Cut-and-Cover Tunnel Structures

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INTRODUCTION

Shallow-depth tunnels, such as large sewer tunnels, vehicular tunnels, and rapid transit tunnels, are frequently designed as structures to be constructed using the cut-and-cover method. Tunnel construction is characterized as “cut-and-cover” construction when the tunnel structure is constructed in a braced, trench-type excavation (“cut”) and is subsequently backfilled (“covered”). For depths up to 35–45 ft this method is often cheaper and more practical than underground tunneling, and depths of 60 ft or more are quite common for rapid transit cuts. This chapter discusses the design and construction of the larger cast-in-place concrete structures used as sewer tunnels or transportation tunnels for pedestrian, vehicular, or rapid transit traffic. The tunnel is typically designed as a box-shaped frame, and due to the limited space available in urban areas, it is usually constructed within a braced excavation. Where adequate space is available, such as in open areas beyond urban development, it is often more economical to use open-cut construction. Where the tunnel alignment is beneath a city street, cut-and-cover construction interferes with traffic and other activities. This disruption is lessened through the use of decking over the excavation, placed immediately following removal of the first lift of excavation. The deck is left in place with construction proceeding below it until the stage is reached for final backfilling and surface restoration. Figures 17-1-17-4 show cross sections of the more common types of cut-and-cover tunnel structures.

In this chapter, discussions or characterizations of usual practice in the design and construction of cut-and-cover tunnel structures refer generally to practice in the United States. The design and construction of these structures in Canada, Mexico, Europe, Asia, and elsewhere abroad is similar in many respects, but it can differ in many respects as well.

Subway Line Structures

In cut-and-cover construction between stations, the subway tracks are usually enclosed in a reinforced concrete double box structure with a supporting center wall or beam with columns. These tunnel structures are commonly referred to as “line” structures. The track centers are normally located as close together as possible. In a typical double box section, each trainway will have a clear width of about 14–15 ft, depending upon width of vehicle and clearances to be provided for equipment and manways (see Figure 17-1). The configuration of subway line structures can depart from the typical section to accommodate atypical track alignment or grade. When, for example, system standards mandate that stations be designed with a center platform (see below), the track centers will need to be widened through an appropriate transition length upon approaching the station. Occasionally, it will be advantageous or necessary to gradually change the alignment and grade to the “over and under” position, in which one track lies above and in line with the other. In general, the configuration of the subway line structure must be subordinate to system requirements for track alignment and grade.

Subway Stations

Station structures include the trainway for trains, boarding and off-boarding platforms, stairs, escalators, concourse areas for fare collection, and service rooms. If the line structure is two circular tunnels constructed by tunneling methods, the station may be designed with a single center platform. If the line structure is a cut-and-cover double box subway line structure, the station is usually of the side platform type, except at terminals where center platforms are normally used to comply with system standards.

The usual perception of a cut-and-cover subway station is that of a two- or three-story reinforced concrete structure constructed in a rectangular excavation 50–65 ft wide, 500–800 ft long, and 50–65 ft deep. Typically, the station is a two-story structure with two tracks, as well as the center or side platforms, supported on the invert. A mezzanine floor typically lies between the roof slab and the invert/platform level. Figure 17-2 shows a basic cross section at the 7th/Flower Sta-
tion, constructed for the Los Angeles County Metropolitan Transportation Authority (MTA).

The complete subway station will be much more complex than is indicated by Figure 17-2. Internal configuration will be significantly affected by the need to provide escalators, stairs, ventilation requirements, rooms for mechanical and electrical equipment and other maintenance, and safety and service facilities. Architectural treatment of the station will also affect internal configuration and may have an im-

Fig. 17-3. Cross section (varies), double box configuration, Central Artery, Boston.

Fig. 17-4. Typical cross section, 20 ft transport/storage sewer tunnel, San Francisco Clean Water Program.

portant effect on the design of the basic structure as well. The external configuration of the station will ordinarily be irregular at and above the mezzanine level, where station entrances must be provided.

Although the two-story station may be considered conventional, more complex station structures are not unusual, particularly in and near the center of urban areas. At these locations the subway stations may be constructed at the intersections of principal system trainway lines, for example.