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Use of Sustainable Techniques in Lebanese Construction Industry

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ABSTRACT

This study attempts to identify, document, and assess the existing knowledge, level of awareness, and sustainability practices amongst the different participants in the Lebanese construction industry. The analysis is based on a survey of owners, designers, and contractors, focusing on the willingness and readiness of the Lebanese construction industry to implement sustainable techniques. A case study was also conducted illustrating a key sustainability practice in construction, namely the recycling of asphalt pavement. The results indicate a limited level of use of sustainable practices, such as green design or recycling of construction materials. The paper concludes with recommendations on how to 1) improve awareness regarding sustainable practices amongst the various stakeholders in the Lebanese construction industry, and 2) overcome some of the barriers for implementation.

INTRODUCTION

The construction industry is a major consumer of natural resources (e.g., soils, rocks, water, minerals, forestry, fossil fuels). The United States' Green Building Council estimates that buildings are responsible for 2/3 of the total country's electricity consumption, 1/3 of total Greenhouse gas emissions, 136 million tons of construction and demolition waste, and 1/8 of the country's potable water [Franklin Associates 1998]. Globally, building construction consumes 40 percent (3 billion tons annually) of the world's raw materials [MDEQ 2007]. The recent increase in construction activities worldwide, coupled with an increased rate of depletion of natural resources, has encouraged researchers and practitioners to investigate sustainable construction techniques. These techniques include the use of renewable energy, building energy efficient infrastructures, and recycling of construction materials. The success of such techniques depends on local conditions, norms, and practices. For example, an attempt was made to recycle construction demolition material in Beirut's Central Business District, which included an estimated 4 million cubic meters of rubble resulting from the destruction caused during the civil war [Lauritzen 1998]. A recycling plant was procured in 1995 and was operational for only a limited period. Problems arose during operation (e.g., inadequate sorting of rubble waste from earth before loading into the crusher), which made the plant un-economical.

The objective of this paper is to identify, document, and assess the existing knowledge, level of awareness, and sustainability practices amongst the different participants in the Lebanese construction industry. The study also identifies some of the barriers for implementation.

SUSTAINABILITY AND THE LEBANESE CONSTRUCTION INDUSTRY

One of the earliest studies on sustainability is the Brundtland Report by the World Commission on Environment and Development (WCED). The report defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [WCED 1987]. Sustainable construction, a subset of sustainable development, advocates the use of technology and knowledge to improve the sustainability of designing, constructing, and operating infrastructures [Chong et al. 2009].

The issue of sustainable construction is of high relevance to Lebanon. The local construction sector is continuously active, causing a major strain to the country's natural resources. The country has 1,200 quarries, of which only 75 had permits to operate in 2004 [Yager 2004]. The annual production from these quarries is 3 million cubic meters of aggregates and sand. This is not enough to meet the annual demand of 3.77 million cubic meters, which were estimated to increase by 73 percent to satisfy the July 2006 war-related demand of 3.5 million tons. The consequences of this rebuilding effort extend to other types of natural resources. The rebuilding of the 60,000 dwelling units, which were completely destroyed or severely damaged, requires 1.2 million tons of cement and 0.22 million m^3 of water [Nasr et al. 2009].

In the wake of the 2006 war, an estimated 2.5 to 3 million cubic meters of demolition waste were generated. In the absence of a national demolition waste management plan and governmental regulations, the majority of that debris was dumped at temporary sites, both existing and reclaimed. For instance, the rubble resulting from the southern suburbs of Beirut (1 million cubic meters) was moved to four temporary sites in the vicinity of Rafic Hariri Beirut International Airport, two of which lie along the Mediterranean Sea shore. The deposited debris, coupled with the absence of adequate stability control measures, pose a safety hazard as its slope has almost reached a ratio of 1:1. The majority of the rubble resulting from other regions was dumped in abandoned quarries, valleys and ponds, causing damage to the ecosystem, visual intrusion, hydrology, and hydrogeology [World Bank 2007]. Recycling efforts in Lebanon were limited to steel and some metal scrap, which were salvaged by the contractors in-charge of transporting the debris to the dump sites.

The 2007 fights in Nahr-El-Bared Camp in North Lebanon resulted in another major amount of demolition waste, estimated at 0.6 million cubic meters [UNRWA 2008]. Based on an agreement with the United Nations Relief and Works Agency (UNRWA), the United Nations Development Program (UNDP) is implementing a rubble removal project where debris from 5,000 housing units are being cleared and transported to a nearby site, where sorting, crushing, and screening will take place prior to final disposal. An effort is undergoing, as part of a research project, at the American University to study the potential of recycling or reusing the demolition material resulting from the 2006 war or the fights in Nahr-El-Bared camp.

The potential for sustainable construction is further illustrated by the Lebanese energy sector. Despite the abundant sunshine, wind, and water resources, Lebanon relies almost exclusively on imported fossil fuels to meet its energy needs, most of which is spent by building facilities. The only form of renewable energy that is used on a grid scale is hydropower,

whose share has been dropping with the increased consumption. Solar energy production is almost exclusively limited to solar water heaters, whose use is on the rise despite the lack of government support [Houri 2006].

The potential for implementing sustainability in the context of the Lebanese construction industry encouraged Majdalani et al [2006] to study key stakeholders' understanding of environmental issues in construction. Their survey, which was conducted in 2003 and 2004, targeted private owner, design firms, and contractors. The results showed a wide variation in levels of environmental understanding depending on the economic position and interest of each of the stakeholders. For instance, Architecture/Engineering (A/E) firms showed highest level of understanding regarding sustainability. The authors attributed this result to the fact that A/E are to a large extent legally responsible for designing projects that serve the intended function. Contractors, on the other hand, are not willing to change their practices for environmental reasons, unless there is a potential for cost savings.

As sustainable construction practices are still primitive in the region, the first step for Lebanon is to document and increase the key stakeholders' awareness of sustainable development. This paper sheds light on the familiarity of Lebanese engineering professionals with measures, standards, and specifications adopted to ensure sustainable development. Through a case study illustrating recycling of asphalt pavement by Lebanese engineering and construction firms, the paper also attempts to identify barriers for implementing sustainable concepts in the context of the Lebanese industry.

METHODOLOGY

A survey with 19 questions was prepared and distributed to 32 Lebanese companies, of which 29 responded. The total number of returned questionnaires was 102, including some sent to freelancers and individuals who preferred not to reveal their work affiliations.

In addition to background questions, the survey tackled issues related to 1) the importance of sustainable concepts in engineering and construction, 2) a definition and description of these concepts, 3) and application in daily work. The survey also zoomed into the issues of green buildings, certification platforms, and obstacles faced in the design of such buildings.

In addition to the survey described above, a case study was conducted on a key and common sustainability practice in construction, namely the recycling of asphalt pavement. The study consisted of a survey that targeted two engineering/consulting firms, and four contractors involved in pavement projects in different locations in the country. The following section presents the results of the survey and the case study.

RESULTS AND ANALYSIS

Survey Results. Of the overall respondents, 63 percent work with engineering/consulting firms, 24 percent are employed by contractors, and 13 percent are with developers. As illustrated in Figure 1, the respondents represent three nearly equal groups: manager and above, senior engineers (with more than 5 years of experience), and junior engineers. In terms of engineering background, the highest representation was for civil engineers (41%), followed by architects (24%) and mechanical engineers (18%). No statistics are readily available for Lebanon; however, to the best of knowledge of the research team, this percent breakdown is representative of the Lebanese engineering community.

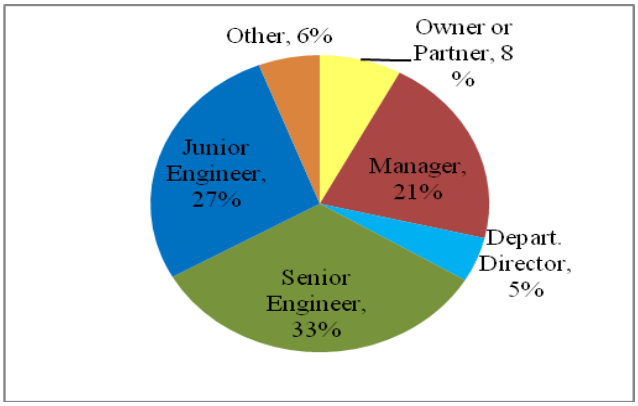

Fig. 1. Respondents By Job Position

The goal of the first set of questions was to measure the Lebanese engineers' level of understanding of the rationale for using sustainable concepts on construction projects. The first question was of technical nature. The results shown in Table 1 were surprising. On a positive note, slightly less than half of the respondents have a clear understanding of the environmental impacts of cement production (production of one ton of cement results in one ton of CO_2 emission). Unfortunately, more than half did not see the relationship between cement production and the consumption of raw material. More surprising was the fact that more than ¼ of the Lebanese engineers consider themselves not familiar with this topic.

Table 1. Every One Ton of Cement Results In

Answer	**Percent Response**[1]
One ton of CO_2 emission	45
Minor effects on the environment	4
Large consumption of raw material	40
No relation to the climate change	1
No relation with gas emission	1
Not familiar with this topic	27

The results of the second question shown in Table 2 indicate a reasonable level of understanding of environmental concerns in construction. Nonetheless, only 19 percent of the respondents cited all three areas of concern (depletion of natural resources, climate change, and energy and power savings).

Table 2. The Environmental Concerns Or Impacts In The Construction Industry

Answer	**Percent Response**
Climate change	61
Rapid depletion of natural resources	68
Energy and power savings	48
No relation with the water efficiency in construction	2

[1] Each respondent had the option of selecting more than one answer. Hence, the percentages do not necessarily add up to 100.

Environmental impacts and construction industry are not related	1
Not familiar with this topic	4

The third question illustrates the Lebanese engineers' awareness of the benefits of sustainable development. Most of the respondents linked sustainability and energy efficiency, which reflects the recent surge in the use of solar thermal heaters across the country. A smaller number saw the relationships between sustainable development and water/wastewater efficiency or materials recycling/reusing. Only 50 percent believe that sustainable concept provide savings in life cycle cost. Nearly 1 of every 4 Lebanese engineers believes that sustainable development leads to higher project costs! This erroneous understanding of sustainable development suggests that cost, or at least perceived cost, is an important barrier for implementing sustainable concepts on the Lebanese construction projects.

Table 3. Results of Sustainable Development As Applied In Engineering

Answer	**Percent Response**
High performance buildings and infrastructure	42
High initial costs but less life cycle cost	50
Improved health and safety measures affecting end users	58
Better energy related components such as lighting, cooling, and heating, and power generation systems	70
Higher overall cost but better quality service	23
Materials recycling and reuse	58
Water efficiency systems, and wastewater treatment and reuse	57
Not familiar with this topic	4

The following question relates to design and construction considerations affecting climate change. The results shown in Table 4 illustrate a reasonable level of understanding of the relationship between material selection and environmental concerns such as climate change. A lower number of respondents saw the relationships between climate change and the types of equipment used, passive design concepts, or building envelope.

Table 4. Factors In Design And Construction Affecting Climate Change

Answer	**Percent Response**
Passive design (including orientation, site condition, aspect ratio etc)	42
Building envelope	32
Materials selection	70
Equipment type used	54
None of the above factors	1
Not familiar with this topic	5

The second set of questions describe the Lebanese engineers' understanding of key elements of sustainable design as well as some of the terminology commonly used. The results of the first question shown in Table 5 indicate that, as expected, Lebanese engineers are more familiar with the term "green building" than with the term "high performance building".

Table 5. A Sustainable Building Project Is Also Called

Answer	Percent Response
A green building project	83
A high performance building project	19
A clean building project	14
Not familiar with this topic	6

As illustrated by Table 6, most respondents link sustainable design with the concepts of reducing, reusing, and recycling resources. This is an encouraging result as the country generate significant amount of construction and demolition material, which can be recycled or reused. Less encouraging is the fact that only 10 percent understand the impact of sustainable design on project cost and quality. Sustainable design might add to the project's capital costs (i.e. planning and execution), however it improves the overall project's quality and therefore reduces operational costs. A study conducted by the United States Green Building Council (USGBC) based on 33 green offices and schools found an average premium of 2 percent for these buildings relative to equivalent non-green buildings. Green buildings, on the other hand, offer several benefits. These include energy and water savings, reduced waste, improved indoor environmental quality, greater employee comfort and productivity, reduced employee health costs, and lower operations and maintenance costs. For example, the average energy savings for green buildings are 25 to 30 percent [Kats 2003].

Table 6. Major Principles Of Sustainable Design

Answer	Percent Response
Reduce, reuse, and recycle resources consumption	81
Ignore additional cost, but assure better quality	12
Reduce, reuse, but not recycle resources	3
Assure better quality and higher capital cost	10
Not familiar with this topic	6

Referring to Table 7, more than half of the Lebanese engineers associate sustainability principles with ecological (or green) design. A similar number of respondents recognize the continuously evolving nature of sustainable design. Unfortunately, only 28 percent perceive ecological design as an improvement over conventional design.

Table 7. An Ecological Design, Also Called Green Design

Answer	Percent Response
Describes the application of sustainability principles into building design	59
Is an improvement over the conventional design	28
Is independent of an replaces the conventional design	5
Undergoes continuous upgrading and modification in order to reach the optimal goal of achieving a full sustainable building system	48
Not familiar with this topic	8

The third set of questions studies the application of sustainable concepts in the daily lives of Lebanese engineers. When asked if they consider any sustainable features in their design or construction, 60 percent answered positively, 31 percent negatively, and 9 percent were not familiar with the topic. As shown in Table 8, the use of sustainable features is more frequent on international projects than on local projects. The international projects mentioned by the

respondents are in Saudi Arabia (Riyadh), United Arab Emirates (Abu Dhabi and Dubai), and Jordan (Amman). These projects are typically very large and attract media and popular attention. As such, including sustainability features in the design of such projects helps attract a wider market. One of the few local projects that were mentioned is the American University of Beirut's Charles Hostler student center, which featured in the American Institute of Architect (AIA)'s Environment Top Ten Green Projects. The project design team replaced the university's original plan of a single large-scale building and open plaza with multiple building volumes connecting a continuous field of habitable space with gardens on multiple levels. The building location was carefully selected to maintain existing trees [AIA 2009].

Table 8. Projects You Worked On Where Sustainability Measures Were Applied

Answer	Percent Response
International projects	30
Local projects	12
In private sector	35
In public sector	22
None of the above	16
Not familiar with this topic	13

As shown in Table 9, the majority of the respondents believe that owners and designers play a significant role in the process of adopting sustainable concepts on projects. Their knowledge and willingness is more important than that of contractors and end users. This result is in-line with Majdalani et al. [2006] who found that Lebanese architecture/engineering firms are more aware about environmental issues in construction than their contractor counterparts. Contractors are generally reluctant to implement new construction techniques or procedures unless they are accompanied with lower costs and higher profits [Chong et al. 2009]. For example, Lebanese contractors have started, over the past few years, recycling structural steel, rebar, or any scrap metal used in construction. This is because the resale value of this material is higher than the cost of recovery. However, no effort is in-place to recycle any of the remaining construction and demolition material (e.g., concrete) because of the perceived high recovery cost compared with the price of aggregates or cement.

Table 9. Responsibility Of Adopting Sustainability On A Project Depends On

Answer	Percent Response
Designer's knowledge and willingness	68
Contractor's knowledge, adequate techniques, and willingness	35
End users' knowledge and acceptance	32
Owner's decision	77
Not familiar with this topic	4

As shown in Table 10, the most significant barriers for implementing sustainable concepts (e.g. green building) are the large initial cost relative to conventional construction, as well as the lack of awareness of such concepts.

Table 10. Some Of The Obstacles For Implementing "Green Buildings"

Answer	Percent Response
The large initial cost compared to the conventional method	67

The lack of life cycle cost analysis	25
The budget separation between capital and operational costs	26
Insufficient research on indoor environment, productivity, and health	23
Lack of awareness	54
Not familiar with this topic	6

The last set of questions measures the Lebanese engineers' familiarity with green building certification platforms such as Leadership in Energy and Environmental Design (LEED). When asked if they are familiar with the LEED system, 39 percent of the Lebanese engineers responded positively, 44 negatively, and 17 percent were "somewhat" familiar. The majority of those who are familiar (or somewhat familiar) consider that the benefits of the LEED system affect and are reaped by society as a whole (see Table 11). This is an encouraging result as it shows that the Lebanese engineers link sustainable concepts, such as green buildings, with benefits to the entire society rather than to one segment only (e.g., occupants, end users, owners).

Table 11. The Major Benefits Of The LEED System Affect And Are Reaped By

Answer	**Percent Response**
Owners	35
Occupants and end users	58
Society as a whole	84
Anyone who comes into contact with the building	20
Not familiar with this topic	5

As shown in Table 12, only half of the respondents who were familiar with the LEED system know of other rating systems. The systems that were mentioned include BREEAM (United Kingdom), HEQ (France), Green Star (Australia), AECB, EERA, and HERS (United Kingdom). The respondents also mentioned two regional systems, Estidama and EHS in the United Arab Emirates, which are tailored to fit the regional requirements of the gulf area.

Table 12. Do You Know Any International Rating System Other Than LEED?

Answer	**Percent Response**
Yes, state one system:	51
LEED is the only system used internationally	9
All systems are a duplicate of LEED, only language differs	13
Not familiar with this topic	27

Overall, the results of the survey suggest that the Lebanese engineers have a reasonable understanding of the importance of sustainability concepts in the construction industry. Unfortunately, the implementation of these concepts remains limited, as shown in Table 8, and mostly on international projects. To further understand the applicability of sustainable ideas, a case study was investigated, namely the recycling of asphalt pavement in Lebanon.

Case Study: Recycled Asphalt Pavement (RAP). A more specific survey on the incorporation of RAP in pavement construction was distributed to consultants and contractors who undergo such projects. Companies were extremely hesitant to respond, perhaps since the cost of recycling was included among the questions. Additionally, the low response rate is due to the short time frame in which the survey was conducted, and the limited designers and

contractors involved in heavy roadway construction. It is worthy to mention that almost all paved roadways in Lebanon are constructed of asphalt concrete [Galal and Chehab 2006].

Of the six respondents, four companies are contractors and two are consultants. The authors had prior knowledge that RAP has not been used extensively in Lebanon. Additionally, governmental agencies do not include usage of RAP in their specifications and contract documents. With that in mind, the questions formulated were general in nature and focused on the overall awareness of using RAP, willingness and obstacles. The authors figured that it was premature to pose technical questions.

All respondents were familiar with using RAP in new pavement construction. Two design firms have used it in their mix design and are willing to continue using it. However, such designs are mostly tailored to construction in the Arabian Gulf area where the RAP-modified mixes perform very well in the hot weather. As for the contractors, while two had used it before, the rest had not but expressed interest in using it if possible. Obstacles cited for not using RAP included political interventions, financial ability, and equipment availability.

Cold in-place recycling has recently been introduced in the Lebanese construction industry. The technique has been successfully adopted in six roadway projects with a total paved length of 75 km. This is currently the most efficient way in reusing asphalt pavement materials in Lebanon. None of the contractors, however, has general procedures in place for incorporating RAP in the production of new asphalt concrete mixtures. Such practice requires that modifications be made to the asphalt plants, an investment contractors are not willing to make if specifications do not require use of RAP-modified mixtures, incentives are not in place, and /or financial resources are unavailable.

The current practices for utilizing milled or removed asphalt vary from one contractor to the other and from one job to another. Dumping of removed asphalt is the most common practice, whether on site for use as backfill material and unpaved access roads, or in approved dumping areas such as quarries, valleys, and lots away from known water streams. Figure 2 illustrates one of the dump sites.

Fig. 2. Milled Asphalt Dumped for Backfilling at Dbayeh Marina.

CONCLUSIONS AND RECOMMENDATIONS

The Lebanese construction industry has a great potential for implementing sustainable techniques. The country's meteorological conditions are favorable for generating renewable energy. Furthermore, the construction (and demolition) industry generates significant amounts of materials, which can be recycled. Nonetheless, as shown by a survey of key

participants, the level of use of sustainable techniques remains limited. Only 12 percent of the respondents have had the chance to implement sustainability techniques on local projects. The survey results indicate that the most significant barriers for implementing sustainable concepts such as green buildings are the large perceived initial cost relative to conventional construction and the lack of awareness of such techniques. Nearly 25 percent of Lebanese engineers believes that sustainable development leads to higher project costs.

The limited use of sustainable concepts in construction is further illustrated by a case study of recycling asphalt pavement. A survey of contractors and consultants revealed that the use of RAP is mostly limited to construction in the Arabian Gulf area where the RAP-modified mixes perform very well in the hot weather. All six surveyed companies are familiar with using RAP in new pavement construction; however, they have varying levels of interest in using it on Lebanese roads. The obstacles cited ranged from political interventions, financial ability, equipment availability, and the lack of specifications and contract documentation.

The following recommendations are made to raise the level of understanding, and increase the level of use, of sustainable techniques in the Lebanese construction industry:

Educate the various stakeholders (public and private owners, design firms, contractor, end users, etc) on: a) the environmental impacts of the construction industry, especially with regards to the depletion of natural resources, and b) the benefits of sustainable practices such as the use of renewable energy and recycling of construction and pavement materials. This effort requires a coordinated participation of universities, government institutions, non-governmental organizations, and the Lebanese Order of Engineers.

Apply a set of incentives/penalties boosting the adoption of sustainable construction. These include using tax breaks or tax exemptions on imported sustainable construction materials, lower permitting or registration fees for green-rated construction projects, lower taxes for local manufacturers, and high penalties/taxes on construction practices compromising the environment. This effort requires the participation of government institutions, local municipalities, and the Order of Engineers.

Change the regulations to enforce the use of sustainable techniques. To raise the level of use of such techniques, institutional, legal, and market barriers should be removed. Sustainable construction (e.g., Green buildings) should be included in building codes. This effort requires the participation of government institutions, the Order of Engineers, and technical controllers.

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REFERENCES

1. The American Institute of Architects (AIA). (2009). "AIA/COTE Top Ten Green Projects: Charles Hostler Student Center." <http://www.aiatopten.org/hpb/overview.cfm?ProjectID=1301> (Sep 21, 2009).
2. Chong, W.K., Kumar, S., Haas, C.T., Beheiry, S.M.A., Coplen, L., and Oey, M. (2009). "Understanding and Interpreting Baseline Perceptions of Sustainability in Construction among Civil Engineers in the United States." *J. Mgmt. Engrg*, 25(3), 143-154.

3. Franklin Associates. (1998). “Characterization of Building-related Construction and Demolition Debris in the United States.” *The US Environmental Protection Agency Municipal and Industrial Solid Waste Division Office of Solid Waste*, Report No. EPA530-R-98-101.
4. Galal K., and Chehab G. (2006). "Evaluating High Performing Structural HMA Pavement Systems using the ME Design Guide." *Civil Engineering Infrastructure Systems Conference (CEIS)*, Beirut, Lebanon.
5. Ghataora G.S., Alobaidi, I., Faragher, E., and Grant, S. (2006). “Use of Recycled Aggregates for Cementitious Backfill.” *Proc. of the Instit. of Civil Engineers, Waste and Resource Mgmt*, issue WRI, 23-28.
6. Houri, A. (2006). “Solar Water Heating in Lebanon: Current Status and Future Prospects.” *Renewable Energy*, 31, 663-675.
7. Ktas, G. (2003). “Green Building Costs and Financial Benefits.” Massachussets Technology Collaborative, <http://www.bostonredevelopmentauthority.org/gbtf/documents/MTCGrnBldgs-Katz.pdf> (Oct. 10, 2009).
8. Lauritzen, E.K. (1998). “Emergency Construction Waste Management.” *Safety Science*, 30, 45-53.
9. Majdalani, Z., Ajam, M., Mezher, T. (2006). “Sustainability in the Construction Industry: a Lebanese Case Study.” *Construction Innovation*, 6, 33-46.
10. Michigan Department of Environmental Quality (MDEQ). (2007). “Green Construction and Demolition / Green Buildings.” P2 Annual Report Addendum, <http://www.michigan.gov/documents/deq/deq-ess-p2-anlrptadd-greenconstruction_234796_7.pdf> (Sep. 7, 2009).
11. Nasr, D., Massoud, M.A., Khoury, R., and Kababian, V. (2009). “Environmental Impacts of Reconstruction Activities: A Case of Lebanon.” *Int. J. Environ. Res.*, 3(2), 301-308.
12. United Nations Development Program (UNDP). (2007). “Lebanon Rapid Environmental Assessment for Greening Recovery.” *Reconstruction and Reform* 2006, Beirut, Lebanon.
13. United Nations Relief and Works Agency (UNRWA). (2008). “A Common Challenge A Share Responsibility.” *Int. Donor Conf. for the Recovery and Reconstruction of the Nahr el-Bared Palestinian Refugee Camp and Conflict-Affected Areas of North Lebanon*, Vienna, Austria, <http://www.un.org/unrwa/publications/NBC/Vienna_23June08.pdf> (Sep. 7, 2009).
14. Yager, T. (2004). “The Mineral Industry of Lebanon.” *United States Geological Survey Minerals Yearbook*, <http://minerals.usgs.gov/minerals/pubs/country/2004/lemyb04.pdf> (Sep 15, 2009).
15. Warren, J., Chong, W., and Kim C. (2007). “Recycling Construction and Demolition Waste for Construction in Kansas City Metropolitan Area, Kansas and Missouri.” *Transp. Res. Record: J. of the Transp. Res. Board*, 2011, 193-200.
16. World Bank. (2007). “Republic of Lebanon Economic Assessment of Environmental Degradation Due to July 2006 Hostilities.” *Report No. 39787-LB, Sustainable Development Department Middle East and North Africa Region*.
17. World Commission on Environment and Development (WCED). (1987). “Our Common Future.*” Oxford University Press*, London.