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Derleme Makalesi

Life Cycle Assessment of Building Materials: Literature Rewiew

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ABSTRACT

Sustainable development policies are often on the agenda as global warming and resource depletion problems are increasing. The construction sector is one of the focal points of these studies with high environmental burdens. Many building materials, methods and tools are used together during the construction process. The Life Cycle Assessment (LCA) method has been developed in order to determine the environmental load of these inputs. As a result of LCA studies, the load of components or processes on the environment can be calculated and critical points can be determined. In this study, the sustainability of construction materials have researched by books, post graduate theses and articles around the world but especially in Turkey and summarised with a table.

Keywords: *Life Cycle Assessment, Sustainable Building Material***,** *Life Cycle Impact Assessment*

Yapı Malzemelerinin Yaşam Döngü Değerlendirmesi: Literatür Taraması

ÖZET

Küresel ısınma ve kaynakların tükenmesi problemlerinin artması sebebiyle sürdürülebilir kalkınma politikaları sıklıkla gündeme gelmektedir. İnşaat sektörü ise ortaya çıkardığı yüksek çevresel yüklerle bu çalışmaların odaklarından biridir. Yapının ortaya çıkması sürecinde pek çok inşaat malzemesi, yöntemi ve aracı bir arada kullanılmaktadır. Bu girdilerin çevresel yüklerinin ortaya çıkartılabilmesi amacıyla Yaşam Döngü Değerlendirmesi (YDD) yöntemi geliştirilmiştir. YDD çalışmalarının sonucunda bileşenlerin veya süreçlerin çevreye verdiği yükler hesaplanabilmekte, kritik noktalar tespit edilebilmektedir. Bu çalışmada inşaat malzemelerinin sürdürülebilirlikleri ve YDD'lerinin ve Dünya'daki özellikle Türkiye'deki kitaplar, lisans üstü tezler ve makaleler üzerinden kaynak incelemesi yapılmış ve tablo halinde özetlenmiştir.

Anahtar Kelimeler: *Yaşam Döngü Değerlendirmesi, Sürdürülebilir Yapı Malzemesi, Yaşam Döngü Etki Değerlendirmesi*

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I. INTRODUCTION

The limited resources in the world and the rapid depletion increase the interest of design, architecture, landscape architecture practitioners and material manufacturers in the construction sector to the issue of sustainability. Some methods such as Life Cycle Assessment (LCA), Carbon Footprint Analysis and Eco-Labelling have been developed in order to determine the negative effects of the buildings on their design, production, use, dismantling and demolition processes. In this context, LCA stands out as a scientific method that evaluates products and processes throughout their service lives and expresses their environmental impacts with clear results.

Emissions of raw materials for building materials, processing in factory, replacement and transport of the construction site constitute 86% of the emissions to total air [1], [2]. In addition, wastes generated during construction and demolition processes constitute a significant portion of the amount of waste generated in cities.

Life cycle assessment is a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair, maintenance and disposal or recycling. Environmental impacts such as depletion of abiotic resources, photochemical oxidant creation, global warming, acidification, eutrophication, ozone depletion, and human toxicity, etc. LCA evaluates all kinds of environmental impacts from raw material acquisition to disposal. LCA provides a comprehensive and systematic approach to environmental assessment. For this reason, environmental sustainability is preferred in sectors such as construction, food, tourism and raw material acquisition [4], [5]. The life cycle process is shown in Figure 1.

Figure 1. *Life Cycle Assessment Process*

Bishop, in his ‘Pollution Prevention’ named book, listed the goals of life cycle assessment as; product or process development, cost reduction, decision-making and environmental measures, customer requirements, compliance with ISO (International Organization for Standardization) standards, legal sanctions, marketing and eco-labelling. [6].

Life cycle assessment includes definition of goal and scope, inventory analysis, impact assessment and interpretation of results (Figure 3). LCA results could be useful inputs to a variety of decision-making processes [7].

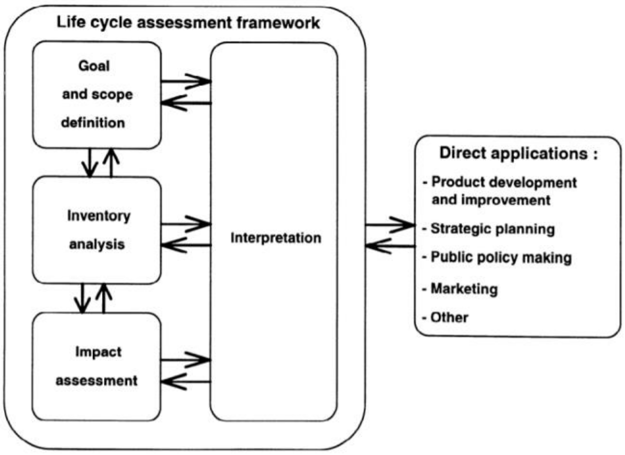

Figure 2. *Phases of an LCA [7].*

The system boundaries of LCA studies are named according to which stage they start and end. It is called obtaining the raw material (cradle), ending the use of the product (grave), the stage where the raw material is shipped to the factory (gate) [8].

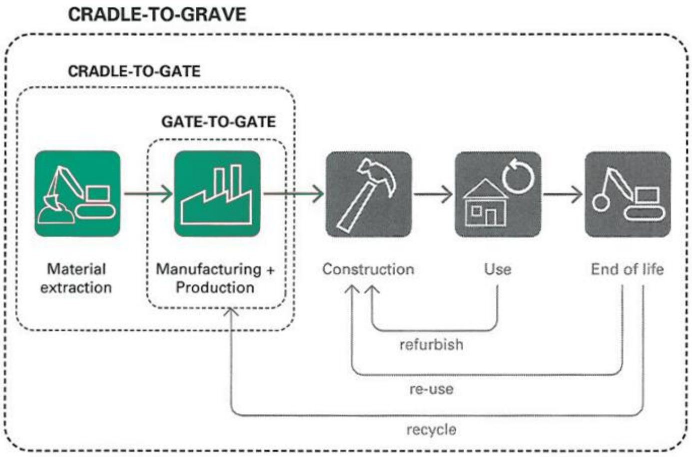

Figure 3 *Simplified life cycle system boundaries of a building [8]*

Life Cycle Impact Assessment (LCIA) is a process that determines the raw material and energy requirements, atmospheric emissions, waterborne emissions, solid wastes and other emissions for the entire life cycle of a product [3].

II. LITERATURE RESEARCH

Buildings used for housing, working, education and social aspects, are the indicator of our development and life culture. The form, height, aesthetics of the buildings and many other subjects such as the material which it is made or covered are provided with strong connections with the city and the place where the buildings are located. Although the presence and beauty of the outer coverings have aesthetic contributions to the building, the loss of the covering leads to vital dangers. The building materials on the facade are exposed to rain, wind, sun rays, biological formations, and air pollution. Facades that get rain, there is a continuous wetting-drying cycle and this process takes more time on the less solar-receiving facades. The water in the building material makes different expansions at the levels above and below the frost level, shortens the life of the material. Similarly, wind is an important factor to be taken into account in facade designs, especially in high-rise buildings [9]. Ultraviolet rays can damage the chemical structure of the building materials as well as the living things. Inflorescence can be seen in facade materials exposed to biological factors. In addition to the damages caused by forgiveness such as earthquake, flood, fire, shortening of the life of building materials due to the above mentioned reasons creates significant disadvantages in terms of economic and natural damages. Although there are some nano technologic developments, there are some reservations due to the fact that they are not applied for a long period of time [10]. The physical, chemical and biological environment of building materials can have many negative effects [11].

In the literature research, books, articles, papers, postgraduate thesis published between the years 2005-2019, in Turkey and World, are summarized by the time.

Taygun (2005) "A model proposal for the life cycle assessment of building products" is a doctoral study at Yıldız Technical University. 'LEED', 'Athena', 'BEES', 'BRE' ('BREEAM', 'EcoHomes', 'Envest', 'Environmental Profiles', 'SMARTWaste'), 'Analytica', 'Pre' (LCA) 'SimaPro', 'Eco-Indicator' Impact Assessment Method, 'IVAM' Database, 'Eco-Quantum', 'Ecoinvent' Database), 'GaBi', 'TEAM', 'GB Tool', 'Woolley' models and compared [12]. Afterward, the model steps have been determined and an information form has been prepared for defining the building product. In the following sections, sampling was done on polyvinyl chloride (PVC) window frames.

Gültekin (2006) in “Proposal of a model for assessment of the environmental impacts of construction products within the context of life cycle assessment methodology” named doctoral thesis, LCA use in construction sector and a model proposal is made [13]. This model is concretized by evaluating the environmental impacts caused by the maintenance repairs of the wall paper. This model is described by its author as "an open-ended model for the evaluation of the environmental impacts of building products". The wallpapers considered were classified according to their weight by the data obtained from the company brochures and classified according to the amount of emissions reached and associated with the data.

Esin (2007), in "A study regarding the environmental impact analysis of the building materials production process (in Turkey) named article 14 factories from Gebze Industrial Zone were selected and tried to extract environmental impact analyses of building products [14]. In this study, some scorings are defined as bad, middle, good and very good of environmental impact criteria for cement, aerated concrete, glass, iron, aluminium, fibreboard, plywood, PVC, paint, waterproofing materials which information obtained from companies, the results of the scoring were compared. As a result of the study, it is emphasized that these values may change depending on country-to-country, technological changes, and place of production.

Özçuhadar'ın (2007) in “Defining energy-efficient design criteria with the help of life cycle assessment to achieve sustainable design” named master thesis, LCA stages are defined, LCA for buildings, systems such as LEED and BREEAM with LCA were investigated [15]. Reference is made to the existing legislation on the subject in Turkey. Material-based LCA was not sampled and the general framework of LCA was examined.

Çakmaklı's (2007) Ph. D. thesis on " Life cycle assessment of building materials in hotel refurbishment projects: a case study in Ankara " at the Middle East Technical University, especially the materials used in the decoration of hotel buildings without completing their life, has been identified by means of sample postgraduate theses [16]. The materials used in the renovation of three five-star hotels in Ankara were compared according to the six environmental indicators through the Athena LCA program. The environmental impacts of these materials were revealed by using LCA and Life Cycle Costs (LCC) were also mentioned in the thesis.

Sev, (2009) in her book "Sürdürülebilir Mimarlık", mentioned sustainable material as a sub-concept of sustainable architecture. In this book, sustainable building material selection is reduced to ten steps and summarized. Under the title of sustainable architecture methods, information was given about the definition of LCA and how it can be used in terms of architecture [17].

Bayraktar (2010), " A proposal of building material life cycle assessment system for Turkey" at the Istanbul Technical University master's thesis, primarily investigates environmental data made available to Turkey [18]. A system that assesses the environmental impact of building materials in life cycle processes has been proposed in line with the country's possibilities and limitations imposed on environmental impacts. The data obtained from a cement factory in Bursa was used for the case study. The difference of this thesis from other theses is that it defines the Turkish standards and regulations and places where the LCA intersects or approaches. As a result of this study, the creation of LCA data pool for Turkey and creating a scientific committee, would determine the ranking between the impact indicators indicate that the importance coefficient to be determined.

"American Institute of Architects(AIA) (2010), in the "Guide to building life cycle assessment", a guide was given to the architects about how to use the LCA. The history, types, definition and impact categories of LCA have been introduced, and the relationship between the construction sector and LCA has been graded as material, product, building and industry. Afterwards, the programs which make LCA of buildings have been given a wider scope, although they have examined the programs that make LCA. Sampling was carried out by making LCA's of 8 different buildings. Finally, information was given about how to use LCA in building design and improvement stages [19].

Ölmez, (2011) in" Comparison of sub-processes and final products of iron and steel production with life cycle assessment" named master thesis, made at METU, LCA study was carried out with the SimaPro software (coke making, sintering, iron production and steel production) required for the production of iron and steel. Environmental impacts have been calculated and evaluated according to the Impact 2002+ impact category [20]. LCA boundaries were selected from the cradle to the door, and one tone of product or intermediate product was chosen as the functional unit. In the scope of the thesis, iron steel production details are given. Turkey's energy modelling was done for study's year. SimaPro screenshots of all stages are shared in annexes. It is a detailed and rigorous thesis with its factory data.

Rajagopalan, (2011) in "Residential life cycle assessment modelling for green buildings and building products" named thesis, EPS (expanded polystyrene) moulded reinforced concrete wall system and wooden buildings were compared with LCA method [21]. In addition, traditional and green-labelled carpets, paint and linoleum coatings were compared with the BEES (Building for Environmental and Economic Sustainability) LCA data set.

Üçer'e (2012) "Life cycle assessment of masonry wall types using simulation technique" in METU master thesis, the masonry walls; baked clay brick, aerated concrete blocks, natural stone and mud bricks were examined by their service life [22]. In the end-of-life applications of LCA's of these materials, scenarios have been produced as waste embedding, reuse and recycling. The prepared data was transferred to the SimaPro, an LCA software. Environmental impact scores of the alternatives identified through this software have been obtained and the results are discussed.

Kahraman (2013) in "A sustainable building assessment model proposal for new residential buildings in Turkey" doctoral thesis, developed a sustainable building evaluation system according to Turkish construction sector needs [23]. In the context, the many sustainable building certification systems as LEED, BREAM, CASBEE, Open House, LenSe, SBAllience, SBtool investigated, a proposal has been made to the system for Turkey. This system model has been prepared in full, mid, core versions. In order to adopt LCA to this model most common 241 different construction details have included.

Yiğit, (2013) "Life cycle assessment in ferrous foundry industry" named MS thesis at METU, the environmental impact of iron foundries has been investigated for life cycle evaluation [24]. The LCA's of the two facilities, which differed in practice, were modelled by the SimaPro program. Impact 2002+ was chosen as a method of environmental impact calculation. With the scenario of six different iron production scenarios, LCA studies were continued and as a result, which method had the least environmental impact was determined.

Petek Gürsel et. al. (2014), in "Life cycle inventory analysis of concrete production: A critical review" named article very detailed literature search was made. In the study, it was emphasized that Life Cycle Inventory Analysis (LCIA) is essential in order to make healthy LCA. A summary study of the studies related to the LCIA of cement and concrete was formed. As a result of this research, it has been stated that while the effects of the holistic LCA approaches are generally in the minority, such as energy and carbon dioxide effects, VOCs (volatile organic compounds) or heavy metals are not studied. Technological and regional differences are not emphasized much, and these are among the criteria that can greatly affect LCA studies. It is stated that the production of concrete is 2% of the production in the whole world but it is neglected and the effect of this production amount on the depletion of water resources or the release of toxicity is not included in the calculations. In addition, it is also shared that the positive effects of cementitious properties (SCMs) in concrete production are not reflected in LCA studies [25].

Petek Gürsel (2014), in "Life-cycle assessment of concrete: Decision-support tool and case study application" doctoral dissertation at the University of California, developed a tool for analysing the life cycle assessment of various concrete mixtures designed for specific projects [26]. This tool could calculate environmental burdens both Microsoft Excel and internet based program. Although not directly, the supply chain, concrete production process and materials have been developed. It is stated that the program, which can have wide application and flexibility by adapting local variations and technological alternatives to the tool, can be used in the United States and other countries. By replacing Ordinary Portland Cement (OPC), Supplementary Cementitious Materials (SCMs) with substances such as fly ash or slag, a significant reduction in global warming potential and other environmental impacts can be achieved. Various alternatives have been proposed for reducing the environmental impacts for the Turkish cement and concrete sector. Within the scope of the thesis, three different levels of LCA have been conducted: cement, concrete and public buildings.

Karaman Öztaş (2014), within the scope of her PhD thesis titled "A model proposal for the life cycle impact assessment for the Turkish building material sector", focuses on the life cycle impact assessment (LCIA), which is one of the sub-headings of the LCA studies [27]. LCIA models developed in some countries such as Europe and America are examined. In the study, it is indicated that each country has specific environmental sensitivities. It is determined based on the 11 environmental impact categories for Turkey. The benefits, constraints and difficulties encountered in the model are explained by proposing a correlation in which the total environmental performance is calculated for the LCIA stage. The model was tested on expanded polystyrene foam material and the results of the model were compared with other LCIA models.

Barecka et. al. (2014) in "Life cycle assessment of zero-emission façade construction" named conference paper, compare façade solution of three different opaque solutions. These are opaque insulating panel with opaque glass finish, insulating panel with photovoltaic (PV) finish and glass finish with phase change materials (PCM). These solutions are compared with LCA by two methods, Material Input per Servisce Unit (MIPS) and Eco-Point (Simapro program). LCA phases are involves production, operational and total LCA. As the result of the study, PV panel is the most sustainable material by the way of electricity production [28].

Souza et. al. (2015), "Comparative life cycle assessment of ceramic versus concrete roof tiles in the Brazilian context" In their study, ceramic and concrete roof tiles are compared with LCA method. The life span for 1 m2 roof cover was accepted for 20 years. In the study, nine different sensitivity analyses were performed by Monte Carlo Environmental Impact Analysis Method [29].

Seto (2015) "Life cycle assessment and environmental efficiency of concrete materials" in the master thesis, concretes formed using 7 different cementitious materials, which are defined as more sustainable, were examined by LCA methodology. These materials; conventional concrete, blast furnace slag, fly ash, silica fume, limestone, recycled aggregates and photocatalytic concrete. According to the results of the experiment, 6 functional units were formed and modelled in Gabi program [30].

Garcia et. al. (2016) "Eco-efficiency analysis of the life cycle of interior partition walls: a comparison of alternative solutions", In this article, 5 different wall systems mentioned as gypsum panel wall, brick wall, concrete block wall, aerated concrete and gypsum block wall system are discussed. All of these wall systems LCA and LCC studies were completed [31].

Kobeticova and Cerny (2017) "Ecotoxicology of building materials: A critical review of recent studies" named article compiled the results of the research about the building materials, in particular ecotoxicology. It is reported that the LCA studies focused mainly on cement, concrete and ceramics, but also investigated the causes of their damage to ecology [32].

Benli Yıldız (2017), "Development of a sustainability framework for glass fiber reinforced concrete (GFRC) facade panels with life cycle assessment (LCA) method" named doctoral dissertation GFRC facade panels with steel carcass and heat insulated panels; LCA and LCIA studies were made. As a result of these studies, critical points have been identified as material and process. Afterwards, more ecological structural elements have been proposed by theoretically with the use of industrial wastes and recycled materials. LCA and LCIA studies of the alternatives were conducted. According to the results, the most ecological materials and processes are brought together and compared with the first building materials, ecologically [33].

Bideci et al, in its articles, investigated the usability of waste tires in concrete to reduce the ecological footprint on the environment. Waste tires have been substituting aggregates into concrete, breaking them into small pieces. According to the results obtained, it was noted that the concrete had a negative effect on fluidity when the rubber wastes were cut long, but it was used shorter with self-compacting concrete mixtures; gave good results [34].

Igro et. al. (2018), "How can life cycle thinking support sustainability of buildings? Investigating life cycle assessment applications for energy efficiency and environmental performance" named article, the effects of life cycle thinking on energy efficiency and environmental performance in building life cycles were investigated. In this study, it is mentioned that the functional units, building service life, transportation, operation and disposal processes of the buildings that will be accepted for building life cycle can be considered. As a result, life cycle thinking has been described as a good way to use resources and to reduce our environmental impact [35].

Yılmaz et. al. (2019) in "Environmental performance analysis of insulated composite facade panels using life cycle assessment (LCA)" named article, environmental effects of 50 mm thick polyurethane and rockwool filled composite facade panels were determined by using LCA method and compared with each other and developed sustainable models. Hence, the facade panels' cradle-to-gate process (raw material supply, production and disposal phases) were examined. As a result of the study, it is seen that the polyurethane filled composite facade panel has more advantageous environmental performance than the rock wool filled composite facade panel [36, 37].

Panesar et. al. (2019) in "Effect of transportation of fly ash: life cycle assessment and life cycle cost analysis of concrete" named journal, produced four different concrete mixtures by adding fly ash. Mechanical and environmental effects of fly ash added concrete samples have been revealed. By LCA and LCC studies, obtained the results of the environmental impact and costs. In this study, it is also determined that the distance, fly ash is worth to bring in terms of environmental effects. As a result of the study, it can be seen that as the ratio of fly ash increases in concrete mixes, the distance can be prolonged [38]. All of the studies are summarized in Table 1, within the context of author, year, content, material and life cycle impact categories.

Table 1. *The literature survey was expanded from the Ph.D. thesis of Benli Yıldız*

	Author	**Year**	**Content**	**Material**	**Life cycle impact categories**
1	Taygun [12]	2005		LCA models and programs have been studied and a new model has been created. Polyvinyl chloride windows chosen for example	_
2	Gültekin [13]	2006	LCA	Wall Papers	-
3	Esin [14]	2007	Environ-mental Assessment	14 building Material (cement, aerated concrete, glass, iron, aluminum, fiberboard, plywood, PVC, paint, waterproofing)	Some criteria such as very good, good, medium, bad are determined.
4	Özçuhadar [15]	2007	LCA	In, LCA has been studied by theoretically.	_
5	Çakmaklı [16]	2007	LCA	3 hotel with 5 star refurbishment projects	Primary energy consumption, solid waste quantity, air and water pollution level, global warming potential and natural resource use
6	Sev [17]	2009	_	Book on sustainability	_
7	Bayraktar [18]	2010	_	Regulations and LCA is investigated.	_
8	AIA [19]	2010	LCA	A guide book for LCA, there are LCA's for example buildings.	_
9	Ölmez [20]	2011	LCA	Production of iron and steel	Impact 2002^+

Table 1 (continue). *The literature survey was expanded from the Ph.D. thesis of Benli Yıldız*

10	Rajagopalan [21]	2011	LCA	The wall system made with EPS molded reinforced concrete wall system and the wooden wall system LCA's have been compared. In addition, carpet, paint and linoleum materials are also given in comparison with LCA.	Traci
11	Üçer [22]	2012	LCA	Baked clay brick, aerated concrete block, natural stone and adobe bricks	Eco-indicator 99
12	Kahraman [23]	2013	LCA	240 Building Detail (Slab, wall etc.)	Eco-indicator 99 (I) V2.08
13	Yiğit [24]	2013	LCA	Environmental impact of iron foundries	Impact 2002^{+}
14	Petek Gürsel et. al. [25]	2014	LCA, LCIA	It is a literature review on LCA, concrete and SCM are based.	_
15	Petek Gürsel [26]	2014	LCA	Cement, SCM, concrete, Commercial building	Global Warming
16	Karaman Öztaş [27]	2014	LCIA model	Polystyrene foam material	A new LCIA model for Turkey
17	Barecka et al. [28]	2014	LCA	opaque insulating panel with opaque glass finish, insulating panel with photovoltaic (PV) finish and glass finish with phase change materials (PCM).	Material Input per Service Unit (MIPS), Eco-Point,
18	Souza et al. [29]	2015	LCA	ceramic and concrete roof tile	Impact 2002^{+}
19	Seto [30]	2015	LCA	Traditional concrete, high furnace slag, fly ash, silica smoke, lime stone, recycled aggregate and photocatalytic concrete were made of LCA	AP, GWP, Resource consumption, Water consumption
20	Garcia et. al. [31]	2016	LCA, LCIA	Gypsum panel wall, brick wall, concrete block wall, aerated concrete and gypsum block wall system	ADP, ADPF, GWP, ODP, HTP, EP, FAETP, MAETP, TETP, POCP, AP
21	Kobeticova, Cerny [32]	2017	LCA	The effects of building materials on ecotoxicology	Eco-toxicity
22	Benli Yıldız [33]	2017	LCA, LCIA	Glass fiber reinforced concrete (GFRC) facade panels	ADP, ADPF, GWP, ODP, HTP, EP, FAETP MAETP, TETP, POCP, AP
23	Bideci et al. [34]	2017	_	The usability of waste tires in concrete	_
24	Ingrao et. al. [35]	2018	LCA	The study of the impact of the life cycle on sustainability of buildings	_
25	Yılmaz [36]	2019	LCA, LCIA	50 mm thick polyurethane and rock wool filled composite facade panels	ADP, ADPF, GWP, ODP, HTP, FAETP, MAETP, TETP, POCP, AP, EP
26	Yılmaz et. al. [37]	2019	LCA, LCIA	50 mm thick polyurethane and rock wool filled composite facade panels	ADP, ADPF, GWP, ODP, HTP, FAETP, MAETP, TETP, POCP, AP, EP
27	Panesar et. al. [38]	2019	LCA, LCC	Effects of fly ash transport on the environmental sustainability of concrete	ADP, ADPF, GWP, ODP, HTP, EP, FAETP, MAETP, TETP, POCP, AP

Abbreviations in the table;

- LCA: Life cycle assessment
- LCI: Life cycle inventory
- LCC: Life cycle cost,
- LCIA: Life cycle impact assessment
- GWP: Global Warming Potential,
- ODP: Depletion potential of the stratospheric ozone layer
- AP: Acidification potential of soil and water
- EP: Eutrophication potential
- POCP: Formation potential of tropospheric ozone
- ADP-E: Abiotic depletion potential for non-fossil resources
- ADP-F: Abiotic depletion potential for fossil resources
- FAETP: Fresh Water Aquatic Eco-Toxicity Potential,
- MAETP: Marine Aquatic Eco-Toxicity Potential,
- TE: Terrestrial Eco-Toxicity,
- HTP: Human Toxicity Potential

III. SUMMARY AND CONCLUSIONS

As a result of all these studies, it turns out that it is difficult to compare the LCA's. The reasons for this include the selection of a functional unit from building material to commercial building, the selection of different LCA boundaries from cradle to gate or cradle to cradle, and the introduction of regional factors such as location, climate and technology as a result of the studies carried out in different countries.

The studies can be divided into two main categories as the works which are generally provided with data one to one with the manufacturer company; the works which are used as building materials by going through literature, company catalogues and classic details. Although the studies containing factory data contain detailed data from cradle to gate, some acceptances have to be made for both groups during the use, maintance, and disposal phases. The recycling capacity, ratio and prevalence of the country in which the study is conducted can be more sustainable because of the high recycling rate of material which has a lot of environmental impact during the production stage. From a different angle, it is obvious that service life affects the environmental and economic sustainability in the life cycle. In some studies, the product life may vary from 20, 50 to 60 years. In order to compare the 60-year-old with the 20-year-old material, it is necessary to multiply the effects of the short-lived material by triples. In this study, 23 different sources were investigated. Most of them (15) are based from a master or doctoral thesis. 17 study contain LCA study. Initially studies on the issues carried out in Turkey, in general as literature survey, at the end of the examination consists of selecting a material impact. Karaman (2014) 'in which the life cycle impact assessment on the proposal for a model, based on a survey made by experts, has identified the weighting coefficients of the calculation method for Turkey. Esin (2007), who came into direct contact with the producers, has determined the environmental criteria and evaluated the materials through these materials. To summarize all these studies, a lot of studies have been done and carried out. However, it is usually terminated by the determination of the environmental effects of the product and does not contain field data. Improvements have been observed in the studies of Petek Gürsel (2014), Benli Yıldız (2017) and Yılmaz (2018).

A knowledge base of many products made LCA's to complete lack of LCA data must be established in Turkey. It is developing in proportion to the number and types of LCA held in Turkey. Lack of data on the subject should be eliminated quickly by the fact that scientists have branched out on LCA, formed teams and worked on this issue. In addition to the aesthetic, economy, ease of implementation and workmanship of the materials used when designing a building, designers should make an informed choice about their environmental impact. For this reason, a sustainable material library for Turkey should be developed and many information should be shared in the same environment.

Construction materials manufacturers should undertake a life cycle assessment not only to obtain ecological product labels, but also to learn ways to reduce the environmental burden of their products. In light of the results, more sustainable products should be obtained with research and development units for a sustainable future.

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