LEED Needs to Reevaluate Demolition to Stay Relevant

University of Arizona
Senior Capstone
Sustainable Built Environments 498
April 17, 2019
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I. Introduction

The definition of a sustainable building is one that stresses the importance of the structure's efficiency when consuming energy, water, and other consumables. The building needs to address both the health of the occupant and the environmental impact of the building from pre-construction through post-occupation. There are many rating scales available when a site owner wants to have a building accredited to demonstrate its sustainability. These assessments evaluate multiple aspects of the design, construction, and operation of a building to determine its environmental impact. The most widely implemented evaluation system in the United States is Leadership in Energy and Environmental Design, or LEED ("US EPA, OSWER, Office of Brownfields and Land Revitalization").

The LEED accreditation process is recognized as the benchmark for ranking sustainable buildings in the United States. LEED certification provides building owners and operators with the tools they need to have an actionable and quantifiable effect on their site's environmental impact (GenFlex Roofing Systems). By promoting a whole-building approach to sustainability, LEED recognizes performance in site planning, site development, water efficiency, energy efficiency, building materials, waste reduction/division, indoor air quality, and attention to regional concerns (GenFlex Roofing Systems).

The current LEED scorecard contains many aspects of demolition and construction waste practices; however, it allows for projects to gain points through demolition requirements that are already required in most large cities. This means that the site owner does not need to take additional care to demolish the building sustainably outside of what is required in common construction protocols in California. Additionally, the LEED V4 scorecard allows for owners in states outside of Ca. to ignore points in the demotion waste category but pick up enough points in other categories and still carry a LEED title. These two scenarios demonstrate a serious flaw in LEED's accreditation system: LEED does not go beyond standard construction practices in regards to demolition.

In addition to these flaws, the LEED accreditation process poses further weaknesses in establishing sustainability in demolition. Buildings usually gain a sustainable rating by addressing only two components of the construction process: the site's location, and the erection of the building. The certification process does not have stringent prerequisites on projects' waste streams, and demolition and construction waste or C&D waste often are not recycled to the maximum extent nor do the waste facility have frequent audits to ensure they are diverting what is claimed.

The LEED certification process needs to be more stringent during the demolition aspect; only by considering all aspects of a building's life cycle can LEED continue to push the envelope on what we believe are the best practices of sustainability. ***If LEED wants to continue to be the leader in sustainable building accreditation, then LEED needs to implement stringent requirements under the construction and demolition waste management planning prerequisites and requirements.*** In this analysis, I will attempt to demonstrate the inefficiencies of the current LEED grading criteria and plan on making recommendations on the different methods that could be implemented by LEED to make the demolition of a building have more importance on the grading scale.

An explanation and analysis of the grading criteria of the demolition section of the LEED scorecard for projects Building Design + Construction (BD+C), will identify the existing gaps and help to illustrate an understanding of what the best practices of demolition. To express that sites can push the limits of what LEED claims to be effective, a LEED project that pushed the envelope during the demolition process will be analyzed.

The intent behind each prerequisite and point requirement of LEED certification V4.1 will be defined and addressed in this work, in addition to a thorough definition of common demolition waste material and the corresponding waste classification. Providing data from the Environmental Protection Agency (EPA) will confirm the negative effects of demolition. I will perform an analysis of common demolition waste practices in the greater Los Angeles area to provide a baseline for demolition practice in a large city and contrast the trends with those found in the LEED project and their respective demolition and construction waste. To illustrate innovative ways to address demolition waste, this study will provide an analysis of several projects that were not LEED certified but demonstrated standard methods within the county. Finally, recommendations on requirements that should be added to the LEED grading scale to optimize a building's sustainability in demolition practices and make the building truly "green" will be discussed.

II. Literature Review

A. What is LEED?

Leadership in Energy and Environmental Design (LEED) is an internationally recognized built environment certification system. The LEED program provides third-party verification that a building was built with consideration of its performance across "energy savings, water efficiency, CO2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts," (United States Environmental Protection Agency, 2016). The LEED certification process provides building owners with a template for implementing practical and measurable solutions for sustainable building design, construction, operations, and maintenance.

LEED is recognized as an international system because it covers all building types and provides constant iterations to its prerequisites and requirements as building practices change. The entire building lifecycle is taken into consideration when grading the site; this includes facets such as preconstruction, job in progress, tenant building out to retrofit the building. A building can earn points on the LEED scale within five categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality (Gentn). This paper will be focusing on the materials and resources category of LEED.

The U.S. Green Building Council (USGBC) became the first established leadership in sustainable sites. LEED achieved this by creating multiple rating systems designed around multiple types, scopes, and typologies. LEED also established rating systems for commercial size projects. In 2004, LEED created its first set of guidelines for Commercial Interiors (CI) rating system for heavily occupied structures such as corporate, retail, and institutions. In 2006 LEED created the second rating for systems which was designed for Core & Shell projects (Cottrell, 2011).

B. What is demolition?

Demolition is the clearing and removal of existing structures on a site before new construction or retrofit. To begin the demolition process, an assessment of the building and site is conducted to determine if there are any hazardous material that needs to be removed. These hazards often are metals such as lead, beryllium arsenic, cadmium, and hexavalent chromium. These potential hazards need to be determined before demolition or construction can begin so proper safety measure can be made.

There are two common techniques to test for hazardous metals. First, there is a surface wipe technique. This test is completed by collecting surface dust from the area in question; the dust sample is then sent to a laboratory for analysis (Selvey 2017). The second and less reliable technique is using an X-ray Fluorescence gun to determine the metals in the potentially hazardous material. When waste in the demolition process comes back as hazardous, a specialty contractor is hired that can provide comprehensive services for waste identification, verification/tagging, hauling, and disposal of the hazardous materials following applicable federal and state regulations. The common hazardous demolition waste comes from asbestos-containing materials that are both friable and non-friable, lead-based and lead-containing materials, materials that contain polychlorinated biphenyls (PCBs), solvents, chemicals, and petroleum-derived products (Napier 2016).

Clean Demolition is the dismantling or wrecking of a structure for any purpose. The issue with dismantling or wrecking of a structure is the demolition waste, or often referred to as C&D waste. C&D waste can consist of woody and plant materials, concrete, gravel, aggregate stone and rock, masonry and rubble, metals, wood, plastic, glass, doors and windows, asphalt, gypsum, carpet and pad, cardboard and paper, plumbing fixtures, lighting fixtures, plastics, and/or salvaged building components ("Industrial and Construction and Demolition (C&D) Landfills" 2016).

It is important to demonstrate an understanding of what the common materials that make up the Construction and Demolition (C&D) waste streams from demolition and abatement of sites. First, there must be an understanding of common demolition and abatement practices and standards. After establishing an understanding of the common material and waste streams of a construction site, one will understand the negative impact that demolition and abatement have on the on both the natural and built environment.

Numerous types of hazardous wastes can be found in demolition as construction materials have changed over the years. One primary example can be found in the EPA's classification of asbestos as a known human carcinogen, (United States Environmental Protection Agency, 2016). Asbestos fibers are 80 percent smaller than a human hair, which leads to them being easily inhaled. After the fibers have been inhaled, the fibers cling to the side of your lungs and esophagus, which leads to serious health concerns. When asbestos-containing material is removed from a building, the material must be placed into a sealed container and be soaked in water to assist with breaking down the material, United States Environmental Protection Agency, 2016).

C. Why is demolition a problem?

Information about waste generation and disposal is an important foundation for managing materials. This is because the sustainable management of materials requires thinking beyond waste to focus on the life cycle of a product (U.S. Environmental Protection Agency, Office of Land and Emergency Management, Office of Resource Conservation and Recovery). The life cycle begins at the time the material is produced, and progresses through its use, reuse, and ultimately recycle or disposal. The sustainable method of materials management is known as Sustainable Materials Management (SMM). SMM conserves resources, reduces waste, and minimizes adverse environmental impacts from materials. The EPA 2015 fact sheet provides analysis of MSW trends in generation and management, materials and products, and economic indicators affecting MSW U.S. Environmental Protection Agency, Office of Land and Emergency Management, Office of Resource Conservation and Recovery). The fact sheet also includes a section on the generation of construction and demolition C&D debris. While this debris is not a part of MSW, it comprises a significant portion of the nonhazardous solid waste stream (U.S. Environmental Protection Agency, Office of Land and Emergency Management, Office of Resource Conservation and Recovery).

In 2015, there were roughly 548 million tons of C&D waste generated in the United States. U.S. Environmental Protection Agency, Office of Land and Emergency Management, Office of Resource Conservation and Recovery). Removed concrete was the largest contributor at 70 percent, and asphalt generated 15 percent of the waste. Wood products such as door, millwork, and framing made up 7 percent. The last 8 percent was made up of items such as plastics, soil, insulation, and glass. Ninety percent of the overall waste that came from a construction site came from demolition. In 2015, 262 million tons of municipal was generated versus 548 million tons of waste came from C&D material.

The growth in population and the upswing in the economy has led to a construction surge, and with this surge comes added construction waste. The Environmental Protection Agency (EPA) has endorsed and funds designated C&D landfills. These designated facilities accept waste that has been removed from demolition and or construction sites related to major structures such as buildings, and public infrastructure. The largest waste stream from C&D waste is concrete. Many facilities now offer concrete recycling, but before the facility accepts the concrete, it must be separated from other waste streams and free of any major obstructions such as rebar. The clean concrete can be crushed and repurposed as a new aggregate. If the construction site can dispose of clean concrete, it is not only environmentally friendly, but they also pay less for the disposal of the concrete (Krause Manufacturing, 2014).

D. What are the LEED Demolition Points?

The LEED V4.1 manual from the US Green Building Council has three areas that can earn a point for demolition. This will provide the intent for each point and what items must be addressed to receive the point. (Enck, Corey). The first way to earn points through the demolition process is through the Construction and Demolition waste management planning prerequisite. The goal behind this prerequisite is to reduce the C&D waste that leaves the site and is disposed of through recovering, reusing, and recycling materials. The requirements are to develop and implement a waste management plan that must set the waste diversion goals for the project. This is done by identifying a minimum of five materials and the percentage of the overall C&D waste that will be diverted from landfills or incineration plants (Enck 2015).

In the waste management plan, it must be specified if the materials will be separated into separate waste bins or commingled. If the material is commingled, there must be information on where the material will be taken and how the waste facility will sort and recycle the material. Finally, there is a final report detailing all major waste streams generated, including disposal and diversion rates. Alternative daily cover (ADC) does not qualify as material diverted from disposal. Land-clearing debris is not considered construction, demolition, or renovation waste that can contribute to waste diversion (Enck 2015).

Once the prerequisites are met the site can start to receive LEED Credits. One point is given for recycle or salvage at least 50% of construction, demolition, and land clearing waste, The building can also earn 1 credit for diverting a total of 75% of waste from a landfill or incineration plant and recycle at least an additional 25% of construction, demolition and land clearing waste through reuse or salvaging (Enck 2015).

A building's project team can also earn an additional one point in the Resource and Materials section if they plan for future building improvements. The team must develop and follow a waste management plan set in place for any future building retrofits, renovations, or modifications on the site. The plan for future improvements must meet or exceed 75 percent of recycling or salvage for construction, demolition, and land clearing waste (Enck 2015).

Another point may be earned through the Building Life Cycle Impact Reduction BD+C. This credit demonstrates that the design and project team has implemented and followed strategies to reduce the negative impact the building has on the environment during its life cycle. The design team must also take into the plan on reusing existing building and its resources. The building can also earn the credits if the project team demonstrates a reduction in materials used through life-cycle assessment.

A site owner can earn up to five points by reusing a historic building. If a historical building is selected the team must keep the existing building structure, envelope, and interior nonstructural elements (Enck 2015). None of the historical buildings' integrity and characteristics can be demolished unless the area is deemed structurally unsafe and has been approved by the local historical society or the U.S National parks service. If the building needs improvements, the building must follow the U.S. Park Services outline on preservation, restoration, or rehabilitation of a historic building (Enck 2015)

There is a second option to receive five points in the Building Life Cycle Impact Reduction BD+C2, is to renovate an abandoned or vacant building. The building must keep at least 50 percent of its original surface area existing structure, enclosure, and interior structural element (Enck 2015). Due to abandoned or vacant building often having substation damages and deterioration, LEED allows up to 25% of a buildings' surface area to be removed from the rating calculation.

The third option to receive four points within the Building Life Cycle Impact Reduction BD+C2 category is by reusing recycled or salvaged material from either on-site or off the building buildings (Enck 2015). By reusing the material, it can apply to 50 percent of the surface area that must remain intact. Building materials that can be reused and applied to the surface area percentage are structural elements, enclosure materials, and permanently installed interior elements. Items that cannot be used in the surface area calculations are window assemblies and any hazardous materials that come from the site (Enck 2015)

The USGBC allowed a pilot credit to be created to address a higher quality of construction and demolition waste plan. The purpose of the credit is to achieve a higher quality of C&D waste diversion. This would be done by verifying standard for recycling facilities that will accurately quantified waste data and provide industry standards or better on waste rates. The pilot credit required recycling of all non-hazardous construction and demolition materials. This would be done by commingling the site waste and sending the waste materials to a mixed-recovery facility that can properly sort and dispose of all C&D waste; the mixed recovery facility would also be audited by a third party to verify the facility-average recycling rates. (United States Green Building Council 2018).

After completion of the project, the waste facility must continuously be monitored by the established third party during the life of the LEED certification. The waste facility must submit waste diversion reports that provide the raw data that complies with the established waste management plan. The reports are typically issued out monthly. During the first year of the waste facility, the center needs to have an onsite audit at least once and then followed by once every two years unless further investigation is deemed necessary. After the waste facilities services, the project site will need to obtain a final diversion report that separates each material by type and includes individual recycling rates, and how the material was recycled, (United States Green Building Council 2018).

III. Methodology

This capstone will be case study between four non-LEED certified building and one LEED-certified building. The focus will be on the demolition portion of their construction and will demonstrate that standard practices are already pushing the envelope in demolition waste disposal. The goal is to demonstrate the shortcomings in the LEED methodology and show the need for more stringent standards. The five projects are retrofits to existing buildings that enjoyed the implementation of creative ideas that cut down the waste streams produced by demolition. The key to selecting all the same style of projects was to ensure that the waste streams coming out of each project were consistent with one another.

New criteria that need to be added to the LEED grading scale to stay relative and competitive in the sustainability and construction fields will be proposed. These suggestions will come from the data and research collected from the three projects that have had innovated demolition practices. The last area a sustainable building needs to address is how the site can reduce waste, pollution, and environmental degradation. To complete this point, a comprehensive design and construction process needs to be implemented by the site’s owner that will lead to techniques during the construction process to minimize adverse environmental impacts.

Providing data from the Environmental Protection Agency (EPA) will confirm the negative effects of demolition. LEED certification claims to verify the level of the buildings' efficiency, innovation, and the impact on the surrounding environment from pre-construction to occupancy; this paper will illustrate that we still have a long way to go in these efforts.

IV. Discussion/Results

This capstone will be case study between four non-LEED certified building and one LEED-certified buildings. The focus will be on the demolition portion of their construction and will demonstrate cutting edge practices to push the envelope in demolition waste disposal. The goal is to demonstrate the shortcomings in the LEED methodology and show the need for more stringent standards to earn points on waste categories. The four non-LEED sites will include:

755 South Los Angeles St Los Angeles, CA
1801 Century Park East Los Angeles, CA
401 Wilshire Blvd Santa Monica, CA
10880 Wilshire Blvd Los Angeles, CA

The four non-LEED buildings were retrofits to existing buildings that enjoyed the implementation of creative ideas that cut down the waste streams produced by demolition. My baseline LEED project is also a retrofit and is located at 777 S Aviation Boulevard, El Segundo, CA.

It is vital to demonstrate an understanding of what the common materials that make up the Construction and Demolition (C&D) waste streams from demolition and abatement of sites when analyzing the data from each site. First, there must be an understanding of common demolition and abatement practices and standards. After establishing an understanding of the common material and waste streams of a construction site, one will understand the negative impact that demolition and abatement have on the on both the natural and built environment. The last area a sustainable building needs to address is how the site can reduce waste, pollution, and environmental degradation. To illustrate this point, a comprehensive design planning and construction process needs to be implemented by the site's owner; this analysis will allow for techniques to be implemented during the construction process that will minimize potential adverse environmental impacts.

LEED certification claims to verify the level of the buildings' efficiency, innovation, and the impact on the surrounding environment from pre-construction to occupancy; the following case studies will illustrate that we still have a long way to go in these efforts.

V. Case Studies

All five identified case studies have been studied within the County of Los Angeles. Many cities within the County of Los Angeles align with LEED and require a waste management plan be created as part of the pre-construction phase. Santa Monica and El Segundo require this planning to acquire a construction permit, and LEED requires it to establish a bench line on the project.

777 S Aviation Boulevard

The Federal Aviation purchased the South Aviation Boulevards site in El Segundo, CA as an additional administration location. The building was purchased with the plan on making major extensive structural, interior and site upgrades in hopes of acquiring a LEED certification. The project achieved LEED platinum in the BD+C: New Construction rating system. The demolition scope for the 777 project had an original estimate of roughly 1330 tons of waste coming off the site. There were two categories that made up the waste stream. A total of 1,162 tons of concrete was estimated to be removed from the project. The total estimated amount of C&D waste was 24 Tons. The waste streams were created of multiple items. Removal, off-haul and disposal of all items required to be demolished included the following concrete items: footings, slabs, building foundations, columns, beams sidewalks, street curbs and gutter, and a city utility vault. The C&D waste consisted of equipment pads, roofing system and roof-mounted equipment, HVAC, plumbing, and fire sprinkler, abandoned utilities, landscaping, and interior finishes, (777 Pechon 2018).

Gensler, the project architect, placed a requirement on the project that the site must meet or exceed an 80% diversion rate of waste ending up in a landfill which matches what the City of El Segundo mandates. The waste management plan based on the entire project projected 1,498 tons of waste coming off-site. The following charts are the waste management plan for the FAA project. The first chart sets the parameters for how the project will meet the 80% diversion rate set south by the city, (777 Pechon 2018).

Reuse, Recycling or Disposal Processes to Be Used

Describe the types of recycling processes or disposal activities that will be used for material generated in the project to achieve the required 80% diversion rate . Indicate the type of process or activity by number, types of materials, and estimated quantities that will be recycled or disposed in the sections below:

01 - Reuse of building materials or salvage items on site (i.e. crushed base or red clay brick)

02 - Salvaging building materials or salvage items at an off site salvage or re-use center (i.e. lighting, fixtures)

03 - Recycling source separated materials on site (i.e. crushing asphalt/concrete for reuse or grinding for mulch)

04 - Recycling source separated materials at an off site recycling center (i.e. scrap metal or green matls)

05 - Recycling commingled loads of C&D matls at an off site mixed debris recycling center or transfer station

06 - Recycling material as Alternative Daily Cover at landfills

07 - Delivery of soils or mixed inerts to an inert landfill for disposal (inert fill).

08 - Disposal at a landfill or transfer station.

09 - Other (please describe)

(777 Pechon 2018)

The below chart explains the estimated quantity of each waste stream coming off the site. The asphalt was removed by truck to a facility in Gardena, CA that crushes the asphalt back into an arrogate that can be resold. The rest of the waste was picked up in 10-yard waste bins and brought to the California waste facility to sort through the material and filter out all items that can be recycled, (777 Pechon 2018).

SECTION 1 - RE-USED/RECYCLED MATERIALS

Include all recycling activities for source separated or mixed material recycling centers where recycling will occur.

Type of Material	Type of Activity	Facility to Be Used / Location	Total Truck Loads	Total Quantities		
				Tons	Cubic Yd.	Other Wt.
Mixed C&D	Demo	California Waste Services	4	24		
Concrete	Demo	California Waste Services	8	64		
Asphalt/Concrete	Demo	Gardena Crushing	60	960		
Drywall	Construction	California Waste Services	3	30		
Mixed C&D	Construction	California Waste Services	60	420		

(777 Pechon 2018).

Progress Photo

After Photo

755 South Los Angeles Street

The owner of the South Los Angeles Street project plans to turn an old fabric factory into a mixed-use residential building. In order to begin construction two different construction permits were pulled, make the building eligible for separate LEED accreditations. The two rating systems would be LEED BD+C: Core and Shell for the first accreditation and BD+C: New Construction for the second accreditation. The Demo scope for the Norton project had an original estimate of roughly 1,470 tons of waste coming off the site. There were two categories that made up the waste stream. A total of 852 tons of concrete was estimated to be removed from the project. The total estimated amount of C&D waste was 618 Tons, (755 Holliday 2018).

The removal and disposal of all items required to be demolished included the following concrete items; footings, slabs, staircases, building foundations, columns, beams sidewalks, street curbs and gutter, and CMU blocks. The C&D waste consisted of equipment pads, roofing system and roof-mounted equipment, HVAC, plumbing, and fire sprinkler, abandoned utilities, landscaping, interior finishes steel, terrazzo glass wood brick, three elevators, and aluminum, (755 Holliday 2018).

The city of Los Angeles itself does not require a waste diversion plan for construction. The state diversion plan that comes from the green building code does not apply to building retrofits. The initiative that the general contractor took on the project the site is still meeting the 80% diversion rate that many cities and architects mandate, (755 Holliday 2018).

Before Photo

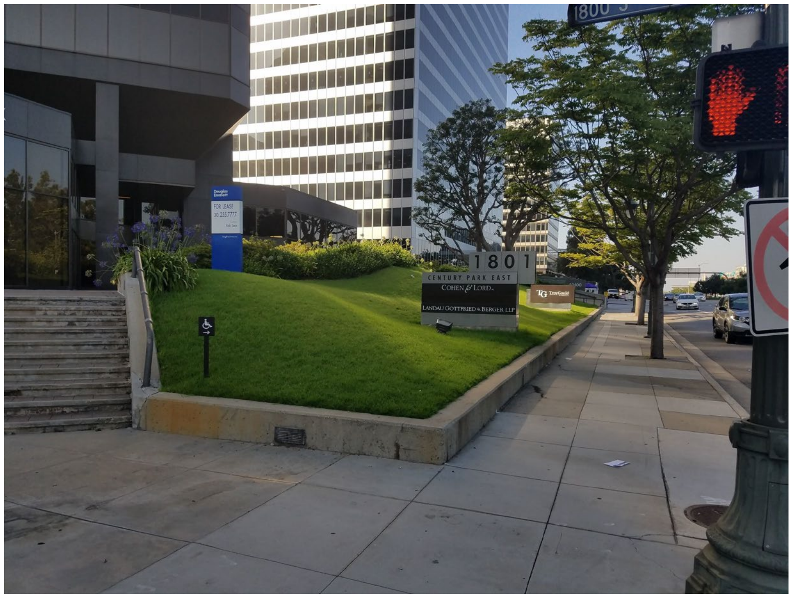
Progress Photo

The remaining non-LEED projects, while all in different cities and with different waste management requirements, were designed by the same architecture firm/ property management company. Just as an architect implemented a waste diversion requirement on the LEED, the remaining non-LEED projects were placed with the same requirement that the project must meet an 80% diversion rate of waste.

1801 Century Park East

1801 Century Park East site in Los Angeles, CA took on the challenge of having an extensive remodel. The goal of the project was to bring the interiors and exteriors to modern standards the project would fall into the LEED BD+C: New Construction rating system if it sought accreditation. The demolition scope for the 1801 project had an original estimate of roughly 4,900 tons of waste coming off the site during demolition. There were three categories that made up the waste stream. A total of 373 tons of concrete were estimated to be removed from the project. The total estimated amount of C&D waste was 917 Tons, and non-hazardous waste projected 3,594 tons, (1801 Holliday 2018).

The waste coming from 1801 was created by following concrete items: footings, slabs, staircases, building foundations, columns, beams sidewalks, street curbs gutters pavers retaining walls, planters, stairs, benches, ramps, and bollards. The C&D waste consisted of equipment pads, electrical lines, roofing system and roof-mounted equipment, HVAC, plumbing, and fire sprinkler, abandoned utilities, landscaping, interior finishes, steel, terrazzo, marble, and glass, (1801 Holliday 2018).



Before Photo

Progress Photo

10880 Wilshire Boulevard

10880 Wilshire Blvd site in Los Angeles, CA took on the challenge of having an extensive remodel very similar to the 1801 project. The goal of the project was to bring the interiors and exteriors to modern standards the project would fall into the LEED BD+C: New Construction rating system if it sought accreditation. The demolition scope for the 10880 project had an original estimate of roughly 2,640 tons of waste coming off the site during demolition.

There were two categories that made up the waste stream. A total of 1,436 tons of concrete were estimated to be removed from the project. The total estimated amount of C&D waste was 1,191 Tons. The waste coming from 1801 was created by following concrete items; footings, slabs, staircases, building foundations, columns, beams sidewalks, street curbs, gutters, pavers retaining walls, planters, stairs, benches, ramps, and bollards. The C&D waste consisted of equipment pads, electrical lines, roofing systems and roof-mounted equipment, HVAC, plumbing, fire sprinkler, abandoned utilities, landscaping, interior finishes/furniture, aluminum steel, terrazzo, marble, glass, fiberglass, and fire retardant, (10880 Holliday 2018).

Before Photo

Progress photo

401 Wilshire Boulevard

401 Wilshire Blvd site in Los Santa Monica, CA took on the challenge of having an extensive remodel similar to the previous two projects project. The goal of the project was to reuse an old retail space and convert restaurant and upgrade the plaza setting to bring the main lobby, and exterior facades were brought to modern standards. The project would fall into the LEED BD+C: New Construction rating system if it sought accreditation. The demolition scope for the 401 project had an original estimate of roughly 2,012 tons of waste coming off the site

during demolition. There were two categories that made up the waste stream. A total of 1,476 tons of concrete were estimated to be removed from the project. The total estimated amount of C&D waste was 536 Tons. The demolition waste was created by were created by following concrete items: beams, benches, pavement planters, retaining walls, driveways, sidewalks, bollards, and structural slabs. The C&D waste consisted of wood, glass, drywall/plaster, aluminum, electrical lines, HVAC, plumbing, landscaping, furniture, steel, terrazzo, marble, and fire retardant, (401 Holliday 2018).

The state, county, city, and building architects all have varying requirements on waste coming off a construction site that is more stringent than the next.

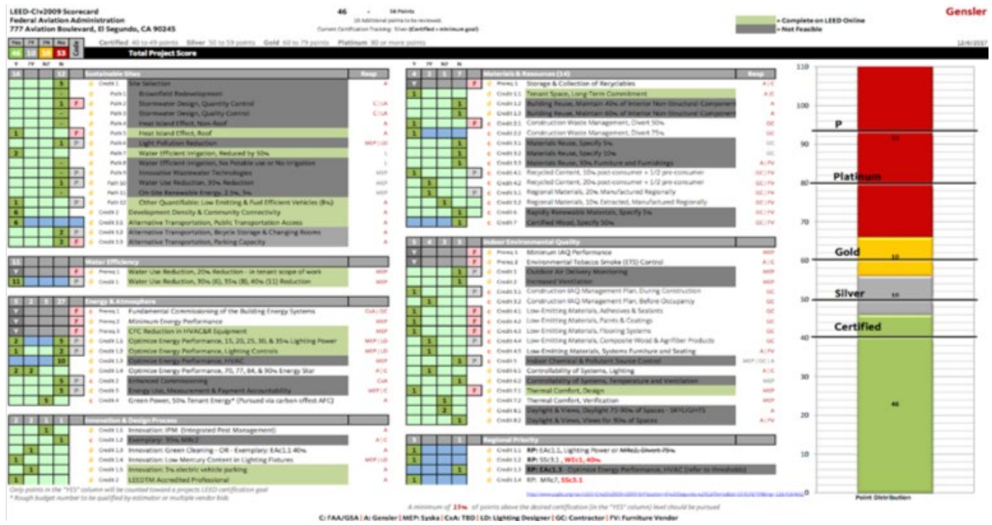
California has mandated that each construction site follows three building codes related to waste. The first code is the California Green Building Standards Code or commonly referred to CAL Green Code. The purpose of this building code is to improve "public health, safety, and general welfare by enhancing the design and construction of buildings through the use of building concepts 2016, Cal Green)." The Cal Green code only applies to use and occupancy of newly constructed building or structure, throughout the State of California (2016, Cal Green). The second code that each site must follow is 301.3.2 Waste diversion. The requirements refer back to the Division of State Architect (DSA) code 5.408. IN 2013 the DSA implemented the code 5.408 on all publicly funded projects meet a 65% waste diversion rate 2013, DSA.

Before LA County adapted the Cal Green code in January 2011, the waste requirement referred to Chapter 20.87 of the LA County Code. The code requires projects in the unincorporated areas to divert 50 percent of the debris generated during construction. Its purpose is to increase the diversion of construction and demolition debris from disposal facilities in growing and planned future cities in the county.

The LEED Waste regulation accounts for waste streams that leave a building, which correlates directly back to demolition. LEED gives credits for multiple areas the construction waste stream, the sole purpose of the credits is to cut down on waste. LEED is a global accreditation program so it must consider all economic sectors when making bench lines for credits.

777 S Aviation Boulevard

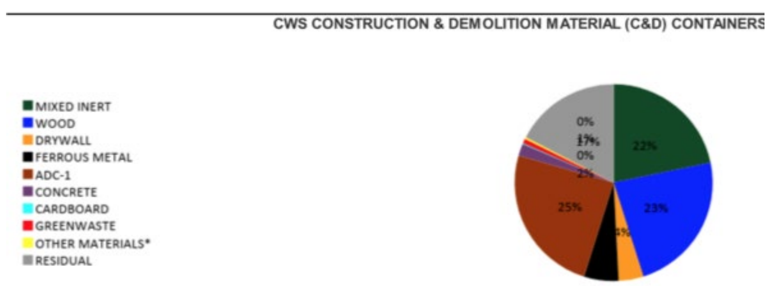
The 777 project received a LEED platinum certification with a cumulative score of 46 out of 56. The project achieved one point in the following subcategory within the materials and resources section; Construction Waste Management, divert 50%, Construction Waste Management, Divert 75%, Recycled Content, 10% post-consumer + 1/2 pre-consumer, Recycled Content, 20% post-consumer + 1/2 pre-consumer. During March 2018, the Federal Aviation Administration project had its peak demolition production. During that month a total of 130 tons were removed from the site. Of the 124 tons of Construction and Demolition waste, 6 tons were recycled, leaving only 5 tons that ended up going the landfill, (777 Pechon 2018)



During the peak time duration of demolition, the four non-LEED projects monthly waste diversion hit their respected waste diversion goals, (777 Pechon 2018).

1801 Century Park East

In June 2018, the Century Park East project had its peak demolition production. During that month, a total of 288 tons were removed from the site. Of the 288 tons created from construction and demolition waste, 283 tons were recycled, leaving only 5 tons that ended up going the landfill, (1801 Holliday 2018).



SUMMARY OF SERVICE

ALL MATERIALS	WEIGHT (TONS)	PERCENTAGE
TOTAL INCOMING	288.00	100.00%
TOTAL RECYCLED	282.72	98.17%
TOTAL RESIDUAL	5.28	1.83%

10880 Wilshire Boulevard

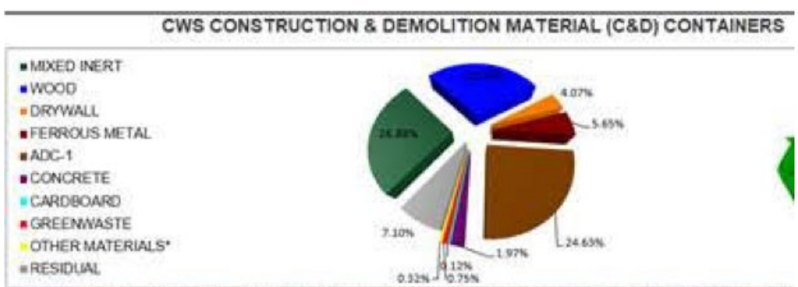
Between August 2018 and February 1 of 2019, Project 10880 accumulated 1,761 tons of waste. Waste services were able to recycle 96% of the material coming off the site. Only 83 tons of waste was diverted to the landfill, (10880 Holliday 2018).

SUMMARY OF SERVICE

ALL MATERIALS	WEIGHT (TONS)	PERCENTAGE
TOTAL INCOMING	666.98	100.00%
TOTAL RECYCLED	619.65	92.90%
TOTAL RESIDUAL	47.33	7.10%

755 South Los Angeles Street

From September 2018 to January 2019, the 755 project that did not have any LEED nor city demolition requirements created 667 tons of waste during the five months. A total of 620 tons of waste were recycled, (755 Holliday 2018).

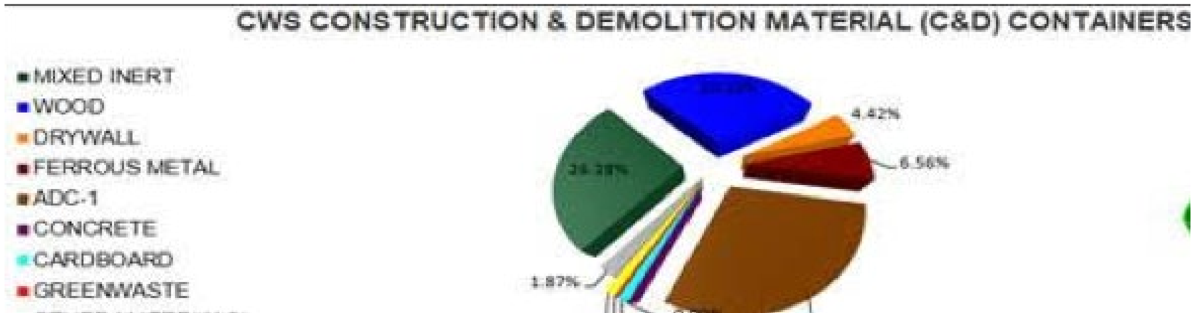


SUMMARY OF SERVICE

ALL MATERIALS	WEIGHT (TONS)	PERCENTAGE
TOTAL INCOMING	2,179.90	100.00%
TOTAL RECYCLED	2,096.63	96.18%
TOTAL RESIDUAL	83.27	3.82%

401 Wilshire Boulevard

During May 2018, the 401 project created 927 tons of waste. The city mandated 70 percent diversion rate was abided by, and 910 tons of construction and demolition waste was recycled, leaving the 17 tons to go to the landfill, (401 Holliday 2018).



SUMMARY OF SERVICE

ALL MATERIALS	WEIGHT (TONS)	PERCENTAGE
TOTAL INCOMING	927.41	100.00%
TOTAL RECYCLED	910.04	98.13%
TOTAL RESIDUAL	17.37	1.87%

XI. Recommendation/Limitation

The LEED project that was used for comparison was the FAA project which was classified under the Building Design + Construction rating system. The LEED requirement that the project received points on where to create a Construction Waste Management plan, divert 50% of the C&D waste from the landfills. The project received another point in diverting 75% of the construction waste. The overall projects produced 1130 tons of waste and diverted 87% from the landfill.

The four non LEED projects which followed city code and industry standards in demolition diverted more waste from the landfills. The non-LEED projects had their waste sorted and weighed at the same waste facility as the LEED project. During five months, the 755 project created 667 tons of waste. The 10880 project accumulated 1,761 tons of waste during a sixth month period. The amount of waste diverted was 96%. In May of 2018, the 401 project created the largest amount of waste with 927 tons. The project was able to divert 98% of its waste. The century park East project reached a 98% diversion rate when it created its largest amount of waste.

After a thorough assessment of LEED and evaluating one LEED, and four non-LEED case studies, I would recommend that LEED adapts the same requirements that Cal Green mandates for all new construction within the state and raise the prerequisite for diverting waste to 80%. LEED credits that were discussed throughout this paper should be reclassified as prerequisites rather than credits and receiving credits for reusing an existing building should not be allowed. As many cities push for developers to infill the cities and rezone areas to make it attractive for developers to develop vacant areas within the city limits, building owners can rack up credits or points for items that California is already requiring.

A limitation while conducting this research was lack of access the LEED multiple projects LEED scorecard and their waste reports. Cross-referencing the current analysis with other identified case studies with all critical values and inputs from other locations within the states to see how LEED compares to building requirements outside of California would strengthen this case study's findings. Additionally, for LEED buildings to become aggressive when it comes to demolition and sustainable, how LEED can have more stringent requirements when it comes from Construction and Demolition waste should be further investigated.

Finally, an additional analysis of waste regulations in other regions of the country should be performed to provide baseline requirements for C&D waste streams. It would be important to identify if there are common practices of methods and strategies used for demolition that are common from states to state, as LEED changes its requirements when items become common practices. If multiple regions have similar common practices, then the credits need to be changed.

XII. Conclusion

LEED is meant to accomplish global changes in the built environment and promote well-being for people by promoting building sustainability. LEED is often regarded as the leader in sustainability certification. Because it is recognized as the leader the certification has to recognize many different categories during construction. There are benefits and drawbacks with LEED certification. The overall concept and positive attributes of LEED outweigh the negative attributes.

One of the most positive aspects of LEED is the effort the United States Green Building Council keeps the certification and update their prerequisites and requirements when common practices improve in constructions areas such as methods, strategies, and technology implementations on the project. Having a universal standard of credits to receive certification Make it easy to set bench lines in each category, so every building applying to LEED knows what to except if they meet different prerequisites and requirements.

Conversely, LEED has some definite areas of opportunity in a constantly evolving world. One of the largest areas of opportunity for the attributes of the LEED certification process is the lack of requirements on what happens to the waste generated during a construction project. The way the current grading scale a project cannot take any innovative on cutting down the waste streams that end up in landfills and still gain a LEED certification by implementing strategies in other categories to pick up the missed points.

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