SUSTAINABILITY IN TRANSPORTATION INFRASTRUCTURE

Sustainability in transportation infrastructure refers to the broad field of making transportation networks sustainable economically, socially, and environmentally. It is part of the broader issue of transportation sustainability, which also examines the users and vehicles in transportation systems.[1] Transportation infrastructure sustainability is closely related to other similar fields, such as urban planning, fossil fuel use, technological development, and safety. Transportation infrastructure sustainability is an issue that guides policy makers and engineers worldwide, and has generated a wide range of solutions including bike lanes, public transportation, public escalators, and pavement recycling.

Improving Sustainability

Sustainable transportation corridors often provide facilities for cars, pedestrians, and bicycles. (image: Wikimedia Commons)

Transportation sustainability aims to ensure the transportation network continues to serve the population now and well into the future.[2] This leads to a variety of goals, including improved accessibility, mobility, safety, security, equity, resource use, land use, noise levels, ecosystem impact, and livability.[3] Many of these goals seek to make transportation a more pleasant and enjoyable experience for the public while reducing dependence on personal automobile usage. The current drive for sustainability is largely centered around improving the livability of cities and reducing energy usage.

In the area of social sustainability, reduced dependence on automobiles is becoming an important point of discussion. Many Western cities have become auto-dependent and some scholars note concern on how this affects low-income residents who do not have access to personal automobiles.[4] These residents, known as Transportation Disadvantaged groups, can be negatively affected by sprawling cities and limited public transportation.[5] Providing good transportation options for these groups is an important component to sustainable transportation infrastructure.

While attention is commonly given to vehicle emissions, a significant amount of energy usage and emissions are due to infrastructure construction and maintenance. Life-cycle analysis can help identify these causes. In infrastructure, the additional energy and emissions requirements range from 31% of tailpipe emissions in air travel to an additional 155% of tailpipe emissions in rail.[6] These additional energy requirements are due to vehicle manufacture, system maintenance, construction, and other miscellaneous factors.[7] Awareness of these factors is designed to help mitigate overall environmental impacts from transportation infrastructure.[8]

History

Urban sprawl was a factor in bringing attention to sustainable transportation infrastructure (image: Wikimedia Commons)

Recent interest in sustainable transportation began in the 1970s when observers noted that the world's current rate of development was unsustainable.[9] A significant reason for this was the rise of the automobile, which was recognized as a feature of unsustainable urban environments.[10] Heavy automobile usage in cities encourages road congestion, resulting in delays and lost productivity. In many cities, the widespread use of automobiles has led to urban sprawl which often increases trip distances. The energy crisis of the 1970s also helped to bring the sustainable transportation movement to public attention, giving the movement a start.[11] Since that time in the United States, walking and biking infrastructure has developed, with more emphasis on good land development.[12] Many cities have constructed new light rail and train networks and increased bus service.

Solutions

A variety of design solutions have been tried across the world to promote sustainability in transportation. These solutions incorporate a variety of innovations, but generally focus on reducing private automobile usage and increasing bicycle, pedestrian, and public transportation. The level of investment in these additional means of infrastructure can vary, and many cities built public transportation systems long before sustainable transport became an issue. Expanding public transportation is a common solution that can help increase social sustainability by providing reliable transportation for Transportation Disadvantaged groups.[13] Public transportation can include a variety of modes, such as light rail, bus rapid transit, and bike-sharing programs.

International

In Scotland, sustainability strategies aim to reduce personal car use and encourage public transportation as well as reduce the need for long trip distances.[14] In the Netherlands, highways and parking lots are sometimes buried underground to allow development overhead.[15] Additionally, new development is limited so as to encourage maximum benefit from existing infrastructure.[16] Pedestrian and bicycle traffic is encouraged through an extensive transportation network designed for these modes and traffic calming measures designed to make travel safer.[17] In Europe, roadways are commonly designed around a particular speed, with emphasis on the roadway design as a means to control driver speed.[18] Bus rapid transit has been particularly successful in Latin America, where routes can be constructed relatively cheaply and separate buses from regular traffic.[19]

Technology

Transportation infrastructure sustainability is not limited to infrastructure design, but also includes the materials used in construction. For example, asphalt concrete is a common pavement used for roads and uses petroleum products as a binder, thus limiting its long-term sustainability. Much research has been done in the area of pavement recycling, and as a result, about 100 million tons of asphalt are recycled each year in the United States.[20] Recycled asphalt can be used both as a pavement base and also remixed into new asphalt concrete batches, helping to reduce the rate of asphalt consumption.[21]

Construction

Construction of sustainable transportation infrastructure generally involves common construction methods applied to new designs. In many instances, new transportation corridors are unnecessary. Existing corridors can be modified or rebuilt to accommodate alternative means of transportation. For example, streets can be reconfigured to convert traffic lanes to wider sidewalks, which encourages foot and bicycle traffic.[22] This type of construction is not technically challenging and can be done using existing methods and technology. Roundabouts are another solution that require some reconstruction but offer sustainability benefits. Roundabouts reduce delays, reduce fuel consumption, and improve safety at intersections.[23]

Complete Streets

One increasingly popular policy and design principle is complete streets (also known as livable streets). Complete street design methodology encourages engineers to design streets with a variety of users and transportation modes in mind. Complete streets are varied and can incorporate a variety of constructed features, but generally include good pedestrian corridors, bike lanes or bikeways, public spaces, and public transportation stops. Evidence also exists that complete streets improve neighborhood health, economic vitality, and transport safety.[24] Of particular interest to engineers is the evidence that complete street design improves safety despite design features that normally are considered unsafe, such as narrower lanes, obstacles within the clear zone, and roadside parking.[25] This may be due to increased driver awareness and attention to roadway conditions.[26]

Example

Medellin public escalator (image: Municipality of Medellín)

One example of a city that has incorporated sustainability into its transportation planning is Medellin, Columbia. Medellin once was home to the intense Colombian drug war, but thanks to a large citywide revitalization project, crime has been drastically reduced and the city is experiencing economic growth. A significant reason for this success is the effort Medellin has put into providing efficient public transportation in poor neighborhoods. Medellin has installed a 1200-foot long outdoor escalator in one of its poorer neighborhoods to shorten commute times by nearly a half hour and improve access to the hillside community.[27] Other transportation projects in the city have built cable car systems to connect poor neighborhoods with the main city. Medellin also features a bus rapid transit system and metro rail. For these and other efforts, Medellin received the Institute for Transportation & Development Policy's*Sustainable Transport Award* in 2012.[28] These efforts have helped the social sustainability of the city.

Research Trends

Much research is currently examining ways to modify existing infrastructure to improve sustainability. Examples include placing solar panels on parking lots to provide shade and generate power, building a car charging network for electric cars, and introducing bike and pedestrian infrastructure into existing streets and greenways. Researchers are also working on innovative designs to capture energy from cars, such as the proposed Cross-Wind Bridge in Lisbon, Portugal. The Cross-Wind Bridge, a pedestrian/bike bridge over a busy highway, would capture wind from passing automobiles to help generate electricity to light the bridge at night.[29] This would allow to bridge to not only recapture energy from passing automobiles, but also develop the local bicycle and pedestrian infrastructure.

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