

PAPER • OPEN ACCESS

## Reuse of Construction Materials after Demolition of Buildings

To cite this article: T V Nasonova *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **272** 022096

View the [article online](#) for updates and enhancements.

# Reuse of Construction Materials after Demolition of Buildings

T V Nasonova<sup>1</sup>, S N Zolotukhin<sup>2</sup>, I A Potekhin<sup>3</sup>

<sup>1</sup>Voronezh state technical university, pro-rector for the organization and right work, Russia

<sup>2</sup>Voronezh state technical university, Chair of building structure and basement, Russia

<sup>3</sup>Voronezh state technical university, business-incubator by prof. Yu.M. Borisov, Russia

E-mail: potekhin\_300587@mail.ru

**Abstract.** In Russia each year appears 15 million tons of building scrap. According to statistic agency data, there were 10% of this measure is reused, almost for backfill pits and some for use as material filler. At Voronezh state technical university in the chair of Building structures and basements, realized experience of construction new low-rise houses made from reused building materials (scrap), which came from demolition places by lean dismantle. From the 2011 year till today by this technology have constructed not less 5 days each year in Voronezh region. The purpose of this research work is an evaluation of the growth the volume of reuse building scrap in Voronezh region. The main task is elimination obstacles of the growth potential of using this dismantle technology with following construction low-rise houses made from reused materials.

## 1. Introduction

In Voronezh in time of 2016 till the 2030 year is planned demolition of 680 living houses. This volume is 50% of the whole volume of houses to demolition in Voronezh region. After demolition operations appear about 1 million cubic meters of building scrap, which necessary to situate on municipal waste landfills. It entails significant costs on waste transportation to landfills and overloads current landfills. The chair of Building structures and basements of Voronezh state technical university has experience of lean dismantling houses, after which are coming salvaged materials, which reused in construction new low-rise living houses and in rural roads base construction. Thus, Voronezh state technical university can solute the problem of building scrap use in half, but it needs to increase a scale of using mentioned above technology.

History of reuse building materials, items and structures have its features. Because of expensive construction and a problem of living space lack after World War II, reusing of building items and structures was popular. Especially in cities, where during the war were most intensive war activity (Voronezh, Stalingrad, Minsk, etc.). After the war, there were used all, what could be used for make living house. And many of these houses stayed till this time.

Analyze of problem world experience and history showed us, that its solution has become each year more and more real. Actuality based on an appearance of ecological problems (at first), economic problems of high-rise of tariffs for landfill (at second), of rising volumes of demolition old houses and construction of new houses. Also, there is a problem of reuse building materials, because of



technologies of building scrap reuse and recycle lag behind of technologies of demolition (dismantling).

Demolition (dismantling) houses by technologies, applied today in Russia, economically and ecologically inexpedient. In contrast, of well-known technologies, offered by VSTU technology development for dismantling and constructing is waste-free and allows:

- use the used ribbed steel concrete plates with defects, cracks, corrosion, which were collected from dismantled industrial buildings. It gives high productivity new house construction process in summer and winter;
- significant decrease time of basements making (from 3 days);
- decreasing masses of made basements;
- economize a cement concrete;
- increase a quality of construction works by using steel concrete plates (made in industrial plants), absent of need in an installation of expensive formwork and high-qualified specialists at new low-rise house construction site;
- the solution of environmental problems of utilization of steel concrete plates during a demolition of houses and utilities.

## 2. Problem analysis

Total during the renovation of living found of Voronezh city will demolish 680 houses, which about 500 thousand cubic meters and 100 thousand tons of building scrap. Equal volume appears from not accountable by statistic demolished industrial and administrative buildings and utilities in Voronezh and \Voronezh region.

Because out of the demolished house are used not all materials, only 60% (stay – 20% garbage during demolition; 20% dust), a potential of problem solution, reusing materials in low-rise construction is 50% of volume. It gives economy on transportation costs and landfill costs.

There is the list of building materials and their directions of using presented in Table 1.

**Table 1.** List of building materials and their directions for reusing.

Structure of house	Materials in structure	Condition and quantity of good material after demolition and sorting
Outside walls	Brick (cinder block)	An Output of usable brick 70%
		Brick – secondary masonry
		Cinder block – secondary masonry
Inside walls	Brick Cinder block Wood	Stone – secondary masonry, road filling, access road, place
		Brick – secondary masonry
		Cinder block – secondary masonry
Floor	Wood Steel concrete	Wood – to fossil fuel
		Timber beam – reuse as a beam if usable condition, or as saw-horse or as fossil fuel
		Steel concrete structures – sorting by engineers, reuse as parts of new house's basement (patent №), as retained formwork during construction monolithic floors
Wooden floor	Wood	Timber beam – saw-horse, formwork, roof structure, fossil fuel
Roof (rafter)	Wood	Timber beam – saw-horse, formwork, roof structure, fossil fuel
Roof (housetop)	Galvanized iron	Slate – only for road (access road and places) basement filling
	Slate	Galvanized iron – to metal scrap
Plaster		Brick scrap, cinder block scrap, stone scrap, all plaster, grout for making basement of rural roads

Technology includes follow stages:

- inspection of buildings by specialists to understand how to dismantle it leans, and making recommendations;
- seek a consumer of low-rise buildings (made from reused building materials);
- engineering surveillance on dismantling and sorting appeared building materials and structures;
- identification physical-mechanical and ecological characteristics of materials, appeared after houses dismantle;
- making a project of low-rise houses with reuse of building materials and structures;
- engineering surveillance on a construction of new low-rise houses.

### 3. Solution development

According to Strategy of building material industry development till the 2030 year, there is government support exists for materials manufacturers. These manufacturers have to develop their technologies as zero-waste and recycling. Realization of this strategy makes closer Russia to countries with high rate of reused building materials refer to manufactured.

Under the management of chair engineers, each year are constructed 3-5 new low-rise houses and unities and some basements of rural roads and place. Experience of this chair (VSTU) is borrowed by some construction companies, which occupied with demolition, sorting, and construction of new houses and new small rural roads.

During dismantle houses (made of bricks with cinder blocks) seem large volume of building scrap, which is possible to use in the construction new rural roads with a hard top.

It needs a preliminary work with owners of land plots, which dedicated to low-rise private houses, heads of regions administration with a purpose to build roads IV class, access roads, temporary roads to demolition sites.

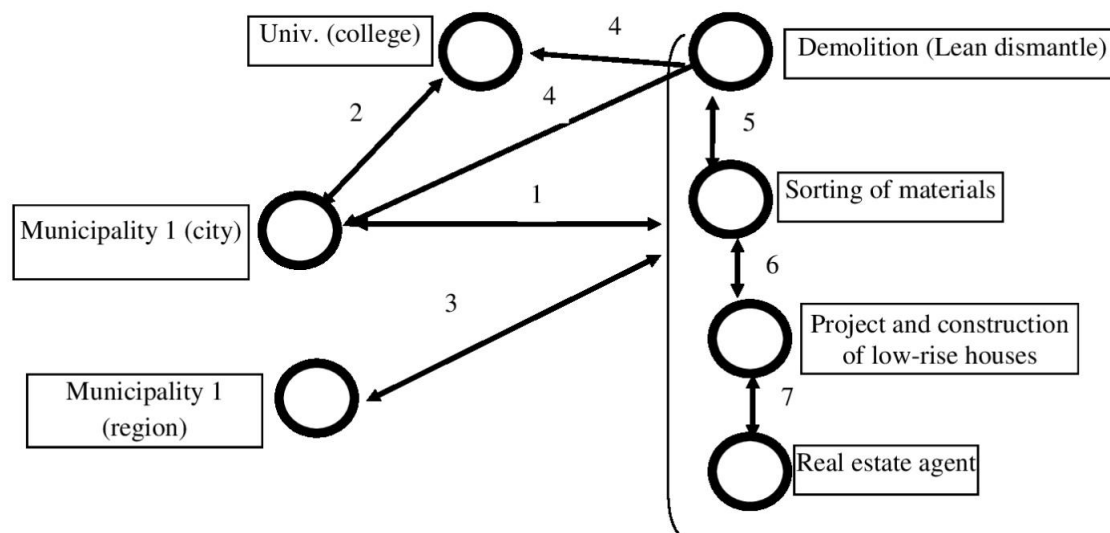
In cluster should be included:

- 1) municipality 1 (city): organizing tenders on demolition works with an obligation of using lean dismantle;
- 2) municipality 2 (region): collecting orders on a construction of new rural roads, places, and access roads;
- 3) university (college): educating for a technology of lean dismantle house; evaluation of remaining building structure resource; sorting of building materials; project and construct new houses and roads from reused materials;
- 4) construction companies – demolition contractors;
- 5) construction companies – sorting;
- 6) construction companies – a project of new houses and construction from reused materials;
- 7) real estate agencies for low-rise houses (made from reused materials).

There is cooperation of these seven participants. Bonding factors are showed in Fig. 1:

- 1) decrease of city expenditures on a realization of Program for renovation (demolition) of old decrepit living houses in the phase of demolition on about 50%;
- 2) setting up the process of demolition operations and its expenditures decreasing;
- 3) receiving a cost-free material for rural road construction;
- 4) decrease a cost of a basement of rural roads on 30-50% (because materials are free, except for their transportation);
- 5) demolition contractors getting right on tender in case of having before the education of technology (in VSTU);
- 6) demolition contractors can sell or free give materials to sorting contractor because he should clear demolition site;
- 7) sorted materials will take project and construction companies;
- 8) demand for the low-rise houses from reusable materials is ready. It needs only to systematize and increase its demand.

In Table 2 is presented cash flows in an industrial cluster.



**Figure 1.** Industrial cluster cooperation structure.

**Table 2.** Cash flows in the industrial cluster.

Stage of cluster technological chain	Cash flows per 1 house		Result
	(-) Expenditures	(+) Incomes	
1.Tender	10 000 RUB	0	-10 000 RUB
2.Lean dismantle	300 000 RUB	0	-300 000 RUB
3.Sorting	20 000 RUB	120 000 RUB	+100 000 RUB
4.Project	20 000 RUB	30 000 RUB	+10 000 RUB
5.Real estate sale	10 000 RUB	20 000 RUB	+10 000 RUB
6.Construction	20 000	500 000 RUB	+500 000 RUB
7.Education	1 000 RUB	0	- 1 000 RUB
		Result	+309 000 RUB

Analysis showed that in a researched economic system (industrial cluster) incomes exceed expenditures. And the support of technological process is not hard. Thus creating an industrial cluster is economically and technologically advisable.

#### 4. The problem of solution realization

There is the range of constraints. To these constrain could be referred lack of specialists for dismantling, sorting, engineers (who can find load capacity of reused materials), (who can make projects of low-rise houses from reused materials). There are many kinds of technical standards, which describe how to restore load capacity of building structures through reconstruction of houses. But reusing of building materials has only one technical standard document BCH 39-83(p) "Instruction to reuse building materials and equipment in a household", developed in the 1983 year. Absent of tax exemptions. Access of all building companies to demolition services. Absent of information about possibility of using the practice of reuse and lean dismantle. As mentioned above countries deposit building scrap in a waste landfill is economically unprofitable due to laws. In Russia, this law regulation is not settled.

Moreover, modern law regulation in construction branch not allows stimulating constructors, who build a new house from reused building materials. For full final solution problem of demolition houses it needs a support by region administration the waste-free technology of reuse building materials (scrap) after house demolition. Also, need a wide information highlighting in society (literature, radio, TV), changes in Federal law "About wastes of production and consumption".

## 5. Conclusions and recommendations

To advantages could be referred absent of need processes of grinding materials, heavy machines with specialized demolish equipment and eliminated manufacturing process of making new building details.

The main perspective is an extension of an assortment of houses' and utilities' projects, which could be constructed from reused building scrap. It allows a decreasing volume of deposition building scrap in waste landfills. As a landmark can be Germany, where the rate of reuse building scrap is 47%. Today in Russia are reused 5-10 % of building scrap. Top rates of reuse building scrap are recorded in Canada – 80%, Belgium – 90%, Netherlands – 99%. These countries by law have seriously restricted possibility of deposition building scrap on waste landfills. That is why these countries were developing technologies of reuse and recycle strong.

Today according researched in this article patented technology were built dozens of low-rise houses (gym, shop, living house, hotel). Cost of a built 1m<sup>2</sup> house from reused materials is 3,5 – 8 thousand RUB, which 3-5 times lower costs of a house from standard technology and new materials. Cost of making basement decreased 5-6 times, walls 2-3 times.

## 6. References

- [1] Information on <http://www.gorduma-voronezh.ru>
- [2] Zolotukhin S and Lobosok A 2011 Reuse of building materials and scrap in low-rise house construction, *Science Herald of Voronezh architectural-construction university. Materials of regional science conference "High-tech in ecology"* issue 1 pp 63-66
- [3] Information on <https://www.youtube.com/channel/UCYGPK70gKwN84pSlkQPR6dg>
- [4] Information on <http://docs.cntd.ru/document/453149000>
- [5] Information on <https://clean-future.ru/info-pererabotka-stroitelnyh-othodov.html>
- [6] Oleynik S. 2016 Building scrap in reconstruction of houses and utilities, *Internet Journal «Waste and resources»* 3 pp 1-10
- [7] Information on <http://clevereco.ru/groro/voronezhskaja-oblast>
- [8] Information on [http://minpromtorg.gov.ru/common/upload/files/docs/Strategiya\\_PSM.pdf](http://minpromtorg.gov.ru/common/upload/files/docs/Strategiya_PSM.pdf)
- [9] Information on <https://kreislaufwirtschaft-bau.rlp.de/de/startseite/>
- [10] Information on <http://www.kreislaufwirtschaft-bau.de/index.html>
- [11] Information on <http://americanarchitecturalsalvage.com/>