

Comparative Analysis of Construction Waste Recycling Policies at Home and Abroad

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Abstract. Through the analysis of the construction waste recycling policies of the United States and Japan, know that complete legal policies, the combination of macro policies and micro policies, governmental incentives are keys to the realize the goal of construction waste recycling of the United States and Japan. Analyze the present situation of construction waste recycling policies in China, combine with the problem in our country, draw lessons from foreign successful experience, put forward the suggestion of our country's construction waste recycling from the law and the economy.

1. Introduction

Construction waste generated from the process of building construction or dismantling, mainly refers to abandoned concrete, spoil, rubble, cullet and other solid waste [1]. With the accelerate of urbanization process in our country, the scale of the building is expanding, and the old buildings that need to be demolished are also growing, which makes the amount of construction waste disposal increasing year by year. From the 1960s, in developed countries is to strengthen the support for construction waste recycling by means of legal policy. In the case of the waste recycling mechanism in our country is not perfect, this paper lessons from foreign successful experience, puts forward the suggestion of our country's construction waste recycling.

2. Construction waste recycling policy in America and Japan

2.1. America

America is one of the earlier countries to recover construction waste, it is guide the enterprise to engage in recycling activities of construction waste mainly from the aspects of technical policy, legal policy, economic policy and so on. It will promote the recycling of construction waste can be achieved.

2.1.1. Use of construction waste in different grade. The annual construction waste output in US about 325 million tons accounting for 40% of total emissions of waste. According to the type and characteristics of construction waste, the recycling of construction waste can be divided into three levels and recycled in different levels: 1) Use in low-level. The construction workers are sorting and piling up the waste, and simply backfill in the construction site, that accounting for about 50% ~ 60% of total emissions of construction waste; 2) Use in middle-level. The enterprises of construction

waste disposal recycle construction waste, replacing traditional roadbed materials with it. Building materials(Supported by 20170540755 and WJZ2016002.) enterprises processes construction waste into a variety of blocks and aggregates, that accounting for about 40% of total emissions of construction waste; 3) Use in high-level. Processing and reduction the construction waste to make it into recycled building materials. Such as handling the construction waste into cement and asphalt [2].

2.1.2. Formulate a complete legal policy to regulate the behavior of recycling of construction waste. The effective use of construction waste in America is due to a complete legal system. The “Solid Waste Disposal Act”, which was promulgated in 1965, classifies solid waste and rules on the disposal and discharge of waste in construction. The “Resource Recovery Act” passed in 1970, to further expand the scope of work on the construction waste management, which from the simple control of displacement and waste disposal to the management of recycling, reuse and reduction. The "Code for Design of Construction Landfill" and "Administrative Licensing System for Construction Waste" promulgated in 1980 made more detailed provisions on the handling of construction waste. The enterprises can discharge or transport construction wastes after the relevant administrative departments have made special permits. These policies achieve control from the beginning, which controls the production of construction waste [3].

The United States has relied on government forces to carry forward the recycling of construction waste and has made three major policy reforms. In the 1960s, the pollution control of construction waste was realized through administrative means by the government and departments; In the 1970s, companies were encouraged to reduce production of construction waste at source by stimulating the market; In the 1980s, the government advocates, enterprise self-discipline and public participate in, states formulate laws and regulations combined with their own characteristics, release the annual emissions of construction waste and limit the emissions of construction waste[4].

2.1.3. Formulate economic policies to guide and encourage enterprises to engage in construction waste disposal. American government has introduced a series of economic policies to encourage more enterprises to engage in the recycling of construction waste. For example, Arizona law stipulates that if the enterprises buy renewable resources or waste disposal equipment through installments, the government can reduce the sales tax payable by 10%[4]. The United States also promotes the recycling of construction waste through the means of direct stimulation. For example, the American government levies discharge, garbage taxes and other taxes on enterprises that emit construction waste.

The American Environmental Protection Agency has launched Building Savings plans to guide companies in the recycling of construction waste, reducing the production and emissions of construction waste from the source. The state government and enterprises to respond positively, there have been a series of demonstration projects. For example, Senator Marion of Ohio classify the construction waste and recycling available construction waste in the process of demolition, making the construction waste recovery rate of the project reach 82%. State governments in America have also formulated policies to guide enterprises classification recycling of construction waste. For example, the California Environmental Protection Agency has established a database of building waste recycling; Texas Department of Transportation invested \$ 677 million in 2013 for the purchase of recycled building materials, making 2.5 million tons of construction waste to be recycled rather than simple landfill, saving \$ 1.2 million for the local Environmental Protection Agency only by the use of broken concrete.

2.2. Japan

Japan has a narrow land area and a shortage of natural resources, making it necessary to consider how to save resources and achieve efficient recycling of construction waste. Japan divides recycling

of construction waste into three stages: the stage of generation, disposal and recycling. The emission of construction waste is reduced and the recycling of construction waste is realized through various stages of legislation combined with strict management system.

2.2.1. Laws and policies in the stage of construction waste production. In the stage of building waste generation, the Japanese government has developed a series of policy to limit the production of waste from the source. The Japanese government has stronger restraints on the construction and destruction of buildings, as follows: during the design stage of the project, it is required to minimize or avoid the emission of construction waste from the construction site as much as possible; the design should extend the life of the building as long as possible; new or demolished buildings shall be applied to the department, and should not be removed without authorization. As shown in Table 1:

Table 1. Laws and policies in the stage of construction waste production in Japan.

<i>Name of laws and regulations</i>	year	main content	Main measures
<i>The action plan for construction waste measures</i>	1994	The government make a policy of building waste recycling that performed by building unit, construction unit and enterprises of construction waste recycling[5]	The enterprise shall submit the plan and the relevant
<i>Construction of by-product recycling initiative</i>	1997	The government requires enterprises to reduce the production and promote the recycling of construction waste; The requirements for the recycling of construction waste is zero emissions	departments shall examine and file the project before the construction or
<i>Green Procurement Law</i>	2001	Try to buy building materials that do not pollute the environment	demolition of the project

Table 2. Laws and policies in the stage of construction waste disposal in Japan.

Laws and regulations	year	main content	Main measures
<i>The progress outline for the subsidiary products properly handled</i>	2002	Building units and construction units shall fulfill their obligations according to the standards of construction waste disposal formulated by the government; The standard includes the reasonable disposal of construction waste and the sequence of construction projects	It is forbidden to stack and landfill
<i>Waste disposal act</i>	2012	Construction waste is the responsibility of the emitter; Construction waste needs treatment specially; Those enterprises or individuals who have not been processed as required shall pay a fine after verification and the serious will be sentenced to criminal detention	construction waste

2.2.2. Laws and policies in the stage of construction waste disposal. In the stage of building waste disposal, Japanese law stipulates that the disposal of construction waste shall be handled by the emitter, and the emitter may, according to the law, entrust the construction waste to the construction waste disposal enterprise for processing. In Japan, “Waste disposal act” and “The progress outline for the subsidiary products properly handled” stipulate that construction waste should be handled by the enterprise or entrusted to other enterprises with relevant qualifications [6]. For enterprises or individuals who do not comply with the law, the government will sentence to criminal detention of not more than five years or penalty below 10 million yen. As shown in Table 2:

2.2.3. *Laws and policies in the stage of construction waste recycling.* In the stage of construction waste recycling, the Japanese government established a system for the recovery of construction waste in order to ensure the efficient recovery of construction waste. In order to regulate the market of recycled materials and guide enterprises to engage in the production of recycled building materials, the Japanese laws clear the relevant business responsibility and entry criteria. The government needs to provide financial support for the enterprises that are resource for construction waste so that can encourage enterprises to make waste resources. At the same time, the law stipulates that the types and proportions of recycled materials for construction waste must be used in the projects, requiring public buildings to use construction by-products as raw materials, and it is clear that there will be penalties for not using them according to the rules. The law mandatory requires the government and construction enterprise to use recycled materials, which can guarantee the interests of the construction waste recycling company, and allowing more of the enterprises engaged in renewable building materials production, so as to realize the construction waste recycling. As shown in Table 3:

Table 3. Laws and policies in the stage of construction waste recycling in Japan.

Laws and regulations	year	main content	Main measures
<i>Resource reuse promotion act</i>	1991	Enterprises need to "recycling" the construction waste and recycle it according to the law; The enterprises will be punished if the renewable resources fail to be used effectively; At the same time, public facilities or buildings must use recycled materials	
<i>Construction waste recycled promotion act</i>	2003	The scope, type and quantity of renewable materials that need to be used in construction projects are clearly defined; The law clearly stipulates that companies fail to fulfill their obligations will be subject to administrative penalties	The system of classification and recovery of construction waste is classified;
<i>The construction of recycle act</i>	2011	1) The building materials shall be dismantled in sort, and the demolition shall be registered according to the regulations; 2) the waste buildings should be removed according to different categories to facilitate the reuse of construction waste; 3) Clear the scope of responsibility of government departments and relevant enterprises; 4) The government is obliged to provide the necessary financial assistance to the enterprises that promote the recycling of construction waste	Public buildings required must use recycled materials

3. Experience and reference of recycling policy for construction waste in the America and Japan

3.1. A complete legal system to ensure the recycling of construction waste

The United States and Japan not only control the phenomenon of random landfill and pile of construction waste, but also to ensure the recycling of construction waste. Practice has proved that the key to the realization of construction waste recycling is to develop a law that complete and conform to national circumstances. More than a dozen laws, such as the "Solid Waste Disposal Act" and the "Resource Recovery Act" issued in 1970 by the US government, and the "Waste Disposal Act" promulgated in 1970 and the "Construction waste recycled promotion act" promulgated in 2003 by the Japanese government have made detailed regulations on the methods, procedures,

corresponding incentives and punishments for the recycling of construction waste. Which makes the recycling of construction waste has a legal basis.

3.2. The combination of macro policies and micro to strengthen the policy of the operability

The United States and Japan have established a comprehensive legal system for the recycling of construction waste and formulated a series of policy measures in conjunction with the law to ensure the system of the law and feasibility of the policy. The American Environmental Protection Agency (EPA) has launched a Building Savings plan direct at laws on the recycling of construction waste, which lists the materials and funds saved by the demonstration project, and encourages enterprises to recycle construction waste. Combined with the law, Japan implements different policies at various stages of the recycling of construction waste. The effective link between law and policy ensures the recycling of construction waste.

3.3. The government encourages the development of construction waste recycling enterprises

In order to encourage the related enterprises in the construction industry to engage in construction waste recycling actively, for which local governments in the United States and Japan have adopted a series of incentives and take the lead in buying recycled building materials. The enterprise of construction waste recycling in the United States could be entitled to tax relief, and the states take the lead in buying recycled building materials, the auditors of the State have the right to conduct administrative punishments for local government that have not purchased recycled materials according to regulations[7]. In order to promote company to increase the investment in the equipment of construction waste recycling, technology research and development projects, Japan encourages central and local governments to take the lead in purchasing and using recycled materials with construction waste as raw material. In this way, enterprises are encouraged to carry out the utilization of construction waste.

4. The current situation and problems of construction waste recycling policy in China

4.1. The current situation of construction waste recycling policy in China

Table 4. Estimation of construction waste output in China from 2007 to 2016.

year	construction completed area(10^4m^2)	construction building waste output (10^4t)	construction building area(10^4m^2)	construction demolition area (10^4m^2)	construction demolition waste output (10^4t)	construction waste output (10^4t)
(1)	(2)	(3)=(2)*0.055	(4)	(5)=(4)*10%	(6)=(5)*1.30	(7)=(3)+(6)[8]
2007	203992.70	11219.60	482005.50	48200.55	62660.72	73880.31
2008	223592.02	12297.56	530518.63	53051.86	68967.42	81264.98
2009	245401.64	13497.09	588593.91	58859.39	76517.21	90014.30
2010	277450.22	15259.76	708023.51	70802.35	92043.06	107302.82
2011	316429.28	17403.61	851828.12	85182.81	110737.66	128141.27
2012	358736.23	19730.49	986427.45	98642.75	128235.57	147966.06
2013	401520.93	22083.65	1132002.86	113200.29	147160.38	169244.03
2014	423357.30	23284.65	1249826.35	124982.64	162477.43	187562.08
2015	420784.94	23143.17	1239717.64	123971.76	161163.29	184306.46
2016	422382.27	23231.02	1264216.27	126421.63	164348.12	187579.14

With the rapid development of modern construction industry, the number of new projects, expansion projects, reconstruction projects and projects to be removed is increasing, which generate a large number of construction wastes. It is found that the annual output of construction waste in China is increasing year by year though estimating the annual output of construction waste in recent years, the results are shown in table 4:

The increment speed of construction waste in China is significantly from 2010. It is estimated that the annual growth rate of construction waste in 2010 and 2011 is more than 19%.

The problem of construction waste has attracted high attention of our government. China has introduced a series of laws to make detailed regulations on the recycling of construction waste. The "Municipal Solid Waste Disposal Law" issued in 1995 has made specific regulations on the collection and disposal of construction waste, and has cleared the responsibility of the designer, the contractor and the government department [6]. The "Law on Prevention and Control of Environmental Pollution by Solid Wastes" promulgated in 2005 has made provisions on the issues that using advanced technology to control the generation of solid waste from the start, it also stipulates that enterprises shall register for the processing of solid wastes, and dispose the waste after getting the approval of the relevant department. In order to standardize the recycling of construction waste, China set up the China Environmental Sanitation Association Construction Waste Management and Resource Working Committee in June 2013, which have issued a report on the construction waste recycling to explore the way to construction waste recycling in China.

4.2. The problems in recycling policy of construction waste in China

There is still a problem with the recovery of construction waste although China has developed a series of policies to promote the recycling of construction waste.

4.2.1. Lack of special laws on the recycling of construction waste. There are many laws on the recycling of construction waste, but there is no specific law to regulate the way of disposal of construction waste. For a long time, the recycling of construction waste in our country is only involved in the regulations, but has not risen to the legal level; it is just a rule, not mandatory. The lack of specific law also makes the scope of the responsibilities for each regulator is unclear and there are loopholes in the regulatory system for building waste.

4.2.2. Lack of supporting system to achieve policy objectives. In order to achieve the recycling of construction waste, the United States adopts the classification of construction waste, and Japan refined the classification of construction waste in order to classify and utilize it. However at present, the utilization of construction waste in our country is piling up or landfill. Construction companies are only required to recycle construction waste, but there is no recycling measure to match them. Furthermore, the rules on the disposal of reclaimed construction waste are not clear enough.

4.2.3. More punish than reward, it is difficult to mobilize the enthusiasm of enterprises. The laws in China only mentioned that the government should give preferential tax to enterprises that engaged in the recycling of construction waste, and supports the enterprises. But what kind of behavior can enjoy tax cut, what are the preferential policies and the policy did not elaborate on what the tax breaks would be, what preferential policies would be, and how the governments support the business without explaining the details. On the contrary, the measurement model and collection range of discharge, and penalties for enterprises that discharge construction waste in the policy are detailed. Foreign experience shows that the government's stimulation and tax preference can motivate enterprises to engage in construction waste disposal.

5. Policy suggestions on perfecting recycling of construction wastes in China

The experience of the United States and Japan shows that the recycling of construction waste is closely related to policies and laws. Learn from America and Japan, and combined with problems in the process of construction waste recycling in China, the following suggestions are put forward for the management of construction waste recycling in our country:

5.1. *A set of policy system for recycling of construction waste is developed*

Make special laws combine with the existing laws and regulations, formulate and perfect the regulations and measures to forming a set of policy system for recycling of construction waste. A number of laws on the recycling of construction waste have been introduced in our country, but they are only some general terms, which make the construction waste recycling without legal protection. Therefore, the special laws should be made for the recycling of construction waste, the policies and measures that suit our national conditions should be introduced to solve the problems of low utilization of construction waste and rampant disposal.

5.2. *Deepen the policy of construction waste recycling*

In the specific policies, the responsibility of the producer and the scope of the extension of responsibility should be cleared, and the distribution of responsibilities in the construction waste recycling process should be refined, the government supervises the enterprises to ensure the effective operation of the policy. Meanwhile, the government should encourage enterprises to adopt the method of classification recycling for construction waste. Recycled construction waste by category can be directly into the market for use. Construction companies do not need to pay for the classification recyclers, and the classified building waste is of higher quality, less impurities and higher recyclable value, and enterprises can obtain more benefits.

5.3. *The government enhanced the support and made clear economic policies*

The enterprises engaged in the recycling of construction waste in our country generally have the following disadvantages: small scale, large investment, high production cost, and unstable product quality, these inherent defects create uncertainty for the development of enterprise. Government as a perfectly rational party, they should fully safeguard the social interests and collective interests. The enterprises that engaged in garbage disposal will be offered a discount on the loan by using economic means, which can ensure the smooth development of construction waste recycling. The government can take the lead in buying green building materials, thus forming a demonstration effect, which will drive the development of the industry of recycled building materials. The government should guide enterprises by various media to carry out the recycling of construction waste and provide reference information to enterprises with the willingness to recycle the construction waste, such as establishing the commodity database of construction waste recycling.

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