Sustainability Rating of Bridge Projects

Scott Snelling, PE
Parsons Brinckerhoff
New York, NY

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This presentation discusses the opportunity for sustainability rating systems to be applied to the bridge industry.

Outline

- Why Sustainability Rating
- 2 Case Study Bridges

- Comparing Sustainability Rating Systems

U.S. Department of Transportation Federal Highway Administration

Greenroads

GreenLITES Evergreen

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This presentation will use four sustainability rating systems to evaluate two case study bridges. If you don't know what a "sustainability rating system" is, that's okay; this presentation will introduce them.

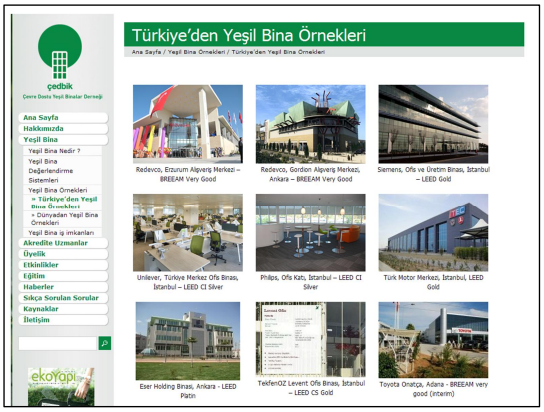
Popularity of Green Buildings

U.S. GREEN BUILDING COUNCIL LEED USGBC

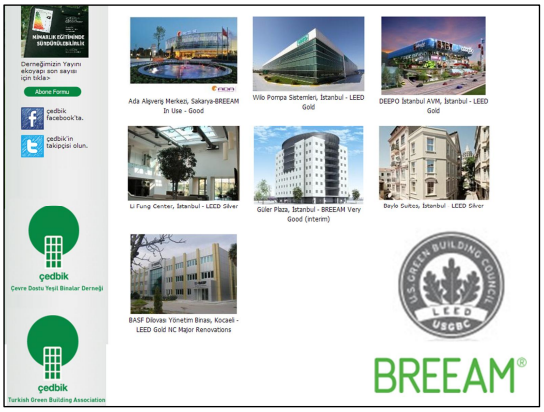
LEED Certified

-Reduce Environmental Impacts
-Energy & Water Efficient
-Recycled Materials
-Sustainable Site Locations
-Construction Impact Mitigation
-High Performance Buildings

LEED certification has succeeded in becoming a mainstream and growing force within the occupied building market.



There are green buildings in Turkey.



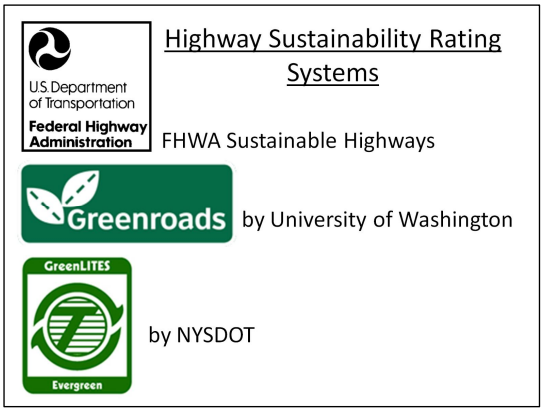
There are green buildings in Turkey.

Bridge owning organizations have built hundreds of LEED certified green buildings.

These bridge owners are likely to begin applying the newly available highway/infrastructure sustainability rating systems to their bridge projects.

LEED: The success of LEED, as applied to occupied green buildings, has been successful. There is now a push to achieve analogous success for infrastructure projects. Recent bridge RFP (Request For Proposal) have required the application of LEED principles, even though it is not always clear how to do this.

The terminology “Sustainable”, instead of “Green”, is preferred for Infrastructure.



Three different Sustainability Rating Systems for Highways are available that can be applied to bridge projects, with reasonable results. Rating systems provide a standard for defining sustainability.

Sustainability Rating Systems are checklists of accepted best practices.

Infrastructure Sustainability Rating System

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envision™

partnership of ASCE, ACEC, & APWA

available for Public Comment thru 2011

ISI has taken an inclusive approach to rating civil engineering infrastructure. This rating system seeks to rate: dams, highways, powerplants, bridges, water treatment facilities, etc. Envision was released for public comment through 2011 and can be used for rating projects on a pilot basis.

The case study bridges were scored (points tallied) using envision, however, ISI has not yet published the method for translating the numerical score into a rating (bronze, silver, gold, etc).

Federal Funding of Transportation Infrastructure

RECOVERY.GOV

USDOT TIGER DOT.GOV

Selection Criteria Include:

· **Sustainability**

· Livability

$2.1 Billion 2010

The need for quantifying sustainability is being driven by the federal government, which is using sustainability as criteria for deciding which projects receive funding.

- American Recovery and Reinvestment Act of 2009 made $275 billion available for federal contracts, grants and loans; $38 Billion to be awarded by USDOT.
-Transportation Investment Generating Economic Recovery (TIGER) Grants of 1.5 Billion were awarded in February, 2010
- TIGER II grants added additional $600 Million

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Outline

⊙ Why Sustainability Rating

● **2 Case Study Bridges**

Overview and Results
Recycled Materials
Context Sensitive Solutions

Alternative Transportation
Lifecycle
Habitat & Ecological Connectivity

⊙ Comparing Sustainability Rating Systems

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The author's employer, Parsons Brinckerhoff, designed both of the case-study bridges. However, the author was not directly involved with either project.

Arthur Ravenel Jr. Bridge

or Cooper River Bridge

· Located in Charleston, South Carolina
· Completed construction in 2005
· Longest Cable Stay Bridge in N. America

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The design and construction of the Arthur Ravenel Bridge predates the creation of highway or infrastructure Sustainability Rating Systems. However, the project implemented many best practices that are encouraged by Sustainability Rating Systems.

St. Croix River Bridge

- Connects Stillwater, Minnesota to Wisconsin
- Preliminary design completed 2010
- Crosses National Wild & Scenic River
- Opposed by Sierra Club

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The project is currently stalled in response to a lawsuit by the Sierra Club environmental group and is awaiting special permission from US Congress to proceed. Local congress-persons, both Replublican and Democrat (including Michelle Bachman and Al Franken), support the project.

Results of Case Study

U.S. Department of Transportation Federal Highway Administration	· 57 of 117 Silver	74 or 117 Platinum
Greenroads	· 38 of 118 Certified*	46 of 118 Silver*
GreenLITES Evergreen	· 63 of 276 Evergreen	62 of 276 Evergreen

Case Study ratings were performed by the author based on the best available information, including interviews with the project engineers. Any errors in the project ratings are the sole responsibility of the author.

*While sufficient credits were earned to qualify for a Greenroads award, not all of the pre-requisites were met. Specifically, the Ravenel Bridge and the St. Croix Bridge did not meet PR-3 Life Cycle Inventory. Ravenel Bridge also did not meet the PR-8 Feasibility Study for Low Impact Development.

Selected Credits from Sustainability Rating Systems

- Recycled Materials
- Context Sensitive Solutions
- Alternative Transportation
- Construction Waste, Noise, Dust
- Life Cycle Assessment and Cost
- Stormwater
- Ecological Connectivity
- Habitat Restoration

Regardless of which rating system(s) gain(s) predominance within the bridge industry, there are common themes. This presentation will touch on a few of these common themes.

Results for Recycled Materials

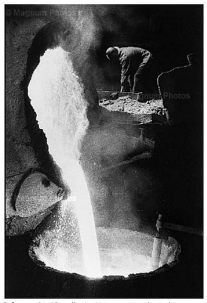
U.S. Department of Transportation Federal Highway Administration	· 6 points 13% Silver	7 points 15% Silver
Greenroads	· 3 points 7% Silver	3 points 7% Silver
GreenLITES Evergreen	· 0 points 0% Silver	0 points 0% Silver

Both bridges specified concrete mixes with fly ash and blast furnace slag.

Recycled Materials

- Steel
- Concrete
- Wearing Surfaces
- Plastic Lumber & Piles

Recycled Materials - Steel



96% Recycled Content in USA

Reference: Steel Recycling Institute, www.recycle-steel.org
Photo reference: Magnum Photos, Eugene Smith

59% Post-Consumer content, per SRI
Economically driven recycling due to scrap value of 0.25$ per pound.
No opportunity for bridge engineers to specify "green" steel; all steel structures receive credits for recycled content.

Recycled Materials - Concrete

Recycled Aggregate:

Tailings, Synthetics, RCP

Photo: flickr.com kuinsy13

Photo: Library of Congress

Pozzolan Cements:

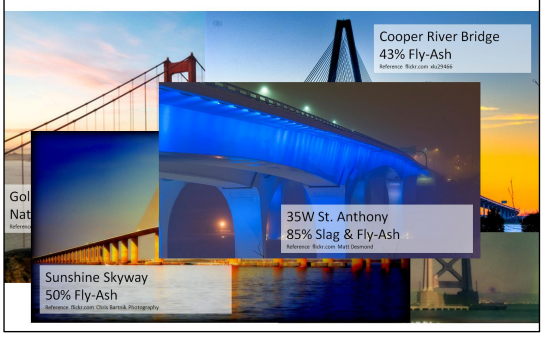
Fly-Ash, Slag, & Flume Ash

Concrete can be crushed and recycled as aggregate or fill, but has no scrap value. Recycled or by-products, such as mine tailings, can be used instead of virgin aggregate.

The greenhouse gas emissions and energy use associated with concrete vary drastically depending on the mix used. Portland cement is energy intensive to produce and is responsible for 5% of the world's CO_2 emissions. China is the world's largest CO_2 emitter, with 20% attributed to its cement kilns. Portland Cement emits more than one ton of carbon dioxide for every ton of cement produced.

Pozzolan cements have zero carbon emissions to produce, since they are industrial by-products. Unlike Portland cement, pozzolans have no carbon emissions associated with calcination. The bridge industry has used pozzolan cements as an admixure to Portland Cement for more than 50 years. Typical bridge concrete specifications currently call for an admixture of 10% to 15% pozzolan cement to be blended with Portland. The majority of industrial by-product pozzolans continue to be landfilled, and there is opportunity for bridge engineers to specify higher percentages of pozzolan cement.

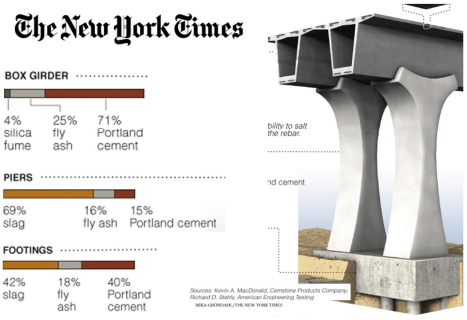
Concrete – Pozzolan Cement



High percentages of pozzolan cement have primarily been used on design build projects where they were chosen as the lowest priced concrete with the required physical properties. Decreased energy use, greenhouse gas emissions, and land fill use were merely happy side-effects.

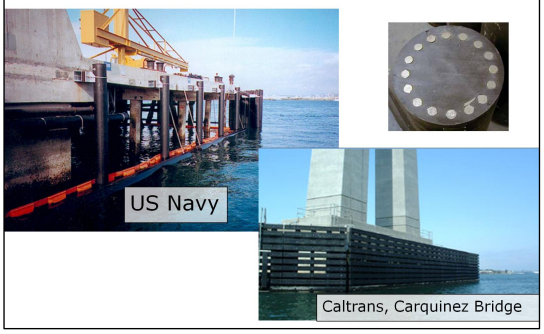
The low permeability of the pozzolan blend concrete for Cooper River Bridge allowed the use of uncoated rebar to meet a 100 year design life.

Concrete – Pozzolan Cement



The 35W bridge got positive attention from the mainstream media for using "green" concrete.

Recycled Materials – Plastic Piles



US Navy uses recycled plastic piles at installations around the world to replace timber fender systems. Per Alling (1998) of the Naval Postgraduate School, while the initial material costs of plastic piles are approximately double of timber, the plastic piles have significantly lower life cycle costs due to decreased maintenance and replacement costs. Recycled plastic piles last double to ten times longer and are more energy absorbing.

Recycled Materials – Plastic Lumber

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Bridge using structure of recycled plastic lumber was constructed at Fort Bragg in 2009. Designed by Parsons Brinckerhoff.

More recent rail bridges have been constructed. Max spans are currently about 65 feet, but longer spans will be possible in the future.

Results for Context Sensitive Solutions

U.S. Department of Transportation Federal Highway Administration	· 5 points 11% Silver	5 points 11% Silver
Greenroads	· 5 points 13% Silver	5 points 13% Silver
GreenLITES Evergreen	· 9 points 30% Silver	7 points 23% Silver

Context Sensitive Solutions is a process of fostering communication between project stakeholders to strive for consensus in project decision-making.

Ravenel Bridge: Community meetings and community bridge office at the site. Design changes based on stakeholder dialog: pedestrian and bicycle lane, lighting improvements, and selecting the diamond tower design among other options.

St. Croix Bridge: Public open house was held. A visual quality review committee, with member participation from the stakeholder groups, was established.

Context Sensitive Solutions

Cooper River Bridge (Arthur Ravenel Bridge), Charleston, South Carolina

The existing steel truss bridge did not include bike or pedestrian access. The new bridge was not initially planned to include bike or pedestrian access. However, the project used a Context Sensitive Solutions process . The local community pushed for and succeeded in getting bike and pedestrian access added to the project.

The bike and pedestrian way has become extremely popular. This is an example of the process working.

Results for Alternative Transportation


U.S. Department of Transportation Federal Highway Administration	· 4 points 9% Silver	4 points 9% Silver
Greenroads	· 4 points 9% Silver	4 points 9% Silver
GreenLITES Evergreen	· 21 points 70% Silver	25 points 83% Silver

Alternative transportation credits encourage modes other than single occupancy motor vehicles, including pedestrians, cyclists, busses, transit, freight, car pools, and low-emission vehicles. Both case study bridges received credits for providing a combined sidewalk/cycle path.

Results for Construction Waste Management


U.S. Department of Transportation Federal Highway Administration	· 1 point 2% Silver	0 points 0% Silver
Greenroads	· Pre-requisite	Pre-requisite
GreenLITES Evergreen	· 3 points 10% Silver	0 points 0% Silver

After building the new Ravenel Bridge, the existing bridges were demolished using explosives. More than 80% of the material from the demolished bridges was barged to sea to create artificial reefs.

Design for Deconstruction

Cooper River Bridge
Charleston, South Carolina

Jamestown Bridge
Rhode Island

There are opportunities for sustainability rating systems to encourage bridge designers to think more about the end of the lifespan. To shift the mindset from building for posterity, to one of a finite service life.

Results for Ecological Connectivity


U.S. Department of Transportation Federal Highway Administration	· 6 points 13% Silver	0 points 0% Silver
Greenroads	· 3 points 7% Silver	0 points 0% Silver
GreenLITES Evergreen	· 6 points 14% Silver	6 points 14% Silver

The Ravenel bridge: bridge lights were designed to minimize potential impacts on nesting loggerhead sea turtles and migratory birds.

Results for Habitat Restoration


U.S. Department of Transportation Federal Highway Administration	· 6 points 13% Silver	0 points 0% Silver
Greenroads	· 3 points 7% Silver	0 points 0% Silver
GreenLITES Evergreen	· 6 points 14% Silver	6 points 14% Silver

Ravenel Bridge: After construction, disturbed wetlands were restored to their natural condition and sections of the old bridges were excavated and rehabilitated to wetlands. In areas where wetlands could not be restored, mitigation banks were created. Twenty mature trees affected by the project were relocated.

Results for Life Cycle Cost Analysis & Life Cycle Assessment


U.S. Department of Transportation Federal Highway Administration	· 1 points 2% Silver	1 points 2% Silver
Greenroads	· 4 points 9% Silver	4 points 9% Silver
GreenLITES Evergreen	· Not Applicable	Not Applicable

Both projects used life cycle cost analysis during the type study phase to evaluate competing alternatives.

Neither project performed a life cycle assessment to estimate embodied energy or greenhouse gas emissions.

Maintenance

1% Reconstruction Cost, Annually

- Painting
- Cleaning
- Deck Repair
- Scupper Work
- Joint/Bearing Repair

Per Yanev, "Bridge Maintenance"

In other words: A $100M bridge will cost $1M per year to maintain (and further increasing with inflation). This means that over a 100 year bridge life, the resources used to maintain a bridge will of the same magnitude as the resources used to build it.

Designs that reduce maintenance, can have a great effect on reducing life cycle costs and resource use. Concrete and weathering steel eliminate painting (confinement for re-painting is very expensive and resource intensive).

Using flexible/integral piers can eliminate joints and bearings.

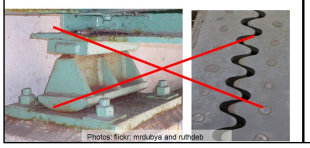
Maintenance

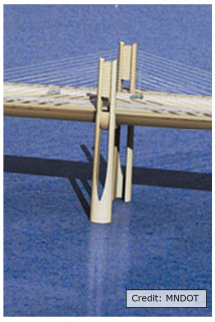
St. Croix River Bridge

· Jointless

· Bearingless

· Paintless





Joints, bearings and paint are high-maintenance items and best eliminated, when possible.

St. Croix Bridge: the intermediate piers are integral with the deck. Deflections due to temperature, creep, and shrinkage are accommodated by flexibility of the piers.

Good detailing is an important contributor to bridge durability, but is not able to be scored by existing Sustainability Rating Systems.

Outline

⊙ Why Sustainability Rating

⊙ 2 Case Study Bridges

Overview and Results
Recycled Materials
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Lifecycle
Habitat & Ecological Connectivity

● **Comparing Sustainability Rating Systems**

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Type of Assessor

U.S. Department of Transportation Federal Highway Administration

· Self-Assessment by Project Team

Greenroads

· 3rd Party

GreenLITES Evergreen

· Self-Assessment by NYSDOT Department

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· Independent Auditor

Time to Rate

U.S. Department of Transportation Federal Highway Administration

· 8 Person-Hours

Greenroads

· 80 Person-Hours

GreenLITES Evergreen

· 8 Person-Hours

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· 40 Person-Hours

Fees to Rate - $100M Project

· Free

· $5,000 to $35,000

· Free
to Projects in New York

· to be determined

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Conclusions / Recommendations

· Sustainability Rating Systems are checklists of best practices.

· Functions
- Guidance to design/planning process
- Spur innovation, lessons learned
- Communicate Quality to public

Sustainability Rating Systems are a useful tool that have succeeded in the green building industry and have potential to succeed in the bridge industry.

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Conclusions / Recommendations

· Easy and Informative

· Challenging and Authoritative

· Only available in New York
Most bridges rate Platinum

· Has Potential

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