Importance Of Engineering Materials In The Mandate Of Iron And Steel Industry

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Abstract: Nigeria's economy is dependent largely upon highway transportation, making it expedient to focus significant attention on road construction. The cost of road construction in Nigeria is very high, and the rate of road failure is alarming. One of the reasons for this is the inefficient management and utilization of construction materials. With proper research, many locally available materials and technology can replace imported ones, leading to reduced construction and maintenance costs, and eventually with more facilities in place. The relevance of engineering materials to nation's economy was highlighted with reference to iron and steel industry. Some of the achievements of the engineering research institute and industry in Nigeria were highlighted to justify its crucial importance to the mandate of the iron and steel industry. Some of the achievements include the modification of Bricks making machine design, and construction of a melon shelling and separating machine, fabrication of interlocking paving stone making machine and the interlocking Brick machine developed by Nigerian Building and Road Research Institute. The fabrication of portable gas cooker developed was also mentioned. These are some of the hard technology developed. Some of the soft technologies developed were also stated in the paper. This includes the national techno-economic assessment of enterprises in the engineerin[9] materials sub-sectors, survey investigation on the cause of high casting defects in Nigerian steel industry and proffer solutions.

Keywords: - Transportation, Roads, Construction, Fabrications, Materials and Casting

Role of Engineering Materials

Engineering Materials are fundamental to technology and economic development. Many advances in engineering design have been achieved as a result taking advantage of developments in materials, for example, high speed aircrafts, suspension bridges, modern houses, computers, television sets, automobile, etc. Considering the automobile further, the various components that make up a typical automobile are presented in Table 1.1

Table 1.1 Automation components and materials

Component	Material
Engine Block	Cast iron and aluminum
Bumpers	Steel, aluminum or rubber
Deck lid	Steel
Fenders	Steel
Wheels	Steel
Gas tank	Steel, or plastic
Windows	Safety glass
Interior trim	Plastic
Structure	Mild steel
Catalytic converters	Ceramics
Electric Cables	Copper and plastics
Tyres	Rubber, steel cords

The materials presented in Table 1.1 are unique in their ability to perform required functions. Engineering products contain materials that are strong, reliable and durable. In addition, they must perform in the service environment. Materials play a vital role in our modern technological society. These roles are as follows:

1. Materials are required for efficient energy conversion systems.
2. They are important to maintaining a high level of health and safety in the society
3. Striking a balance between our standard of living and environmental protection.
4. Materials are central and vital to high productivity in

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manufacturing.

5. They are fundamental to maintaining competitiveness in manufacturing and production process
6. Materials are needed for packaging in diverse industries.
7. The design and manufacturing concerns in mechanical engineering depends on input of appropriate materials to translate the design into a functional product. Before a material can be selected or specified, it must undergo some form of processing. The processing method can be primary or secondary to bring the material to a suitable shape for a specific purpose. After processing, the material must be tested to ascertain its properties. It can then be assembled into a specific product. This product may be monitored in service. The product after its useful life, may be discarded or recycled. Every engineering student takes a course in engineering materials. This is because the Engineer relies upon materials for many purposes, it is important to understand their properties, behavior and limitations [2].

Classification of Materials

Engineering materials can be conventionally grouped into broad groups according to Ashby W.

This is shown in Fig 1.1.

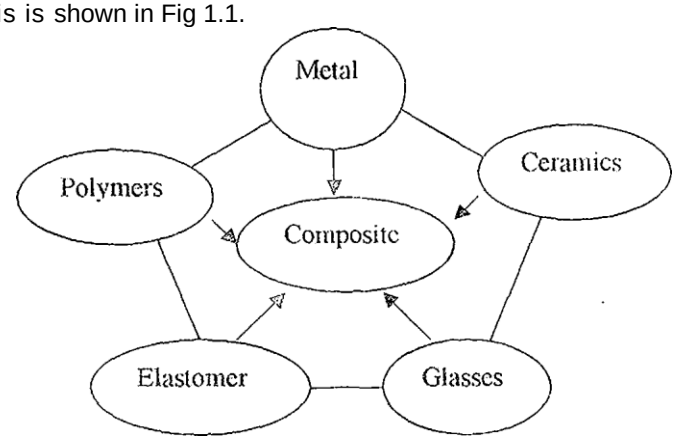

Fig 1.1 Materials group)

Engineering materials can also be classified according to the nature of the material into man made (synthetic) and natural. This classification method is depicted in

Fig 1.2

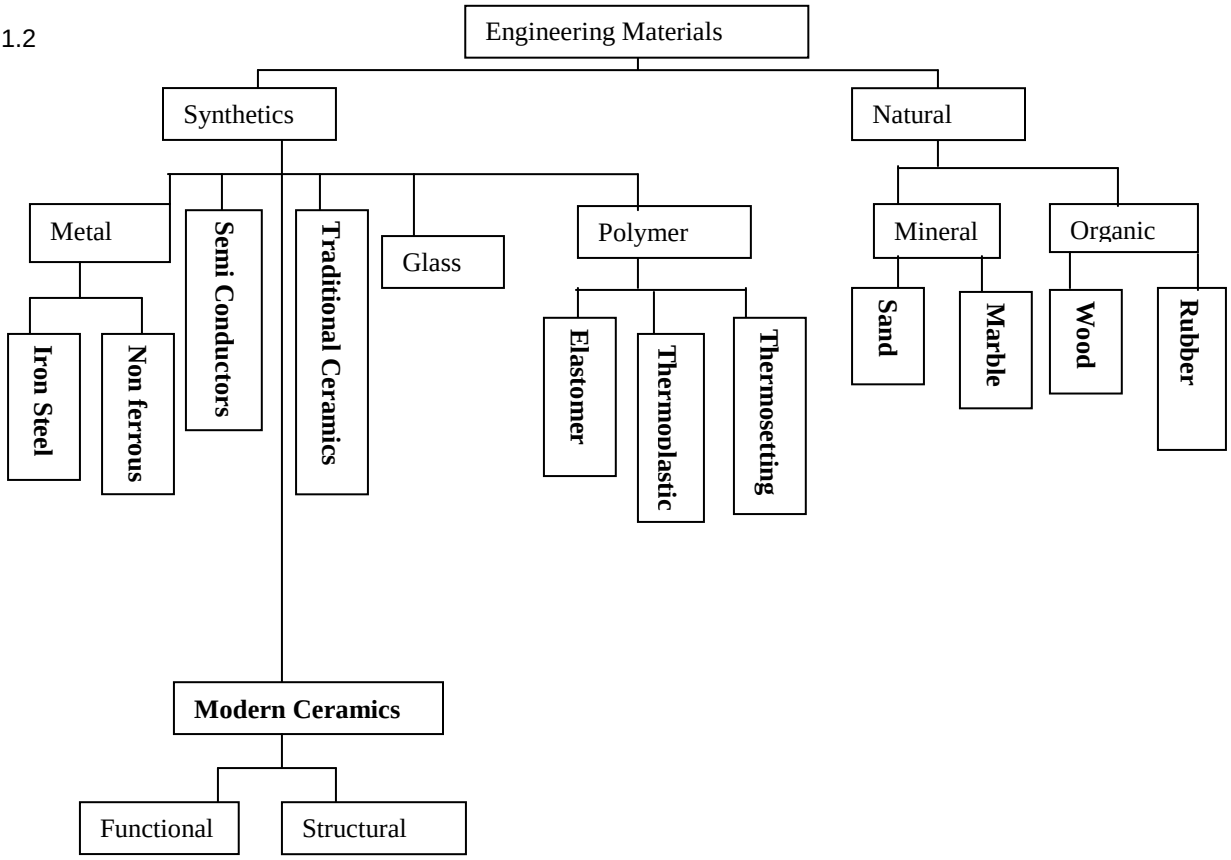

Fig. 1.2. Nature of material

Engineering materials generally can be classified into metals and non-metals. The metals can be further categorized into ferrous and non-ferrous metals as shown in Fig 1.3. The ferrous metals are pure iron, cast iron, low, medium and high carbon steels, stainless and silicon steels. A further sub-division of cast iron is shown in Fig. 1.4. Non-ferrous metals are not based on iron. They can be classified as heavy, noble, and precious. Examples of the heavy metals include copper, lead, tin, nickel, zinc etc. the precious or noble metals are gold, silver, platinum, rhodium, palladium. Examples of the light metals are aluminum; magnesium, titanium, and beryllium (see Fig 1.3).

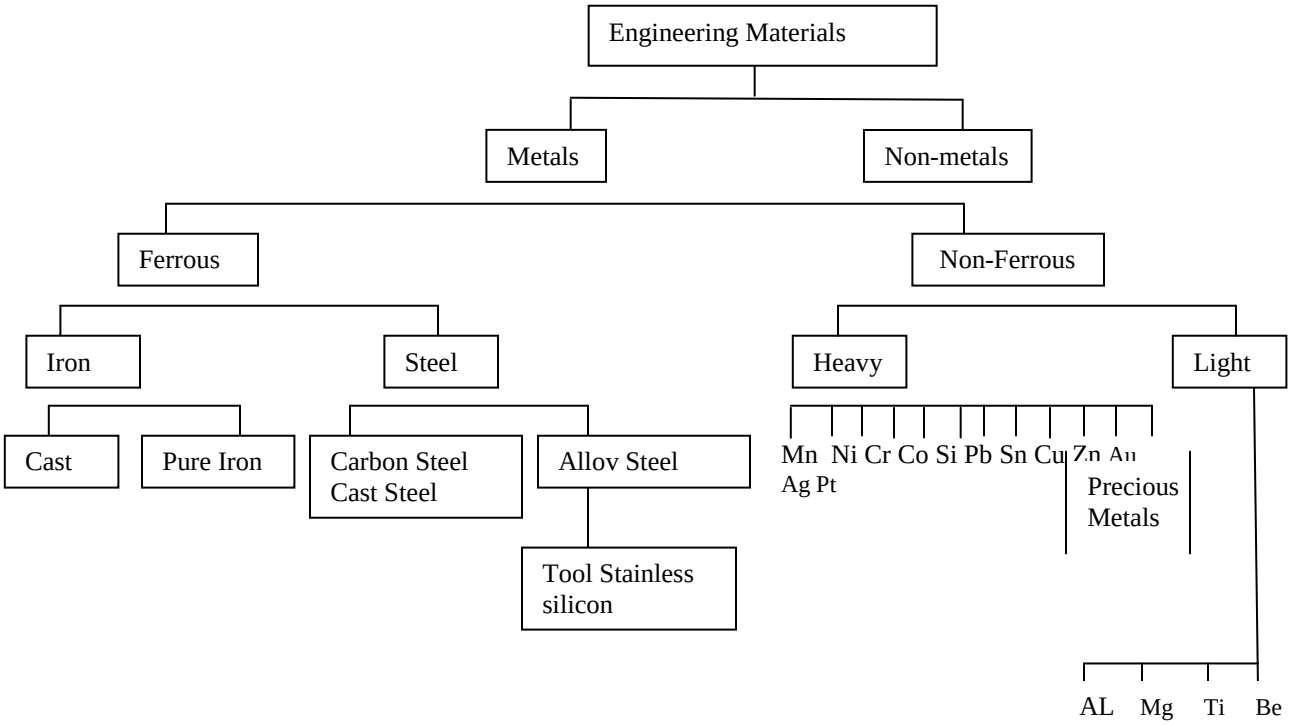

Fig. 1.3. Classification of materials

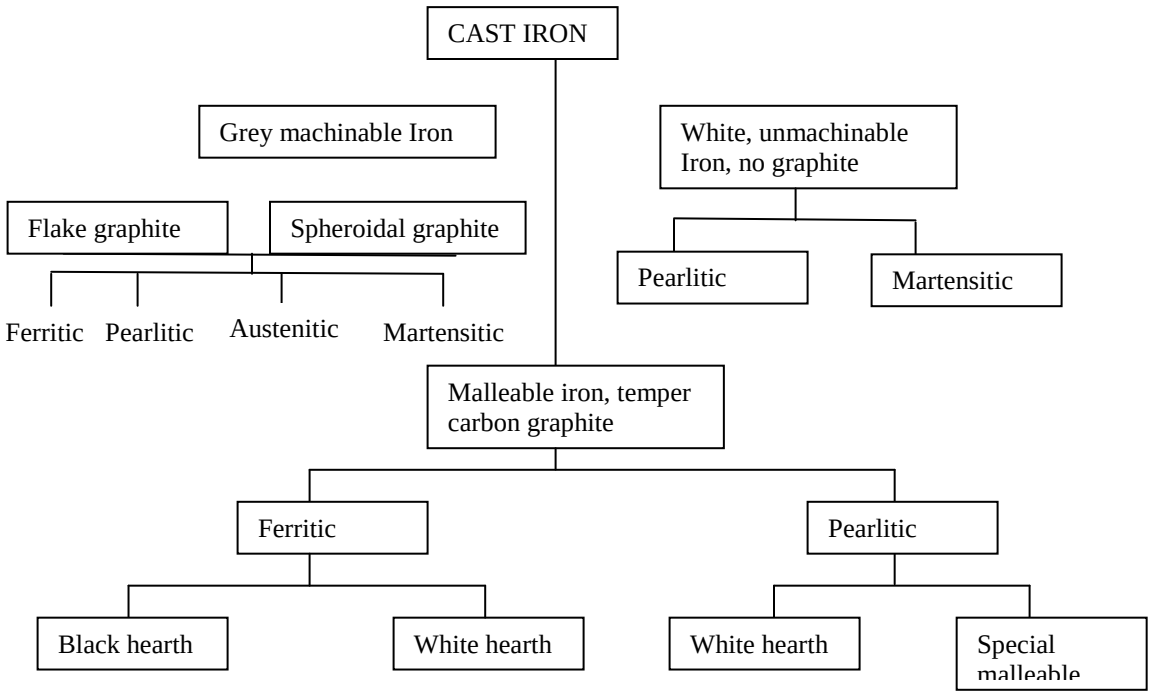

Fig. 1.4. Sub-division of cast iron

The non-metallic materials are also classified into natural and synthetic. Examples of natural materials are diamond, stone, mica, asbestos, leder, wool, wood, cork and fibres. Some examples of synthetic materials are glass, ceramic, elastomers, plastics, cermets, carbides, nitrides and composites. Fig 1.5. Shows the classification of non-metallic materials.

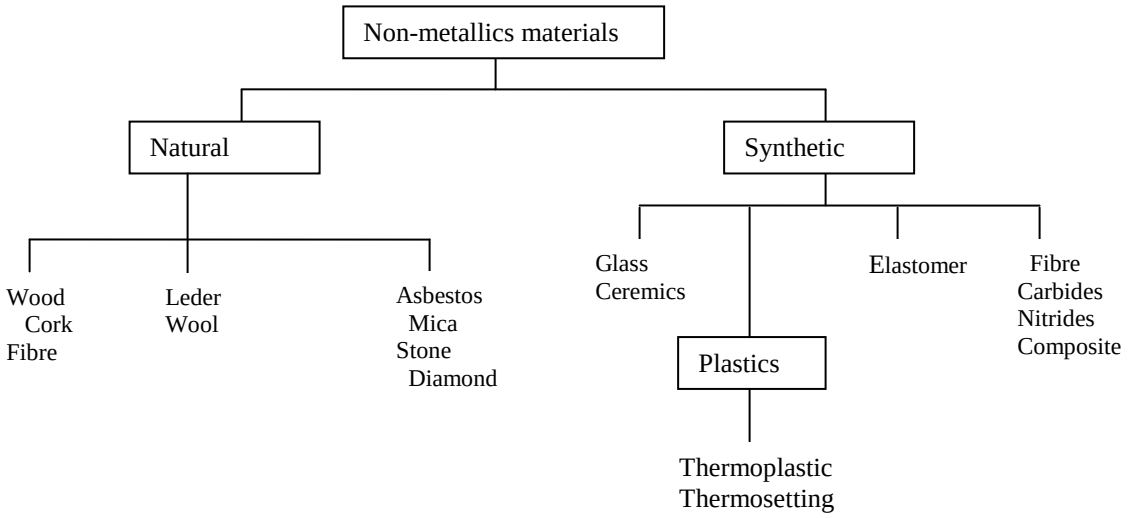

Fig. 1.5. Classification of non-metallic materials

Auxiliary materials do not actually fit into the main materials groups. They are materials used in the machine building and manufacturing industries. They are also important in the operation of machines. Auxiliary materials are presented in Fig.1.6.

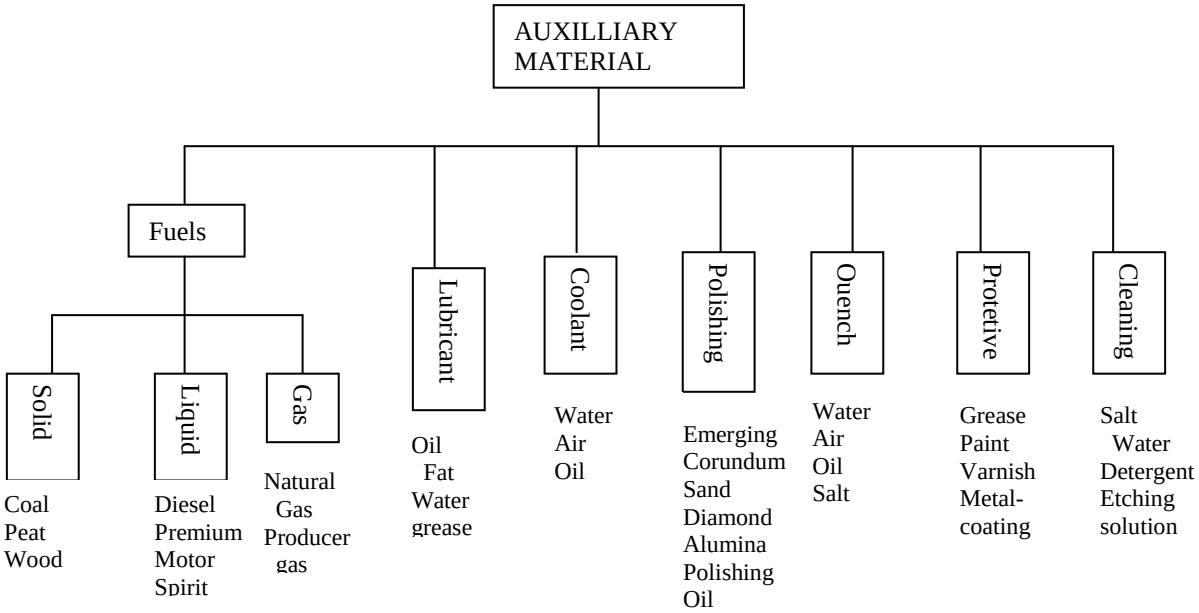

Fig.1.6. Auxiliary Materials

Non Metallic Material

The non-metallic materials constitute, the major bulk of materials used in building and construction projects. The materials which are mostly earth-based or derived almost entirely from earth's materials have been classified by Raw-Materials Research and Development Council (RMRDC) into the following categories, [7].

a) crushed aggregates and construction stones
b) decorative and ornamental stones
c) clay and bricks
d) cement and asbestos

Ceramics

Ceramics may be defined as those non-metallic materials produced by high temperature firing of natural clay and certain inorganic matters. Most ceramic materials have crystalline structure. Their electrons are, however, not free like those in metals but are involved in either covalent or ionic bonding with adjacent atoms. This gives rise to high stability, transparent form and poor thermal and electrical conductivity. Ceramics materials in building construction includes clay bricks, floor and wall tiles, sanitary wares, store wares as well as pipes and

fittings for sewage drainage. Ceramics also have applications in such diverse areas as

a) domestic uses e.g. table wares, dinner wares, flower vases and dental wares
b) thermal insulation e.g. insulating bricks
c) electrical uses e.g. electrical insulators, motor brushes and battery carbons
d) laboratory and engineering uses e.g. crucibles, pestles and mortals, jet nozzles, rocket motors and spark plugs
e) chemical uses e.g. acid resistant tiles and sinks, hospital equipment and chemical engineering apparatuses'

Thus, ceramics are mostly important materials not only in construction hut also in day-to-day living in modern society. The wide areas of application of ceramic products should, therefore, combine with the high demand to confer viability of integrated ceramics factories. Currently, the ceramics industry is dominated by the local pottery establishment. The few major ceramics and tiles manufacturers in Nigeria, are perennially battling for market acceptance and increase in production output as the Nigerian market brands the foreign ceramics as original and stigmatizes the locally manufactured variety as inferior. This stigmatization discourages patronage. Sales are concomitantly low and increase in production becomes unrealizable. This inevitable stifles the development of the local ceramics industry. At the last count, the following are the major ceramics and ti'es industries in Nigeria

a) Nigerian-Italian Ceramics Industry, Ifon, Ondo state
b) Niger Grob Ltd, Abeokuta, Abeokuta Ogun state
c) Quality Ceramics, Itu, Akwa Ibom state
d) Proda Ceramics Works, Enugu, Enugu state
e) Okigwe Pottery Works, Okigwe, Imo state Naraguta Pottery Works, Jos, Plataeu state
g) Modern Ceramics Ltd, Umahia, Abia state
h) Alhaji Sanda Ceramics Ltd, Kano, Kano state

Their combined output is considered to be less than 15% of the total demand in the market. The rest is satisfied by importation mainly from Italy, France, England, India, Brazil and more recently China.

Cement

Cement is a most important input in road and building construction. Most of the need have in the past, been met by bulk importation as done by Nigeria Flour Mills Ltd, Yinka Folawiyo & Co. Ltd and Dangote Nigeria Ltd or in bags. Recently, importation in bags was banned ostensiblyo all better control of imports, regulate product quality and encourage local production. It is uncertained if this objectives are been met in the short run what the ban has achieved is to restrict the importation to a few rich political financiers who have facilities for bulk handling and bagging of cement to the total exclusion of the medium and small scale importers. The consumer is inevitably the worse for it as price have remain high and have only recently been reviewed upwards again to close to N1,000 per bag in the lagos area. Steanwhile the privatization of the various government owned cement factories seems to be yielding quality is being enhanced and wastage is getting check. Many of the plants which hitherto operated at very low capacities have begun to function optimally and returned to profitability. The recent commissioning of new modern plant at Ewekoro in Ogun state by the West African Portland cement company plc (WAPCO) is aimed at increasing local production and optimising production efficiency. The Ukpilla cement factory in Ukalagu is said to be contemplating a similar expansion. The benue cement company whose take over by Dangote was resisted by the middle betters has now made peace with the core investors and is said to beging to operate more efficiently than hitherto as its machies and plant are being rubbished for production. This trend of getting private investors to take over and refurbish the plants for greater efficiency is consistent with the accommodation of the Tianjin Cement Industries Design and research institute (TCDR1,1999) that the first stage of cement industry development in Nigeria should be to rehabilitate the existing cement plants and make them run I full capacity: The touted alternative mini cement technology production quote which the association of small scale and medium scale Enterprises agreed in 1999 was a viable alternative to the capital intensive full fledge cement plant, does not seem to have seen the light of day as no mini-cement factory has been established anywhere in Nigeria since then it would appear. Therefore the nation is sticking with the old conventional plant routes for now in this regard, the industry should have two objectives;

a) the meeting of the nations cement demand locally, and
b) The acquisition or development of technology for the manufacture of cement production facilities.

The latter objectives were met by the china by operating a technology acquisition route tagged import digest-absorb-upgrade. Thus they imported full integrated plants from industry leaders in Germany, united states and England, studied them carefully and went on to develop similar facilities with improved performance characteristics. This strategy can very easily be feasible n Nigeria insofar as some conditions are met. For instance, power consumption in cement Production is very high. There is need, therefore, for electricity supply to be upgraded and made steady. Training of personnel and machine building also needs be intensified.

Clay and Bricks

Bricks are used zildly qs qrchitecurql or structural units in building construction: they are manufactured from such earths material as shales, clay and -fine sized lateritic soils having a reasonable plasticity to promote bonding and at liste 3% iron oxide to confer the reddish brown colour of bricks the shale/clay deposits widely available in the sedimentary basins and the base complex areas Despite this vast raw materials

occurrence, there are only nineteen bricks production plants in the country. Ownership of the factories resides in the federal and state governments and some independent local and foreign investors. The total installed capacity is 327.5million tones per year Table 3 below shows the location and installed capacity of the Nigerian clay bricks factories. That the industry has not grown for ten years in spite of increased activities in other manufacturing sectors is probably a reflection of lack of appreciation of clay bricks as a cheap construction material. There is thus the need to educate the public about the viability of clay bricks which are remarkably cheaper than cement- based materials used for similar purposes. Clay bricks arc environment- friendly and cost very little to maintain

Class

Glass is an important material in building construction and therefore a relevant-element of research in the mandate of the NBRRI. The basic raw materials for the manufacture of glass are Quartz sand (65- 98% SO_2), feldepar Al_20_3, Limestone CaO, Dolomite Mg0-1Ca0

Table 3: Production Capacity of Nigerian Bricks Factor

S/N	Factory	Location	installed Capacity
I.	Nigerian Brick & Clay Product Ltd	Ikorodu, Lagos State	15m
2.	Nigerian Bricks & Clay Products (Borno) Ltd	Maiduguri, Borno State	15m
3.	Nigerian Bricks & Clay Products Ltd	Bagauda,Kano, Kano State	15m
4.	Nigerian Bricks & Clay Products Ltd	Entigu, Enugu State	15m
5.	Nigerian Bricks & Clay Products Ltd	Kaduna,Kaduna State	15in
6.	Nigerian Bricks & Clay Products Ltd	lbadan, Oyo State	15m
7.	LACON (Nig.) Ltd	lgbogbo, Lagos State	15m
8.	Clay Products Ltd	Ezinachi, Okigwe, lmo State	20m
.	Borno Clay Products Ltd	Maiduguri, Borno State	20m
10.	Ekiti State Brick Works Ltd	Ire- Ekiti, Ekiti State	20m
11.	Chanchanga Clay Products Ltd	Minna, Niger State	20m
12.	Sokoto clay Products	Talata Mafara, Sokoto State	20m
13.	Oranmiyan Clay Products Ltd	lpetumodu, Osun state	20m
14.	Wuron Construction Materials Ltd	Wurn,Sokoto State	20m
15.	Gateway Bricks Ltd	Lapeleke, Abeokuta, Ogun State	20m
16.	Clay Products (Nig.) Ltd	Okigwe, Imo State	15m
17.	Burnt Bricks Ltd	Otukpo, Benue State	20m
18.	Burnt Bricks Industries Ltd	Adamawa, Yola	20m

Sod Soda Ash Na_70_3 or Na_2CO_3, salt cake Na_20, coal dust C and borax or boric acid. The Raw materials research and development council has done extensive work to locate the sites where these materials occur in commercial quantity. Those available locally include glass sand limestone and feldspar. Economic deposit of soda has not been full) established. Borno state where a soda ash pilot plant was established by the RMRDC, however seems the most promising location for the materials. There are three broad groups of glass products. These include glass containers e.g. bottles and jars for food, drug, chemicals and cosmetics packaging pressed and blown glass for lighting and electronics and flat or sheet, glass for building louvers and automotive windshields. Table 4 shows the glass manufacturing industries currently in existence in Nigeria, their locations and products mixes The three local plants which manufacture glass for the construction industry produce mainly louvers and window sheet glass. Reinforced glasses which are used where substantial strength is required, as in swinging glass doors, are not made. Thermally strengthened glasses are not produced either. These are imported from abroad for special applications. These clearly are areas of application that the nation needs to invest in even if only to substitute import. This is particularly so because the technology needed can be readily acquired [7].

Table 4: Locations of factories and the Products

	Factory	Location	Product
1	West Africa Glass Ww	P Port Harcourt, River St	Bot Bottles, containers, table Glass glasses, glass wares
2.	Delta Glass Factory	U Ughelli, Delta stale	Glass Glass bottles and containers
3.	Aba Glass Factory	Aba, Imo State	Louv Louvers and Windows Conta Container
4.	Bendel Glass Factory	Ughel Ughelli, Delta state	Louv Louvers and containers
5.	Oluwa Glass Factory	Ighok Igbokoda , Ondo state	Louv Louverss and windows glasses
6.	Metal Box Toyo Glass	Agbar Agbara, Ogun state	Cont Containers and Bottles
7.	Triplex	Lbad Ibadan, Oyo state	Win Windshield
8.	African Glass	Ikeja, Ikeja, Lagos state	Bottle Bottles
9.	Ballapur Glass	Kadu Kaduna, Kaduna State	Bottle Bottles

Polymers

Polymers or plastics have extensive application industry and construction. They are also widely used in homes and offices as containers, household utensils and decorative or structural furniture. There are two types of polymer materials thermoplastic an thermosetting polymers. The first group are those which when made from the monomer, are capable of being formed into new shapes by the application of heat and pressure thermoset cannot be worked as they set into rigid molecular structure at the end of the polymerizatior process. Composites are materials which have polymers as matrices with metallic or non-metalic reinforcements to confer improvements properties. Some of the major uses major uses of polymers arc in the production of auto accelerator pedals with mtegraly molded hinges, high strength chemically inert battery boxes, electrical power cables and conductors. Polymers also find extensive use in home construction for waste water and

soil waste piping, water reticulation portend as dividers in terrazzo flooring and markers and barriers in road construction The Eleme petrochemical plant in Port Harcourt and the kaduna refining and petrochemical company Kaduna were set up to produce resins for the plastic industry. However, resin productions in plants have been 1 fit and starts because of ineptitude and corruption in the turn around maintenance (TAM) programmes of plants. Producers of secondry plastics products like sheets, films, pipes hoses etc thus rely on imports for most of their raw materials need.

Asbestos

Asbestos is the generic name for a numbers of fibrous minerals noted for high insulation characteristics. Asbestos fabric may be seprated and spun or felted to make non combustible fabrics. Asbestos mineral has limited occurance in Nigeria. The most impel-Wit deposit estimated to total 31 million tonness being in clan Dido and mallam Tanko areas of shemi in sokoto state there is another smaller deposit in the federal capital territory. Consumption of asbestos worldwide is a little more than 4 million tones its major areas of application in the Nigerian construction industry are in the production of roofing sheets. Ceiling sheets and asbestos cement pipes for water and wastes transmission. The Nigerian asbestos cement manufacturing sector is said to consume less than 20,000 tonnes per year this low consumption will ordinarily discourage exploitation particularly when high capital outlay is needed. However, the many other uses of asbestos as fibre textile for the electrical industry, gasket, ropes, clutch facing sheets packaging floor tiles, asphalt roof coatings, pressure pipes, wall boards and furnace body sheets should commend the material for local development, ifonly to substitute the myriad of asbestos products currently being imported. The asbestos production processes and the use of asbestos particularly in home construction should however be properly supervised to ensure the material does nor constitute the health hazard it has been to asbestos workers in Europe and America. When a critical quality of asbestos particles is inhaled a killer disease known as asbestosis may be contacted. This has in fOrmed the ban placed on asbestos for roofing and ceiling purposes in Europe and America.

Woods

Wood has three major roles in construction. It is a structural member as in roof trusses, railway track sleepers, piles, beams and lintels. It is an important furniture material. It also serves as low strength form work or packaging material. Hard wood like Mahogany, Opepe, Omo, etc are used for two applications while soft wood e.g. Somidoloro or Arere are used for form works and packaging. Woods used extensively as electrical pole for power transmission and for structural and paneling material in coaching building. Wood is widely available in the forest regions of the southern states of Nigeria. Most wood forests are publicly owned but their exploitation is mostly privately managed. It is generally believed that the rain forests are being over exploited to the extent that the rate of harvesting the timbers far outweighs the future wood supply situation insecure and aggravating the current disturbing phenomenon of global warming. Wood processing in Nigeria is limited currently to the felling of timber, the conversion of timber and the seasoning of the converted wood. Conversion is carried out in sawmills. Seasoning is done either naturally in air or artificially in water of stream or lagoons to an average moisture content of 3%. Most wood processing is carried out in Nigeria by small and medium scale enterprises (SME's) save for one or two establishments that produce veneers for furniture ad decorative purposes and plywood and flush doors etc. for building construction. One or two other firms produce particle boards. The main bane of the wood industry, however, is the unregulated or uncontrolled exploitation of forests with very little concern for their replacement. All the teak in the forest of Ogun and Ondo states have been felled and cheaply exported to China and the far east. 'Be role of the various state governments concerned in this unfortunate scenario is, to say the least, deplorable. Public policy on forest exploitation is hazy and ill-defined and government intervention is often sporadic and tentative to the extent that availability of wood for local construction or industrial use is often irregular [7].

Conclusion

There is a clear indication that the level of materials development and application on the one hand and the industrial and economic prosperity of the nation on the other. It can be seen that engineering materials is very crucial to the construction sector of many nations economy. The houses we live in, the road we ply, our ridges, modes of transport, communication are possible due to engineering materials. The Iron and Steel Industry has recorded some achievements since its creation. These include the conduct of Techno-economic survey of enterprises in the engineering materials sub sector of Nigeria's economy. Survey Research on the causes of high casting defects in Nigeria Foundry Industry, proffer ways of their in mitigation and the determination of the suitability of local materials for the production of ceramic products. All these are the soft technology developed. The fortune and future of actions largely depend on their ability to explore, exploit and develop engineering materials. This realization has informed the commitment of more than 14% of all allocations of the United States of America on materials as shape memory alloys and other smart materials has yielded the US huge economic dividends and largely secured for her the leadership position it has occupied in the fields of telecommunication and space technology.

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