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Design Strategies for Landscape Transformation of Abandoned Railways in Urban Centers

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Abstract The railways have significantly contributed to the economic development of the city. However, with the evolution of the city and adjustments in the industrial structure, the relocation and rerouting of major railway trunk lines have resulted in the abandonment of numerous urban railways. The abandoned railways, resulting from inadequate management, have transformed into sites for waste disposal and are particularly vulnerable to environmental issues, including land pollution, degradation of vegetation cover, and a decline in ecological diversity. Abandoned railways in urban centers significantly hinder transportation connectivity and adversely influence the aesthetic appeal of the city. The landscape transformation of these abandoned railways is of paramount importance in the context of urban renewal. These railway sites possess significant potential for stock utilization as specialized, underutilized spaces. Through the processes of re-planning, integration, and renewal, previously underutilized spaces can be revitalized and incorporated into the urban landscape in innovative ways. This approach not only enhances the availability of green leisure areas for residents but also contributes to the realization of sustainable urban development.

Keywords Urban center, Transformation of abandoned railway, Abandoned railway landscape
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In the context of rapid urban development, the railway, which was initially situated on the outskirts of the city, has progressively become enveloped by urban expansion and is now closely integrated with the urban center. This type of abandoned railway spaces is predominantly linked to human activity due to the high foot traffic and dense construction in urban centers[1]. The majority of these railways have made substantial contributions to urban development, possessing significant historical and cultural value, along with a unique industrial character, which renders them inappropriate for large-scale demolition[2]. Consequently, the transformation of abandoned urban railways is predominantly oriented towards heritage transformation. This approach emphasizes the preservation of industrial relics, acknowledges the historical continuity of the site, and integrates the requirements of urban development. As a result, these spaces are transformed into recreational trails, distinctive parks, commercial streets, and other public activity areas that exhibit unique characteristics[3]. This study presents a comprehensive analysis of the utilization of abandoned railway spaces within urban centers, and proposes landscape transformation strategies tailored to the distinct characteristics of various sections of the railway. The objective is to facilitate the rational use of these spaces while preserving historical and cultural heritage.

1 Elaboration of relevant concepts

The urban center serves as the economic, political, and cultural nucleus of the city, characterized by the highest frequency of social and economic activities, as well as the most significant capacity for employment attraction and radiation. The urban center not only emphasizes the historical character of the city but also serves as a significant conduit for the city to present itself to the external world. In comparison to other regions of the city, the urban center is characterized by a diverse range of uses, convenient transportation options, and a high density of land development. These factors collectively contribute to the urban center's unique and significant status.

The abandoned railway landscape constitutes a comprehensive landscape system that encompasses both the abandoned railway and the surrounding landscape along its route[4]. This system can be categorized into two distinct components. The first component encompasses the abandoned railway and the internal landscape of its associated train, which, with their unique historical remnants and industrial characteristics, contribute significantly to the transformation of the landscape. The second component pertains to the external landscape adjacent to the abandoned railway, which includes human-made features such as railway stations and supporting infrastructure, as well as naturally occurring elements such as water bodies, vegetation communities, and other natural landscapes. Collectively, these elements create a rich, diverse, and stratified external landscape. The railway possesses characteristics akin to a landscape belt, characterized by sequences and spans; therefore, the renovation should be classified as an urban linear landscape green belt[5].

Landscape transformation refers to the process of implementing essential modifications or alterations to the existing landscape in order to accommodate emerging forms and requirements, thereby resulting in a distinctly new visual representation of the landscape. The renovation of abandoned railways has the potential to address significant environmental issues while simultaneously revitalizing urban landscapes. This process can infuse new vitality and aesthetic appeal into the city, transforming these areas into notable features of urban development.

2 Existing problems and development potential of abandoned railways in urban centers

2.1 Existing problems of abandoned railways in urban centers

2.1.1 Constraining the pace of urban development. Following the abandonment of the

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railway, a lack of effective supervision can lead to the area becoming a repository for waste accumulation. This situation not only significantly deteriorates the quality of the living environment for local residents but also adversely affects the overall image of the city, resembling a conspicuous "scar", thereby hindering the healthy development of urban areas[6]. Furthermore, abandoned railways, due to their unique elongated and narrow configuration as well as their enclosed nature along the route, frequently obstruct the spatial connectivity between land parcels situated on either side of the railways. This obstruction contributes to the stagnation of development in these areas, hindering their progress relative to the overall growth of the city. Consequently, this phenomenon has emerged as a significant factor impeding the healthy and orderly development of urban environments.

2.1.2 Impeding the smooth flow of urban traffic. The majority of the abandoned railways were constructed many years ago. These railway lines, initially situated on the periphery of the city, have been progressively enveloped as urban land use has continued to expand. When a train passes through a level crossing in the city, vehicles and pedestrians are required to temporarily halt and wait. This situation undoubtedly creates a disruption to the daily travel of the public. Some of the abandoned railway tracks, which could not be removed in a timely manner due to various factors, have become embedded in the pavement and are interspersed throughout the city's roadways. The presence of such obstacles significantly disrupts the smoothness of roadways, introduces potential safety hazards to urban traffic operations, and hinders the seamless connectivity of the urban transportation network. Consequently, these issues represent a critical weakness in urban management and development.

2.1.3 Leading to idle land resources. The rapid urbanization in China has led to a significant contradiction between the supply and demand for land resources, which has emerged as a critical bottleneck hindering the urbanization process. Railways, as critical infrastructure, have occupied significant land resources. However, when the railways were abandoned, the associated land resources, despite being theoretically available for redevelopment, could not be effectively planned and remediated. This was primarily due to issues such as complex ownership structures and ambiguous remediation protocols. The presence of abandoned railway tracks extending throughout the city for an extended period not only detracts from the overall aesthetic of the urban environment but also contributes to the underutilization and wastage of valuable urban land resources[7]. Consequently, it is of considerable importance to thoroughly investigate the potential of abandoned railway lands and to utilize these underutilized areas judiciously in order to facilitate the continued development of the city.

2.1.4 Damaging the urban environmental ecology. The abandoned railway site, owing to its remote location and insufficient oversight, is particularly vulnerable to being utilized as a dumping ground for both domestic and construction waste by local residents and unscrupulous waste disposal companies. The accumulation of waste at this site has persisted for an extended period, leading to the proliferation of mosquitoes and flies. This situation has resulted in a foul-smelling atmosphere, which not only significantly undermines the hygienic conditions and overall image of the city but also poses a considerable challenge for urban management. The more pressing concern is that the pollutants generated infiltrate the soil, resulting in detrimental effects on the ecosystem. This contamination adversely impacts the living conditions of both flora and fauna, while also posing a potential threat to the construction of the urban ecological environment and the health of nearby residents.

2.2 Potential for abandoned railway development in urban centers

In the process of adjusting urban structures, functions, and positioning, an increasing number of railway lines are being relocated and rerouted to accommodate urban development needs. This has led to the abandonment of a significant number of urban railways. The *Regulations on Railway Safety Management* in China mandate the establishment of safety protection zones adjacent to the railway. These protection areas, located on both sides of the railway, are designated as railway land, prohibiting the unauthorized construction of structures. This regulation aims to effectively mitigate external factors that may disrupt railway operations and to minimize safety hazards associated with railway transportation (Table 1). However, this phenomenon has resulted in the accumulation of significant amounts of unused space surrounding abandoned railways. These underutilized areas represent valuable land resources in urban centers, where land is scarce, and they offer promising opportunities for urban renewal and development.

From the standpoint of spatial utilization, the linear configuration of abandoned railways provides a distinct advantage within urban centers. Through systematic planning and design, these abandoned railways can be repurposed into urban greenways, recreational trails, or specialized parks, thereby creating diverse public spaces for community use. Such a transformation will not only improve the ecological quality of the city but will also enhance the sense of belonging and well-being among its citizens.

From the standpoint of economic development, abandoned railways serve as significant carriers of urban history, offering valuable space for urban development due to their industrial heritage and distinctive linear characteristics. Through landscape renovation, the area can be transformed into an urban green corridor, thereby revitalizing the deteriorated and neglected site. This transformation will promote both ecological and economic development within the surrounding community, ultimately fostering a virtuous cycle of urban development. Simultaneously, commercial and cultural components will be integrated to transform the area into a hub of consumption and entertainment, thereby attracting both residents and tourists. This initiative is expected to not only enhance the city's image but also generate economic benefits and create employment opportunities for the surrounding regions.

From the standpoint of urban cultural heritage and innovation, the repurposing of abandoned railways has the potential to enhance both urban cultural heritage and innovative practices. The preservation of historical remains and the exhibition of railway culture enable the public to attain a more profound comprehension of the city's history. When integrated with contemporary design and technological advancements, this approach fosters a distinctive and appealing urban landscape and public space, thereby infusing new vitality into the city's cultural heritage and innovation. This transformation represents not only a recognition and preservation of the city's historical and cultural heritage but also a proactive exploration and implementation of strategies for the city's future development.

3 Landscape transformation patterns and functional development of abandoned railway sites

3.1 Landscape transformation patterns of abandoned sites

The transformation of landscapes associated with abandoned railways necessitates an analysis that considers land scale, geographical location, ecological environment, and urban requirements. Presently, five primary forms

Table 1 Delineation of the scope of the railway safety protection zone

Type of railway	Urban center		Suburban residential area		Residential area of villages and towns		Other regions	
	High-speed railway	Other railways	High-speed railway	Other railways	High-speed railway	Other railways	High-speed railway	Other railways
Coverage of protected areas//m	10	8	12	10	15	12	20	15

of transformation can be identified: railway-themed parks, urban greenways, linear cultural heritage sites, areas designated for art and recreation, and tourist routes. The railway, characterized as a linear space, aligns well with the increasing demand for land designated for greenway development. The transformation of abandoned railways into urban greenways has emerged as a prevalent and favored strategy. This approach not only optimizes spatial resources but also creates opportunities for recreation through the implementation of green spaces and beautification efforts, thereby contributing a new aesthetic dimension to the urban landscape. Successful initiatives, including New York's High Line Park, Taiwan's Dongfeng Bicycle Green Corridor, and Paris' La Promenade Plantée, have exemplified significant potential and value.

3.2 Development of the function of abandoned railway sites

Railway construction is influenced by several factors, including topography, terrain, and traffic conditions. These variables contribute to the development of various types of railways, such as lay-flat railways, overhead railways, and underpass railways. Each of these railway sites possesses distinct characteristics and presents numerous opportunities for functional development. This adaptability can effectively illustrate the diversity of the railway landscape by tailoring the site to meet specific requirements.

The elevation differential between the overhead railway and the ground level offers visitors a distinctive vantage point. In instances where the overhead railway intersects with city streets, the viaduct is frequently employed to mitigate traffic conflicts. The renovation of overhead railways often involves converting the upper section of the viaduct into a recreational area, such as a green park, to provide the public with a tranquil environment. Meanwhile, the lower section of the viaduct can be enclosed with walls and repurposed into a commercial street or corridor, thereby creating a stylish commercial space[8]. The Bastille Green Walkway in Paris features a park situated atop the viaduct, offering a pleasant recreational space for the public. Additionally, the stores located at the base of the viaduct contribute to a distinctive commercial ambiance (Fig.1). In Japan, the underpass of the Yurakucho Station Railway has been repurposed into a restaurant street, whereas the underpass of mAAch ecute has been converted into a mixed-use shopping street. These instances of transformation exemplify the diversity and creativity involved in the redevelopment of overhead railways (Figs.2−3).

The tunnel or culvert created by traversing beneath the railway is characterized by limited illumination and a sealed environment. This enclosure effectively segregates the interior of the tunnel from the surrounding area, resulting in a relatively autonomous space. The tunnel's ability to retain warmth during winter and maintain coolness in summer, along with its capacity to shield against wind and rain, renders it an appropriate candidate for use as an indoor space. The development of the underpass railway site presents an opportunity to establish an exhibition space through the incorporation of wall carvings and displays that highlight railway culture and knowledge. This initiative aims to illustrate the historical development and significant events associated with the railway, thereby facilitating public engagement with history and enhancing understanding of railway culture. Additionally, this approach seeks to contribute a distinctive cultural ambiance to the tunnel space. Alternatively, the utilization of colored lighting, holographic projections, and other techniques can transform the underpass railway site into a dynamic and diverse light art exhibition space, thereby enhancing the visual appeal and attraction of the tunnel environment.

There are several successful cases both domestically and internationally that can serve as references. For instance, the Xiamen Railway Park has repurposed an abandoned railway tunnel into an exhibition hall dedicated to the history of railways, showcasing the evolution of railway development through murals (Fig.4). The Great Sun Shadow Railway Tunnel in Japan has been repurposed as a nostalgic tourist attraction, where original remnants and documentation pertaining to the construction of the railway have been meticulously preserved within the tunnel, allowing visitors to experience the historical essence of the railway (Fig.5). The Hanok Bicycle Tour in Jeonju, Korea features railway bicycles that traverse tunnels adorned with rail-colored lights, creating a vibrant and engaging visual experience (Fig.6).

4 Design strategies for landscape transformation of abandoned rail–way sites

4.1 Preservation of abandoned remains

In the context of landscape transformation of abandoned railways, the preservation of legacy facilities not only serves to evoke memories of the industrial era and industrial civilization but also contributes a distinctive character to the renovated landscape. The retention of these abandoned facilities can be categorized into three primary approaches.

4.1.1 Overall preservation. In the landscape transformation of abandoned railways, an overall preservation approach underscores the benign restoration of buildings, structures, facilities, equipment, tracks, and stations located on the site. This methodology aims to maintain these elements in their entirety, thereby facilitating tourism and enhancing visitor engagement. Through the spatial recreation of original objects, visitors are afforded an immersive experience, thereby enhancing the educational function of railway heritage. Overall preservation is more appropriate for small-scale railway abandonment sites, whereas segmented preservation is typically employed in urban centers to offer targeted protection for areas of significant historical and cultural value.

4.1.2 Partial preservation. Partial preservation emphasizes the selection of the most characteristic, representative, or well-preserved sections of a site for conservation. These preserved sections will serve as focal points within the overall design, functioning as iconic landscapes that contribute a distinctive charm to the entire renovation project.

4.1.3 Constructive preservation. Constructive preservation pertains to the intentional preservation of elements that embody the character and humanistic significance of a site, including items such as sleepers, tracks, signals, road gates, and platforms. These elements have been restored and reimagined to not only maintain the historical essence of the railway but also to imbue them with new functions and meanings. This approach creates a juxtaposition between the old and the new, thereby enhancing the railway-themed identity of the park and stimulating visitors' associations.

4.2 Reuse of abandoned remains

4.2.1 Reuse of railway tracks. Railway tracks

Fig.1 Stores under the Bastille viaduct

Fig.2 Restaurant under the Yurakucho Station Railway viaduct

Fig.3 Shopping street under the mAAch ecute

Fig.4 Xiamen Railway Cultural Park Hong–shan Tunnel

Fig.5 Great Sun Shadow Railway Tunnel in Japan

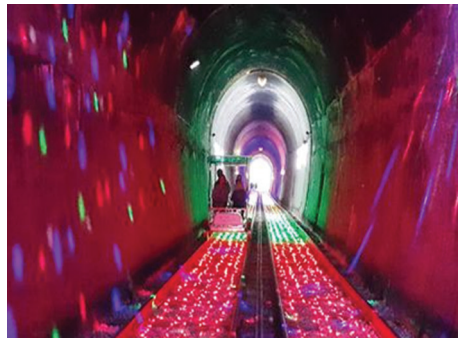

Fig.6 Hanok Bicycle Tour in Jeonju, Korea

exhibit pronounced linear characteristics, which should be effectively leveraged in landscape design. This approach can facilitate the transformation of tracks into garden pathways, bicycle corridors, or green planting areas, thereby enhancing the expression of linear space and emphasizing the distinctive features of railway landscape transformation.

4.2.2 Reuse of trains. Trains serve as emblematic remnants of the railway's forsaken landscapes, each embodying a distinct character reflective of various eras, countries, and functions. As a singular mode of transportation within the original context, the abandoned train possesses significant historical and cultural value, thereby attracting substantial gatherings of individuals. This attraction can be enhanced through the preservation and restoration of the train, allowing it to be situated on-site for tourists to photograph and explore. Alternatively, the train car may be repurposed as a sightseeing vehicle, dining car, or exhibition space, thereby enabling it to continue serving the public, fostering interaction between the train and visitors, and providing a unique experience for tourists.

4.2.3 Utilization of buildings and structures. Buildings and structures situated along railway lines, including train stations and platforms, are prioritized for adaptive reuse. The architectural style of these buildings and structures reflects the productivity levels and the social and cultural contexts of their respective eras, serving as significant repositories of the city's historical and cultural narrative. For structures that maintain well-preserved internal configurations, their functions can be repurposed to accommodate museums, restaurants, or recreational and play areas, thereby attracting visitors as unique spaces within the site. A pertinent example is the repurposed railway in the La Petite Ceinture, which has been transformed into a series of sustainable living and leisure spaces, such as the La Recyclerie restaurant, La Ferme du Rail railway farm, and Le Hasard Ludique cultural venue, all of which integrate the principles of environmental sustainability.

4.2.4 Utilization of waste materials. Waste materials found in railway waste sites, including gravels, sleepers, and metals, typically contribute minimal or negligible pollution to the environment. These materials can be repurposed as foundational elements for terrain fill, paving, landscape walls, and other design features, thereby enhancing landscape architecture. Their incorporation not only reflects the industrial character of the original site but also promotes material conservation and cost reduction in the development of new landscapes.

5 Cultural inheritance in landscape transformation of abandoned railway sites

The development of urban areas, coupled with industrial restructuring and innovations in transportation, has resulted in the emergence of numerous abandoned railway lines and associated wastelands. These railway lines serve not only as historical witnesses to the transformations within cities but also as repositories of significant cultural heritage. Despite their abandonment, they continue to exhibit distinctive characteristics of the industrial era and embody the collective memory of the community. Consequently, in the context of landscape transformation, the excavation, preservation, and promotion of railway culture are essential for the creation of a humanistic space, the enhancement of urban appeal, and the formulation of a new urban identity. To ensure the continuity of the cultural lineage associated with these sites, several aspects warrant further exploration.

5.1 Preserving the spatial texture and form of the original landscape

The distinctive landscape texture and spatial configuration along the abandoned railway serve as a testament to the historical transformations of the city. Although the railway has ceased

to fulfill its original function within the contemporary urban framework, the site, which embodies the memory of the city's former prominence, can not be easily disregarded. In the process of renovation, the preservation of these original landscapes and forms is crucial for maintaining the site's historical memory and for shaping its spirit. Concurrently, retaining the wild and desolate atmosphere that has emerged following the site's abandonment enables individuals to reflect on the rise and decline of the railway, thereby sustaining the historical narrative associated with the location. The transformation of Qijiang Park exemplifies the successful integration of industrial and natural elements, highlighting the aesthetic value of their symbiotic relationship through the repurposing of natural features and structures.

5.2 Extracting the essence of the elements of railway culture

As urban development and modernization continue to progress, numerous traditional structures and historical sites are gradually vanishing, resulting in a phenomenon often referred to as "amnesia". Abandoned railways serve as historical witnesses, and it is essential to communicate their historical narratives through the preservation of associated facilities, structures, and other remnants present at the site. Consequently, it is essential to distill the core elements of railway culture from the remaining landscape and adeptly integrate them into landscape design. This can be achieved through artistic techniques such as reproduction, endowment, metaphor, and symbolization, thereby ensuring the continuity and promotion of local characteristics and cultural heritage.

5.3 Building emotional ties between culture and people in the landscape

In the field of landscape design, cultural connotations are often intangible and qualitative, yet they profoundly resonate with individuals on an emotional level. Designers must adopt a people-centered approach, fostering connections between cultural elements and emotional experiences. Through the incorporation of specific elements and atmospheres, this approach stimulates individuals' associations and resonances, thereby intertwining the present with the past and effectively perpetuating the cultural lineage. The Fifth Day Gangchon Rail Park Project in South Korea represents a renovation of the Gyeongchun Line, which was decommissioned after 70 years of operation. This line traverses picturesque landscapes, including rice paddies, mountains, forests, and rivers. The renovation process retained the original railway tracks on the site, repurposing them for sightseeing cars. This initiative revitalizes the railway, enabling visitors to evoke profound memories and experience the intimate relationship between culture and community in an interactive manner.

6 Conclusions

In recent years, the pattern of urban spatial development has shifted from expansion to a focus on intensification and efficiency. Consequently, cities must pursue strategies for intensive land utilization, rejuvenate underutilized areas, improve land use efficiency, and create additional space for urban development. In this context, abandoned railways within urban centers have emerged as potential development areas for cities, warranting a thorough exploration of their rich historical significance. The examination of landscape transformation strategies can serve not only to revitalize urban areas but also to perpetuate cultural heritage and augment the aesthetic appeal of the city. This is of considerable importance in advancing the public space landscape and contributing to the overall development of the urban environment.

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