Comparative study on legislation of utilization of construction wastes as resources in china and abroad

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Abstract: The dilemma of the “Building wastes Besieged City” has gradually become a national problem. Historical experience in the world shows that establishing a systematic and complete legal system is an effective way and powerful weapon to ensure the comprehensive utilization of building wastes resources. Based on the domestic conditions, the state focuses on the problems and learns from the legislation experience of Chinese and foreign construction wastes recycling laws and regulations, to design the legal system form multiple fields, multiple angles, and multiple levels as much as possible to achieve maximum environmental, social, and economic benefits. This article mainly summarizes the characteristics and outstanding experience of the legislation of the comprehensive utilization of construction wastes as resources in foreign countries, as well as the existing problems of Chinese relevant legal regulations, and provides reference for future research and implementation of relevant legislation.

1. Introduction
Construction wastes, also known as building garbage, refers to wastes concrete, mortar, masonry, iron and steel, wood, glass, gypsum and bitumen linoleum and other garbage, produced during construction of urban and rural areas due to new construction, modification, expansion, decoration, and demolition. It is a construction by-product left over from the end of the entire life cycle after the civil engineering and infrastructure construction consumes a lot of resources and energy. According to statistics, the amount of construction wastes generated in various projects in China ranks first in the world every year. The total amount of construction wastes generated each year is about 3.55 billion tons, accounting for about 40% of urban wastes. Therefore, random dumping and landfilling of construction wastes has not only caused serious air pollution, water pollution, and soil pollution, but also affected human production and life, urban sanitation and scenery, and even caused the collapse of the slope of the dump site and other serious incidents, which created public safety hazards and adverse social impacts. The predicament of “Building wastes Besieged City” has become a national problem.

The comprehensive utilization of construction wastes as resources is an effective way to solve the problem of construction wastes disposal, and legal regulation is a powerful weapon for the comprehensive utilization of construction wastes as resources. Construction wastes can be used as a by-product of construction. It runs through all the process of natural resources, construction materials, building design, functioning and maintenance, construction wastes and the reuse of construction wastes, experiencing the process from “the cradle to the grave”. Therefore, only after the relevant legislation research fully considers the entire life cycle process of construction wastes, strictly control each phase, and focus on the coordination of the three major elements, namely environment, society and economy, can we maximize the environmental, social and economic benefits. This article
elaborates the necessity and significance of legislation for the comprehensive utilization of building wastes as resources, and summarizes and compares the course of the laws and regulations of comprehensive utilization of construction wastes at home and abroad, as well as analyzes and summarizes the favorable experiences of foreign legislation, the problems in domestic legislation, and the profound enlightenment of legislation for the utilization of construction wastes.

2. The necessity and significance of legislation on the utilization of building wastes as resources

The Central Committee of the Chinese Communist Party of and the State Council have successively made national-level strategic plans for green development and low carbon cycle development. In the Several Opinions on Further Strengthening the Management of Urban Planning, Construction and Management, the timetable for “aim for five years or so, basically establishing a system for recycling and recycling of construction wastes” is clearly proposed for the first time. In the Thirteenth Five-Year Plan for National Economic and Social Development, it is proposed to speed up the construction of urban kitchen wastes, construction wastes, disused textiles, and other resource utilization and harmless management systems, and standardize the development of re-manufacturing. General Secretary Xi Jinping once pointed out that the general implementation of the wastes classification system has affected the living environment of more than 1.3 billion people. It is also related to whether wastes can be reduced, resource-recycled, and harmless. Therefore, the reduction, resource recovery, and harmless management are the basic principles and core methods for the comprehensive utilization of construction wastes as resources, and they are effective ways to crack down on the difficulties of the “construction garbage siege” national dilemma. The experience of developed countries in the United States, Europe, and Japan shows that legal regulation is an effective means to solve this problem [1] and is the only way to maximize environmental, social, and economic benefits. Its significance is specifically expressed in:

• Achieving energy conservation, emission reduction and protect the ecological environment. The implementation of the comprehensive utilization of building wastes resources can reduce the demand for the development of primary mineral resources, ease the bottleneck of resource shortage, and achieve energy conservation and emission reduction. According to statistics, if China’s annual construction wastes can be fully utilized, it can save 3 billion tons of natural sand and gravel, reduce soil 160,000 cubic meters, and lower more than 1.5 billion tons of sand stone used by opening of mines and rivers. About 1 trillion standard bricks are produced for fire-free wall and floor materials, and 30,000 tons of fly ash are consumed, and 90 tons of sulphur dioxide emitted from burning bricks are reduced [2].

• Recycling construction materials to reduce land occupation. The construction of the project requires a large amount of building materials, and the production of building materials consumes natural resources such as minerals and forests. Construction wastes is a product of the consumption of natural resources. When it is forgotten, it becomes a construction wastes. However, when it is used as a resource, construction wastes is “urban mineral deposits” and “renewable green energy” and can be “turning wastes into treasure”. The legal regulations of comprehensive utilization of construction wastes as resources, can not only manage but also reuse the building materials reasonably, besides it can also greatly reduce land occupation, increase land use efficiency and solve the “Building wastes Besieged City”.

• Developing new energy-saving and environmental-friendly industries and providing new economic growth points. As an emerging field in the renewable and recyclable industrial chain in the building materials industry, the recycling of construction wastes is an important measure for Chinese implementation of an innovative development strategy, and it is an important part of the development of new industries for green building materials and also brings more employment opportunities. According to statistics, construction wastes recycling industry is expected to create more than 480,000 jobs. By 2020, China will produce at least 3 billion tons of solid wastes for building construction. If 50% of it is converted into green ecological building materials, which means 600 billion yuan will be created, and economic and social benefits can be considerable [2]. Through legislation, and by the use
of the law power, the entire industrial chain of construction wastes generation, classification, transportation, recycling, reproduction, sales, engineering application, and supervision in the building wastes recycling industry is being regulated, so that every link in the industry chain is traceable by the law.

3. Comparative analysis of domestic and foreign legislation of construction wastes

3.1. Legal system of comprehensive utilization of construction wastes as resources in foreign countries

The laws and regulations for the comprehensive utilization of construction wastes in the United States have gone through three generations. The first generation was based on government-led command and control methods to achieve pollution control; the second generation was based on market economic stimulus measures to emphasize the role companies played in the elimination of sources of construction wastes; the third generation was based on further improving policies and governing enterprises to realize the government's advocacy and enterprise self-discipline, meanwhile increasing the public awareness of participation and ability to participate. The U.S. government's Super Fund Law stipulates that "any enterprise that produces industrial wastes must handle the wastes properly and must not dump it at will", so that the amount of construction wastes generated is limited at the source to realize emission reduction likewise. The U.S. pays special attention to the reduction of construction wastes, from criterions and standards to policies and regulations, from government control measures to corporate self-discipline, from architectural design to on-site construction, all of which restricted producing construction wastes and encouraged and rewarded "zero" discharge of construction wastes.

Japan promulgated the Solid Wastes Management and Public Cleaning Act as early as 1970, and subsequently published the Regulations for the Use of Recycled Aggregates and Recycled Concrete (1977), Renewable Resources Utilization Promotion Law (1991), Construction By-Products Recycling Promotion Plan (1997), Construction and Recycling Law (2000), Construction Wastes Recycling Promotion Law (2003). In 2011, the Construction and Recycling Law was revised, and in 2012, the Wastes Disposal Law was revised. The characteristics of the laws and regulations for the comprehensive utilization of construction wastes in Japan are that the system is complete, the terms are specific, covering all aspects of administrative, civil, and criminal legal provisions. In December 2000, the Basic Law for the Promotion of the Formation of a Recycling Society was promulgated. The fundamental principle for the establishment of a recycling-oriented economy and society is to "promote the circulation of substances so as to reduce the environmental burden, so as to achieve sound economic development and build the society in a sustainable way". So, mature regulations have helped Japan achieve almost 100% reuse of construction wastes, and have made remarkable achievements in the recycling of construction wastes.

Germany was the first country in the world to make heavy use of construction wastes. In the 1970s, it launched the “Blue Angels” plan and formulated the Wastes Disposal Law, which was later amended as The Wastes Restriction Management Act. In addition, the Circular Economy and Wastes Removal Act (amended in 1998), enacted in 1994, has had a wide-ranging impact in the world. As the implementer and promoter of Germany's producer responsibility extension system, Germany has many laws and regulations related to the extended producer responsibility system. By enforcing the expansion of this system of production responsibility, it is not merely emphasizing that producers must take full responsibility for construction wastes, but also that producers, consumers, governments, enterprises, and other participating entities should bear some responsibilities. The legal responsibilities of the subject made it possible for all parties to act in strict accordance with legal requirements, thus achieved the goal of improving the overall utilization of construction wastes.

Since January 2003, Korea has implemented the EPR (Extended Producer Responsibility) system based on the abolition of the garbage deposit system. EPR is based on the OECD concept of “expanding producer responsibility”, whose core content is to expand the responsibility of the producer from the production stage of the product to the reuse and final disposal stage of the ultimate wastes that occurs after the product is consumed. If the task cannot be completed, the fines for
penalties would be higher than for repurposing expenses which they should pay. Responsibility for the disposal of construction wastes is not merely the duty of the manufacturer; Instead, the three major economic actors such as consumers, businesses and the government should share their responsibilities to promote the recycling of wastes. The Construction Wastes Reproducing Promotion Law clearly stipulates this.

Singapore implements a franchise system for the disposal of construction wastes. The construction wastes disposal company permitted by government is responsible for the collection, removal, disposal, and comprehensive utilization of construction wastes throughout the country. The Finnish government requires the main implementers of building or dismantling construction to state the detailed information of construction wastes and the detailed measures taken during the permitting and reporting. The recycling rate of construction wastes in Denmark is very high, and the main measure is the legal taxation of landfill and incineration of construction wastes. The Swedish government imposes punitive penalties on people dumping construction wastes at will. Austria uses a costly fee for construction wastes to reduce the amount of construction wastes [3].

3.2. Laws and regulations on comprehensive utilization of construction wastes as resources in China

In our country, the state has enacted the Promotion of Circular Economy Law, Cleaner Production Promotion Law, Environmental Protection Law (amended in 2014), Urban and Rural Planning Law (revised in 2015), Law on the Prevention and Control of Environmental Pollution Caused by Solid Wastes (revised in 2016) and other series of laws and regulations, that all make legal provisions for the comprehensive utilization of construction wastes. Under the guidance of national laws and regulations, local governments have also formulated regulations and rules for the management of local construction wastes, such as Regulations on the Utilization of Construction Wastes in Qingdao City (2013), Regulations on the Administration of Urban Construction Wastes in Nanchang City (2014), Shanghai Construction Wastes Management Regulations (Draft) (2016) and so on.

Clauses 5 of the Law on the Prevention and Control of Environmental Pollution Caused by Solid Wastes: “The producers, sellers, importers, and users of the products are responsible for the pollution of the solid wastes they produce respectively.” which clears the principle “whoever produces the wastes is responsible for it”. Clauses 31: “Enterprises and institutions shall rationally select and use raw materials, energy, and other resources, adopt advanced production techniques and equipment, reduce the amount of industrial solid wastes produced, and lessen the harm of industrial solid wastes.” which is a basic provision of construction wastes reduction from the legal level. Clauses 46:“The engineering construction unit shall promptly clear and transport the solid wastes generated during the construction of the project and use or dispose of it in accordance with the regulations of the competent department of environmental sanitation.”, which clears that the construction company shall carry out the responsibility for the removal and the obligation for reuse of construction wastes generated by themselves. The law puts the comprehensive utilization of construction wastes as resources into the orbit of legalized management, defines the legal responsibility for the construction wastes pollution clearly, and plays a significant role in the prevention and control of construction wastes pollution.

Clauses 23 of the Circular Economy Promotion Law: “The State encourages the use of non-toxic solid wastes in the production of construction materials, heartens the use of bulk cement, promotes the use of ready-mixed concrete and ready-mixed mortar, and prohibits the destruction of arable land by burning bricks.” Clauses 33: “The construction unit shall make comprehensive use of the construction wastes generated during the construction of the project; any company that can’t meet this standard shall entrust qualified production and business operators to carry out comprehensive utilization or harmless disposal.” Clauses 41 and 44 stipulate the implementation of the garbage emission charging system, and the fees collected are specifically used for the classification, collection, transportation, storage, utilization, and disposal of garbage and shall not be used for other purposes. The law has legally defined the “reduction, reclamation, and harmlessness” recycling utilization principle of construction wastes, and provides legal system arrangements for the utilization of building materials, charge of creating construction wastes and taxation concessions, etc.
4. Legislative characteristics, experiences and enlightenment of construction wastes in various countries

4.1 Summary of legislative features and experiences in various countries

The United States is one of the first countries in the developed country to comprehensively utilize the recycling of construction wastes that has passed a series of bills or amendments and has established legal system for the comprehensive utilization of construction wastes as resources, including information disclosure, resource regeneration, technological development, recycling standards, economic stimulus, occupation protection, civil litigation and so on. We can learn main experience from U.S listed as follow:

- The United States has established a complete legal system for the utilization of construction wastes as resources and strengthened the comprehensive utilization of the construction wastes according to national laws, local regulations and industry standard.
- The government, intermediary organizations and corporate responsibilities are clear, actively adopt advanced technical specifications and scientific and technological achievements to constitute a social, professional, efficient and orderly comprehensive utilization system of construction wastes recycling.
- Tax credit support. Construction wastes recycling enterprises can obtain low-interest loans and enjoy preferential policies such as tax and fee reduction.

The legislation of EU countries in the management and utilization of construction wastes has always been at the forefront of the world. The main experience is listed as follow:

- The innovation of construction wastes recycling on the economic and technical level is highly valued, and a legal system of circular economy that connects to each other has been established.
- The collection of construction wastes management fees and accumulation fees to stimulate the source reduction.
- The collection of ecological taxes to improve recycling efficiency.
- Controlling the secondary pollution risk of reuse of construction wastes, technical specifications, process standards and recycling list.
- Government support and policy incentives.
- Taking the advantage of industry organizations to promote the development of construction wastes management and utilization industries.

The comprehensive utilization of construction wastes as resources in Japan has achieved remarkable results, and Singapore and South Korea have distinctive features. The main experiences are listed as follow:

- Firstly, the laws and regulations for the comprehensive utilization of construction wastes in Japan are comprehensive and systematic, and the legal constitution starts from the detailed use of standards and specifications. Then, under the guidance of the concept of circular economy, the nation gradually establish the objectives and development plans for the comprehensive utilization of construction wastes as resources. Finally, from the national legal level, special legislation is made on the comprehensive utilization of construction wastes as resources, so that every link of the comprehensive utilization of construction wastes is traceable.
- Singapore regards wastes reduction as an important development goal, establishing a franchise system for construction wastes recycling, and collecting construction wastes disposal fees.
- Japan and South Korea take the method of collecting and recycle construction wastes, and original emissions are reduced strictly, and recycled aggregate is used mandatorily, and construction wastes disposed properly.

Through long-term efforts of industrialized countries such as the United States, Japan, and European Union, have basically realized the legalization of construction wastes utilization, and have achieved remarkable results in energy conservation and emission reduction. In contrast, although
China has established a legal and institutional framework for the comprehensive utilization of construction wastes, it is still incomplete and it comes with the major problems listed as follow:

- Laws and regulations are not sound, and management system mechanisms are not perfect. National laws and regulations on the comprehensive utilization of construction wastes as resources have been left blank.
- The basic concept of legislative provisions needs to be improved and penalties are not enough. Laws and regulations mainly emphasize the maintenance of urban appearance and environmental sanitation. There is no systematic law and regulatory provision for the comprehensive utilization of construction wastes from the perspective of circular economy and cleaner production.
- The rule for market transactions has not been formed, and macro policies such as fiscal taxation has not been laid out. At present, the transaction of comprehensive utilization of construction wastes as resources is irregular and business models are not Sound, resulting in high production costs of recycled aggregates, insignificant economic benefits and lacking power in the market.
- Technical standards and regulations are difficult to put into effect, and there is no effective mechanism for convergence with administrative regulations.

4.2 Legislative enlightenment

Inductively analyzing the legislative history, legislative rules, and successful experiences of the comprehensive utilization of construction wastes in the United States, Europe, Asia, and China, the article summarizes the legislative enlightenment of the comprehensive utilization of construction wastes for China.

4.2.1 Legalized management is an effective method and means for construction wastes management. The experiences of various countries in the world have proved that the comprehensive utilization of construction wastes is a feasible way to prevent pollution, protect ecology, and conserve resources. And also, legal regulation is an institutional guarantee for the reduction, reuse, and recycling of construction wastes. It is an effective method for the management of construction wastes to improve the legal system for the supervision of construction wastes, eliminate the illegal dumping of construction wastes, and promote the reduction and reuse of construction wastes accordingly. The specific performance are listed as follows:

- Launching a complete legal specification based on the particularity of construction wastes. The Japanese government has specific legislation for construction wastes or special regulations in relevant laws to make construction wastes management lawful. From 1970s on, Germany has enacted more than 180 regulations related to wastes disposal. A number of related associations have also formulated a series of guidelines, regulations and standards for the management and recycling of construction wastes according to German laws.
- The reduction and recycling of construction wastes are the focus of legislation. Legislators seek to reduce and recycle construction wastes through detailed operability regulations, such as the Resource Closure Circulation and Wastes Management Act enacted by Germany, to maximize the recovery and reuse of wastes and garbage at all levels across the country which has been proved successful.
- Comprehensive use of multiple measures to improve the management efficiency of construction wastes. In regard to legal measures of construction wastes management in the developed country, the administrative supervision, economic means such as taxation, and information means are used. The United States has passed the Solid Wastes Disposal Act in 1965, which requires the federal government to encourage states to improve their wastes disposal plans by providing scientific research and financial support.
- Launching the legislation to specify the legal responsibilities of construction-related social subjects. The Construction Garbage Recycling Promotion Law formulated by the Korean
government defines the obligations of the government, emitters and construction wastes disposal companies.

### 4.2.2 Diversification of comprehensive utilization of construction wastes as resources, market running mechanisms forming under policy support, and having great potential for comprehensive utilization of resources.

The main components of a large amount of wastes concrete and bricks in construction wastes are inorganic materials, which are stable in chemical and physical properties such as perfect acid resistance, alkali resistance, water resistance, large particles, and wonderful water permeability. These properties determine that they are adoptable building material after processing. The wastes concrete can be used as cushion layer and surface layer in the road engineering after general crushing, and can also be made into building material products such as concrete bricks and pavement tiles. Recycled aggregates come with a certain size that achieved after the process of crushing, sieving, sorting and cleansing, can also be used instead of natural gravels in reinforced concrete structures. After scrap, iron and all kinds of scrap metal fittings are sorted and concentrated. Afterwards, they can be reprocessed and manufactured into various specifications of steel at the steel plant. A large number of domestic and foreign practices have shown that the ways of comprehensive utilization of construction wastes as resources have gradually diversified.

Without the support of national policies, the processing enterprises of construction wastes will face many difficulties in their survival and development, such as insufficient raw materials, high disposal costs, serious prejudice against the construction wastes recycling products, poor product sales and difficult site selection [4]. The construction wastes recycling industry has a public welfare nature, especially when the construction wastes management system has not yet formed, and the construction wastes recycling utilization industry is still in the initial stage of exploration. So, government policy support is essential. Therefore, government measures have been continuously introduced:

- Increasing the landfill charging standards for construction wastes rationally, issuing preferential policies and incentives for the use of construction wastes recycled materials, and paying resource protection fees [5].
- Strengthening the government’s leading, implementing green credit policies, formulating construction wastes reduction plan, and making the annual wastes reduction goal.
- Preparing technical standards for the use of construction wastes and making clear evaluation methods [6].

Japan, the U.S., the European Union and other developed countries and regions have achieved remarkable results in emission reduction and recycling of construction wastes. Japanese annual recycling rate of construction wastes is 90%, and the environmental problems of construction wastes are basically solved. A survey made by the National Demolition Association (NDA) found that the United States generates approximately 115 million tons of construction wastes a year, of which 75% is recycled, and many builders have a 90% rate of recycled construction wastes. The Dutch construction industry generates 14 million tons of wastes each year, and 70% of construction wastes has been recycled. According to incomplete statistics, the amount of the processing lines of the construction wastes that has a capacity of over 1 million tons a year in China is around 60, no matter built or under construction, together with hundreds of small-scale disposal companies whose total disposal capacity is less than 100 million tons, and the national resource utilization rate is around 5%. So there is a huge potential for the comprehensive utilization of construction wastes as resources in our country.

### 4.2.3 Reflect the conditions of people, conform to the public opinions.

The hazards of construction wastes to the environment are mainly manifested in the following aspects: invading land, polluting water bodies, atmosphere and soil, affecting city appearance and environmental sanitation, etc. The construction wastes are likely to cause stive and lime dust to fly, pollute the atmosphere seriously, form secondary pollution, and also block the soil biological chain during the clearing and stacking process, which causes serious environmental pollution and permanent
damage. According to the reports such as *The People's Daily*, the public is very dissatisfied with the random dumping of construction wastes, and they are worried about land occupation and environmental pollution caused by construction wastes, and they are highly concerned about traffic violations caused by the transport of construction wastes. Studies in northern European countries have shown that re-manufacturers are more environmentally friendly than most rock raw materials and that the potential greenhouse effect is only 1/2 to 1/3 in contrast with the original stone. Therefore, the utilization of construction wastes as resources is an effective way to solve the diversification hazards and disposal problem of construction wastes. It can not only reduce or avoid direct pollution, improve the appearance of the city and reduce the PM2.5 and PM10 indicators effectively, but also lessen emissions such as sulfur dioxide, carbon dioxide and other toxic and harmful gases [7]. The legal regulation of the comprehensive utilization of construction wastes as resources is an important measure to reflect the people’s conditions, conform to the public opinions, and build a resource-saving and harmonious society.

5. Conclusion
Throughout almost all countries in the world, they all faced or are facing the problem of construction wastes once or now. Historical experience drawn from the developed countries such as United States, European Union, Japan shows that the legislation is an effective means to solve this problem, and legislation has been used to force the implementation of the comprehensive utilization of construction wastes as resources. Recently, as national policies gradually advanced further on the reduction, recycling, and harmless disposal of construction wastes, the legal system of the comprehensive utilization of construction wastes will also continue to advance, and which will finally align with the international level.

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