & Quarry 49: n 12, June 1957, p 88-90.
Research and development of process as carried out by Koppers Co; basic equipment required for sintering plant; estimate of cost of producing 1 cu yd of fly ash aggregate based on 1900 cu yd per day plant.

5. 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.

6. Clay mineralogy techniques, M. F. Aukland.
Ohio Geol Survey--Information Cir n 20, 1956, 31p.
Classification and nomenclature of clay and clay minerals; physical properties, such as particle size and composition, bonding strength firing properties, differential thermal analysis, X-ray diffraction, and optical properties; origin and occurrence; structural mineralogy of clays.

7. New method of preparing clay samples for differential thermal analysis, J. D. Walton, Jr.
Am Cer Soc--J 38: n 12, Dec 1955, p 438-43.
Method whi chpermits analysis to be made with test and reference samples freely exposed to furnace atmosphere; data for samples thus heated and when Inconel block was used to contain clay.

8. Oscillating-heating X-Ray diffractometer studies of clay mineral dehydroxylation, E. J. Weiss, R. A. Rowland.
Am Mineralogist 41: n 1-2, Jan-Feb 1956, p 117-26.
Oscillating heating X-ray diffraction technique; typical oscillation heating patterns of basal spacing maxima for Georgia kaolinite, Vermont chlorite, clinoclore, and sheridanite.

9. Quantitative differential thermal analyses of clay and othe r minerals, H. W. van der Marel.
Am Mineralogist 41: n 3-4, Mar-Apr 1956, p 222-44.
Shape and intensity of thermal curve of minerals, when analyzed by dta method, are strongly influenced by amorphous coatings and disordered structures on surface of particles (Beilby layer), and furthermore by differences in particle and/or crystallite size, degree of crystallinity of crystallites and ion substitutions in crystal structure; examples. Bibliography.

10. 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.

11. 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.

12. 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.

13. Fundamental study of clay: XIII, W. D. Kingery, J. Francl.
Am Cer Soc--J 37: n 12, Dec 1954, p 596-602.
Drying behavior and plastic properties; effects of nonionic, anionic, and cationic surface active agents on yield point, plasticity, drying and firing shrinkage, dry and fired density, and rate of drying. Bibliography.

14. Kinetics of thermal dehydration of clays--1,2,3,4,P. Murray, J. White.
Brit Cer Soc--Trans 54: n 3,4, Mar 1955, p 137-87, Apr p 189-238.
Pt 1: Dehydration characteristics of clay minerals; continuation of kinetic investigation of breakdown characteristics of china and ball clays, plastic fire clays and montmorillonites upon heating. Pt 2: Isothermal decomposition of clay minerals; from velocity constants, arrhenius parameters have been determined for kaolinites, secondary micas, halloysites and montmorillonites. Pt 3: Analysis of mixtures of clay minerals; method for kaolinites and secondary mica clays. Pt 4: Interpretation of differential thermal analysis of clay minerals; to test correctness, constants have been applied to obtain; analogous differential heating curves, information on relative life of clay bonds in molding sands, and 3-hr dehydration curves. Bibliography.

15. 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.

16. Estudio sobre propiedades de las puzolanas, A. Ochoa Rivera.
Ingenieria (Mexico) 31: n 2, Apr 1961, p 52-5.
Testing of pozzolan properties; study of diatomite, bentonite, burned clay, perlite, pumice sand, pumicite, and fly ash; method for determination of index of activity; testing of expansion and contraction capacity during drying; data on chemical and physical tests.

17. Izmenenie struktury kolloidnogo kapillyarnoporistogo tela (gliny) v protesesse sushki, M. S. Belopol'skii.
Inzhenerno-Fizicheskii Zhurnal 4: n4, Apr 1961, p 49-54.
Change in structure of colloidal capillary porous material (clay) during drying process; investigation of deformation and strength properties of several clays over wide moisture content range; critical points, obtained on shrinkage curves, drying rate curves and desorption curves; mechanism of structure formation on process of drying kaolin and montmorillonite clays. (English summary).

18. Sinterung von Flugaschen aus Kraftwerken, K. Meyer, H. Klier.
Aufbereitungs-Technik 1: n 1, Jan 1960, p 12-16.
Sintering of flue dust of power plants; granulating capacity is studied from analytical data and technical investigation on melting of flue dust; granulated material is sintered in small scale tests; result of sintering process depends on size of granules; agglomerates may serve various purposes in construction. English summary.

19. Verwendbarkeit von Hochofenschlacke als bituminoeses Heissmischgut fuer den Strassenbau, A. Send, G. Gelsdorf, H. Kaiser.
Stahl u Eisen 80: n 5, Mar 3, 1960, p 290-6.
Use of blast furnace slag as aggregate for hot bituminous mixtures used in road building; laboratory comparison of blast furnace slag vs natural rock gravel; ratio of under-

size pieces after heating at 150-800 C, and effect of compression and impact; field tests; slag gravel is found in no way inferior to rock.

20. Kornformbeurteilung von aufbereiteten Hochofenschlacken-Splitten, H. Kahlhoefer, A. Send, H. Kaiser.
Stahl u Eisen 76: n 15, July 26, 1956, p 957-64.
Evaluation of grain shape of processed blast furnace slag as road aggregate, with special reference to different types of crushers; investigations carried out by Mannesmann-Huettenwerke; effect of crusher type on quality of aggregates; correlation between grain form, weight per cubic meter, and resistance to compression.

21. Investigation of some North Dakota clays and shales, O. E. Manz.
North Dakota Geol Survey--Report Investigations n 13, 1953, 36p.
Survey of unfired and fired properties of clays and shales from various outcrops and commercial deposits; screen analyses with microscopic examination; determination of linear drying shrinkage and water of plasticity of handmade specimens; slaking test of dried specimens; determination of fired linear shrinkage, apparent porosity and water adsorption of fired specimens.

22. Rehydration of fired clay and associated minerals, R. D. Hill.
Brit Cer Soc--Trans 52: n 11, Nov 1953, p 589-613.
Durability of fired clay materials as function of firing temperature; kaolinite, illite, montmorillonite, vermiculite, bauxite, and limonite were fired at temperatures between 500 and 1150 C and then rehydrated in saturated steam at 200 C for periods up to 96 hr; products were examined by X-ray and differential thermal analysis.

23. Roanoke Webster develops highly integrated operation.
Brick & Clay Rec 124: n 5, May 1954, p 35-8, 71.
Methods employed at plant in Roanoke, Va. to produce quality face brick, light weight clay aggregate and top quality concrete block; brick is produced on stiff mud machines; light weight aggregate is made on sintering hearth; operation consists of two brick plants manufacturing stiff mud and molded brick, and concrete building block plant manufacturing both light weight and heavy units.

24. Weight loss and oxidation behavior of structural bodies during firing, R. R. Van Der Beck, J. O. Everhart.
Am Oer Soc--J 36:n 11, Nov 1953, p 383-8.
Twenty materials, including clays and shales and mixtures, were investigated to study factors which affect firing behavior of structural clay materials; methods included differential thermal analyses, oxidation rate determinations, and length change determinations; method for application of resultant data to firing schedules.

25. Adsorbent clays in California, R. S. Lamar.
California J Mines & Geology 49: n 3, July 1953, p 297-337.
Chemical and physical factors affecting adsorption; mining of adsorbent clays; processing fuller's earth and activated clays; use in oil industries; pigments and colorants found in oils; purification of vegetable, animal and marine oils; graphs. Bibliography.

26. Clays and shales of New York State.
Published by New York State Dept of Commerce, Albany, NY.1951, 349p.
Geology of clays and shales; results of analyzing and testing; economic uses; data on unfired properties and pyrometric cone equivalent, percent linear firing shrinkage, fired strength, percent fired absorption, colors of fired specimens, efflorescence tendencies of fired specimens, mineralogical and chemical analyses.

27. Effects of extrusion and some other processes on micro-structure of clay, J. H. Weymouth, W. O. Williamson.
Am J Science 251: n 2, Feb 1953, p 89-108.
Microstructure of plastically deformed kaolinitic clay studied optically in pyroxylin backed films; planar parallelism, and linear parallelism revealed by disposition of rutile and tourmaline prisms, were observable in extruded cylinders; relations between these types of parallelism and schlieren produced by using particolored clay.

28. Sur la constitution des argiles activees, I. Perrinbonnet, J. Mering.
Chimie et Industrie 69: n 3, Mar 1953, p 459-60.
Constitution of activated clay; constitution of montmorillonite subjected to acid activation; method for determining CiO_2 liberated in activation process.

29. Find scumming sulphates by quick method, L. G. Tubbs.
Brick & Clay Rec 122: n 2, Feb 1953, p 59.
Method developed by Barium Reduction Corp for control of dryhouse scum and efflorescence on burned clay products, is essentially turbidity measurement with simple turbidimeter especially adapted so that untrained personnel may make test; use of method makes it possible to add exactly amount of barium carbonate required by particular clay, preventing waste of this material. From paper before Am Chem Soc.

30. Differential thermal analysis, R. C. Patterson.
Am Cer Soc--Bul 32: n 4, Apr 1953, p 117-18.
Basic factors concerned with existence of differential temperature; application to study of clay minerals showed this was dependent upon amount and kind of material used, heat capacity of holder, and rate of heating.

31. Thermal, dehydration, and X-ray studies on montmorillonite, J. W. Earley, I. H. Milne, W. J. McVeagh.
Am Mineralogist 38: n 9-10, Sept-Oct 1953, p 770-83.
Thermal reactions, water loss and changes in crystal structure investigated between 500 and 950 C for five samples with varying chemical composition.

32. Effect of high temperatures on strength of roadmaking aggregates, F. A. Shergold.
Roads & Road Construction 31: n 366 ,June 1953, p 161-3.
Object of work described was to determine what temperatures and for what periods aggregates must be exposed to reduce their strength; eleven different aggregates were investigated; description of each; experimental work described; results.

33. Field practice in lightweight concrete, J. A. Murlin and 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.

34. Sources of lightweight aggregates in Colorado, A. L. Bush. Colorado Scientific Society--Proc 15: n 8, 1951, 368p., 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, fullers' 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.

35. Mineral products company lightweight aggregate plant, B. J. Moats,Jr.
Min Congress J 38: n 4, Apr 1952, p 68-9.
Plant located in Kansas City, Kans, capable of producing 600 cu yd of structural aggregate daily; coal and clay used as raw materials; process of coal and clay preparation and sinterization described.

36. Proper pelletizing technique key to efficient sintering of aggregate, W. C. Bell.
Brick & Clay Rec 120: n 1, Jan 1952, p 46, 49, 52.
Pelletizing problems presented by characteristics of different materials; proper methods allowing use of almost all types of clay to produce light weight aggregate; pelletizing equipment; sintering characteristics of various clays; use of sintered clay aggregate in concrete block.

37. Sintered aggregate produced by push-button plant.
Brick & Clay Rec 120: n 5, May 1952, p 38-9.
New Kansas plant produces 600 cu yd of light weight aggregate daily by sintering process; variable speed feed belts regulate mix; remote control operation.

38. Sintering Ray clay and shale into lightweight aggregate, T. Brown.
Rock Products 55: n 3, Mar 1952, p 94-6.
Manufactured product produced by expansively sintering clay and shale at 2400 F until it is vitrified; flowsheet of light weight aggregate plant; plant and operation described.

39. Effects of heating rate on shrinkage of clays and shales in firing, W. J. Meid and R. K. Hursh.
Am Cer Soc--J 34: n 9, Sept 1, 1951, p 287-90.
Measurements of progressive shrinkage of series of shales and fire clays made while heating at constant rates up to vitrification temperature; comparison of shrinkage be-

havior using different heating rates; striking similarity in shrinkage behavior of shales and fire clays; three typical intervals of rapidly increasing shrinkage followed by periods with lagging shrinkage rate.

40. 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 light weight aggregate from clay at plant in Salisbury, NC; data on raw material, tests and test results.

41. Colloid chemistry of silicate minerals (Agronomy, Series of Monographs, Vol I), C. E. Marshall.
Academic Press, New York, 1949, 195p, illus, diagrs, charts, tables.
Monograph clarifies fundamentals of colloid chemistry of clays; following historical material, structure, properties, sizes and shapes of clay particles are discussed; adsorption by clays, clay acids, ionic exchange reactions, and electro-kinetic properties of clays considered, as well as mechanical properties of suspensions and properties of aggregates and films. Eng Soc Lib, NY.

42. Differential thermal analysis in controlled atmosphere, H. L. Saunders and V. Giedroyc.
Brit Cer Soc--Trans 49: n 8, Aug 1950, p 365-74.
Apparatus described in whichit is possible to control atmosphere over sample investigated; importance of control emphasized, and shown by study of thermal curves of minerals containing oxidizable compounds (e.g.ferrous oxide); in interpretation of exothermic peaks of iron-bearing clays, influence of iron with particular reference to ferrous or ferric state, must be taken into consideration.

43. Crystalline phases in fired shale products, W. E. Brownell.
Am Cer Soc--J 33: n 10, Oct 1, 1950, p 309-13.
Development of crystalline and glassy phases traced in shale specimens fired over range of temperatures; two raw materials of different compositions selected for study, namely, highlime shale and argillaceous shale; mechanical separations and X-ray analyses were used to isolate and identify crystalline phases; development of glass was observed petrographically; identification of phases at various heat treatments was helpful in explaining properties of fired shale products.

44. First aglite plant, W. M. Avery.
Pit & Quarry 42: n 5, Nov 1949, p 182-5, 191.
Illustrated description of plant of Marietta Concrete Corp, Marietta, Ohio, for manufacture of light weight (expanded clay) aggregate, Aglite, made by sintering mixture of finely crushed clay or shale and coal; data on Leftwich sintering machine and other equipment; 5000 masonry units and 6000 silo staves are produced in 8 hr.

45. In light-weight aggregate production select proper burning equipment, E. P. Flint.
Brick & Clay Rec 116: n 4, Apr 1950, p 65-6, 69.
Report on study made by Armour Research Foundation concerning relative performances of rotary kiln and of various types of sintering machines for manufacture of light weight clay aggregate; sintering machines appear to be more adaptable, aggregate from them tends to give harsher concrete and has higher water absorption; rotary kilns give particles with glazed surfaces and resulting low water absorption.

46. Lightweight aggregate from expanded slag.
Rock Products 52: n 10, Oct 1949, p 154-5.
Caldwell B sintering machine used at Lone Star Steel Co., at Lone Star, Tex, for production of slag having capacity of 50 ton per hr; it is rotor type with water cooled side plates, table and cone and driven by 100-hp motor; data on crushing, screening and storing; process is so flexible that neither furnace shutdown nor crusher breakdown will affect operation.

47. Lightweight aggregate from phosphate slimes, R. C. Specht and W. E. Herron, Jr.
Rock Products 53: n 5, May 1950, p 96-7.
Commercial uses developed in Florida for finely divided phosphatic clay, wasted during mining and processing of pebble phosphate; requirements for light weight aggregates; description of deposits; chemical analysis of dried phosphate slime; tests and results; mechanical drying of slimes.

48. North Carolina concern sinters clay to produce lightweight aggregate, W. M. Avery.
Pit & Quarry 43: n 2, Aug 1950, p 87.
Dwight-Lloyd process applied at Salisbury, NC, to produce light weight aggregate from clay at 45 cu yd per hr rate; sintering machine is 42 in. wide and 66 ft long over windbox section, driven by 15-hp U S Vari-Drive; data on hammermill, screens, drum type pelletizer mixer and sintering machine.

49. Producing aggregate from expanded clay by sintering process, L. D. Minsk.
<u>Rock Products</u> 52: n 11, Nov 1949, p 105-7, 116.
Marietta Concrete Corp, Marietta, Ohio, produces 30 to 35 cu yd per hr of Aglite by unique sintering process which involves mixing raw clay with pulverized coal and feeding this mixture onto grate traveling through gas fired ignition chamber; flow sheet of aggregate processing facilities; illustrated description of sintering machine, grinder, crusher and belt conveyor.

50. Recent developments in manufacture of lightweight aggregates, J. E. Conley and J. A. Ruppert.
<u>Min Eng</u> 187: n 4, Apr 1950 (Trans) p 479-85, (discussion) n 11, Nov p 1170.
In search for sources of light weight aggregate, various clays, shales, slates and natural occurring light weight rocks such as pumice, scoria and volcanic ash have received special attention; methods and equipment for producing suitable light weight aggregates; in addition to expanded use of rotary kiln, traveling grate and continuous sintering machines are being installed in many localities. Bibliography.

51. Rotary kiln L-W aggregate plant.
<u>Brick & Clay Rec</u> 117: n 2, Aug 1950, p 44-5.
Typical plan layout for light weight aggregate plant using rotary kiln; for 250 cu yd production from clay or shale material which expands approximately 40%, two rotary kilns are suggested; triple screen series divides crushed aggregate product into fines for mortar, medium sizes for roof and floor fill, and larger sizes for structural usage; flowsheet of equipment.

52. Sintered L-W aggregate plant.
<u>Brick & Clay Rec</u> 117: n 3, Sept 1950, p 51.
Basic plan for aggregate plant utilizing moving grate sintering machine which produces 250 cu yd per day, and can be operated intermittently or continuously; it is adaptable to wide variety of clays and shales; sintering process requires only simple crushing and mixing of clay with coal or coke breeze, multiple screening for size distribution, and storage facilities, in addition to actual sintering machinery; typical plan layout shown in diagram.

53. Sintering machine makes aggregate from variety of clays.
Brick & Clay Rec 116: n 5, May 1950, p 52-5.
New light weight aggregate producing plant in operation is Aglite plant of Marietta Concrete Corp, Marietta, Ohio; automatic sintering plant turns out 250 cu yd of light weight aggregate; standard clay and shale excavating, conveying, crushing, and screening equipment is used; Aglite is light weight aggregate resulting from sintering of mixture of finely crushed clay or shale with small amount of finely ground coal or coke breeze.

54. Southeastern research progress report: Sintering lightweight aggregate, R. L. Crouch and W. C. Bell.
Brick & Clay Rec 116: n 2, Feb 1950, p 45,48.
Results of research program, sponsored by group of Southeastern structural clay products manufacturers, to develop and produce light weight clay aggregates and light weight fired clay building units; main production unit used for making aggregate is 12 x 48-in. Dwight-Lloyd type of sintering machine.

55. 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.

56. Mechanics, techniques and economics of expanded clay-shale aggregate production, W. G. Bauer.
Pit & Quarry 42: n 5, Nov 1949, p 119-21.
Kiln burner requirements; behavior of material in kiln depends on kiln speed, flame temperature and material grading; oil, pulverized coal, and gas burners; burner location.

57. Testing of clays for lightweight aggregate, T. A. Klinefelter, R. T. Hancock and H. P. Hamlin.
Am Cer Soc--J 32: n 9, Sept 1 1949, p 294-6.
Method of testing and evaluating clays suitable for production of lightweight aggregate; procedures to be used with both laboratory furnace and pilot plant rotary kiln are outlined; determinations and tests necessary for relative comparisons of products are described.

58. 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.

59. 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.

60. 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.

61. 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.

62. 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.

63. 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.

64. 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.

65. Basalt rock makes pelletized aggregates.
Concrete 61: n 4, Apr 1953, p 3-5, 54.
Manufacture of lightweight aggregates from local materials, by burning local clays and shales and mixtures of them either in rotary kilns or by employment of traveling grates; new plant at Napa, Calif, utilizes rotary kiln process of burning local material at 1900 F; no crushing and sizing of material after shale has been burned is necessary.

66. Tests of lightweight-aggregate concrete designed for monolithic construction, W. H. Price and W. A. Cordon.
Am Concrete Inst--J 20: n 8, Apr 1949, p 581-600.
Characteristics and origin of light weight aggregates; comparative results of laboratory tests of strength, insulating value, shrinkage and weathering resistance of concrete made with aggregates from 17 producers; expanded shale and slag, scoria, pumice, perlite, exfoliated vermiculite and diatomaceous earth. Bibliography.

67. 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.

68. 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 stimulations of industrial production of larger quantities of light weight concrete aggregates; results of investigation under contract to date. Bibliography.

69. 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

70. Methods used in evaluating adsorbent clays.
U S. Bur Mines--Information Cir n 7475, Sept 1948, 29p, supp plates.
Circular is one of series on clay testing, last indexed in Engineering Index 1943, p 207 as U S Bur Mines Bul 451, by T. A. Klinefelter and others; origin of adsorbent oil bleaching clays, such as fuller's earths or bentonites; commercial use; identification; percolation and contact test methods, applicable to vegetable oils and to mineral oils; colorimeters.

71. Modified differential thermal analysis apparatus, P. G. Herold and T. J. Planje.
Am Cer Soc--J 31: n 1, Jan 1 1948, p 20-2.
In apparatus described, clay sample and standard holder are arranged so that thermocouples become both holder and differential temperature measuring device; this arrangement permits easy removal of sample and also permits investigation of exothermic and endothermic reactions at much higher temperatures without damage to thermocouples. Bibliography.

72. Lightweight aggregates win new attention.
<u>Arch Rec</u> 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 and perlite; vermiculite; clay, shale aggregates including Airox, Rocklite and diatomite; byproduct aggregates such as expanded slag, cinders and fibers.

73. Lightweight concrete aggregate from phosphate waste, A. F. Greaves-Walker and P. P. Turner.
<u>Rock Products</u> 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.

74. Properties of some lightweight-aggregate concretes with and without air-entraining admixture, P. H. Petersen.
<u>U S Bur Standards--Bldg Matls & Structures--Report</u> BMS112, Aug 16, 1948, 7p, 10¢; see also Am Concrete Inst--J 20: n2, 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 strengths; coefficients of thermal expansion, shrinkage, and values for change in length due to wetting and drying.

75. Mechanics, techniques and economics of expanded clay-shale aggregate production, W. G. Bauer.
<u>Pit & Quarry</u> 41: n 1, July 1948, p 71-3, v 41 n 3, Sept p 93-6.
July: Need for investigations of silicate minerals and natural mixtures in form of clays and shales; factors affecting bloating of clay under excess gas conditions, balanced and unbalanced conditions; diagrammatic illustration of stages of gas forming reactions in relation to glass forming reactions along temperature scale.
Sept.: Conditions under which fluid glass begins to form; factors which affect melting behavior of shales and clays such as composition, density, grain size, dispersion, and heating rate; notes on gaseous stage and bleb formation; latter is expansion phenomenon independent of type of gas.

76. Haydite-light-weight aggregate, P. E. Cox.
Cer Age 49: n 3, Mar 1947, p 109-10.
Aggregate developed by S. Hayde is made by heating clay containing small percentage of carbon; swelling tendency, which made such clays unsuitable for brick manufacture, is utilized to make desirable product; description of kiln; suggested procedure for converting brick to Haydite; original patent expired Apr 1946.

77. Fundamental study of clay--VII; Effect of particle size on properties of casting slips, S. S. Kocatopcu.
Am Cer Soc J 29: n 4, Apr 1, 1946, p 99-107.
Binary and ternary mixtures were made of 0.2 to 0.4 mu and 0.8 to 1.6-mu size purified fractions of clay and of 16- to 44-mu size purified flint; specific gravity, deflocculation point, and hydrogen ion concentration determinations made on each composition to obtain same apparent viscosity; small cylinders were prepared by solid casting, and shrinkage, porosity, and modulus of rupture of dried specimens were measured.

78. Les applications routieres des sols coherents, J. L. Bonnenfant.
Annales des Ponts et Chaussees 115: n 4, 5, July-Aug 1945, p 393-426, Sept-Oct p 473-514.
July-Aug: Application of consolidated soils to roads; cohesion due to hydraulic or bituminous bindings; use of soil cements and clay concrete; influence of sand content on shrinkage of sand clay mixtures; surface impregnation of bituminous materials; temporary roads. Sept-Oct: Results obtained in Tunisia; cost data.

79. Decomposition of clay by heat, J. F. Hyslop.
Brit Cer Soc--Trans 43: n3, Mar 1944, p 49-51.
Chief characteristics of heat treated clay are described; solubility tests of heat treated Scottish kaolinitic clay in hot soda solution show that SIO_2 is chemically inactive.

80. Differential thermal analysis of clays and shales, control and prospecting method, R. E. Grim and R. A. Rowland.
Am Cer Soc--J 27: n 3, Mar 1, 1944, p 65-76.
Paper records differential thermal analysis for clay-mineral and non-clay mineral components of clays as well as natural and synthetic mixtures of these minerals; thermal analysis for variety of clay materials; attempts made to show how such analyses may be used practically to evaluate properties of clays.