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Low-Stress Bicycling and Network Connectivity

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16. Abstract

For a bicycling network to attract the widest possible segment of the population, its most fundamental attribute should be low-stress connectivity, that is, providing routes between people's origins and destinations that do not require cyclists to use links that exceed their tolerance for traffic stress, and that do not involve an undue level of detour. The objective of this study is to develop measures of low-stress connectivity that can be used to evaluate and guide bicycle network planning. We propose a set of criteria by which road segments can be classified into four levels of traffic stress (LTS). LTS 1 is suitable for children; LTS 2, based on Dutch bikeway design criteria, represents the traffic stress that most adults will tolerate; LTS 3 and 4 represent greater levels of stress.

As a case study, every street in San Jose, California, was classified by LTS. Maps in which only bicycle-friendly links are displayed reveal a city divided into islands within which low-stress bicycling is possible, but separated from one another by barriers that can be crossed only by using high-stress links. Two points in the network are said to be connected at a given level of traffic stress if the subnetwork of links that do not exceed the specified level of stress connects them with a path whose length does not exceed a detour criterion (25% longer than the most direct path). For the network as a whole, we demonstrate two measures of connectivity that can be applied for a given level of traffic stress. One is "percent trips connected," defined as the fraction of trips in the regional trip table that can be made without exceeding a specified level of stress and without excessive detour. This study used the home-to-work trip table, though in principle any trip table, including all trips, could be used. The second is "percent nodes connected," a cruder measure that does not require a regional trip table, but measures the fraction of nodes in the street network (mostly street intersections) that are connected to each other. Because traffic analysis zones (TAZs) are too coarse a geographic unit for evaluating connectivity by bicycle, we also demonstrate a method of disaggregating the trip table from the TAZ level to census blocks. For any given TAZ, origins in the home-to-work trip table are allocated in proportion to population, while destinations are allocated based on land-use data. In the base case, the fraction of work trips up to six miles long that are connected at LTS 2 is 4.7%, providing a plausible explanation for the city's low bicycling share. We show that this figure would almost triple if a proposed slate of improvements, totaling 32 miles in length but with strategically placed segments that provide low-stress connectivity across barriers, were implemented.

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