Material Flows of the German Building Sector

Matthias A. Heinrich

Technical University of Munich, Institute of Energy Efficient and Sustainable Design and Building, Centre for Sustainable Building, Arcisstraße 21, 80333 München, Phone (+49) 289 23969, email: m.heinrich@tum.de

ABSTRACT

According to estimates of the German Federal Ministry for the Environment, the German building stock contains around 10.5 billion tonnes of mineral building materials, around 220 million tonnes of timber products and around 100 million tonnes of metals. Due to continuous building activities, especially renovation and retrofit measures, it is estimated that this raw material stock will grow by a further 20 % until 2050 [1].

Every year more than 450 million tonnes (5.6 t/person) of mineral raw materials (e.g. sand, gravel) and more than 15.5 million tonnes (194 kg/person) of metals (e.g. steel, aluminium, copper) are required within the sector for maintaining and constructing new buildings.

The focus of this paper is the analysis of construction related raw material flows using material flow analysis (MFA) in Germany. To provide system control options in a circular economy, a deeper knowledge about material flows and stocks is required. A large range of statistical data (e.g. production, import/export, waste etc.) was evaluated and disaggregated, to investigate the impact and self-supply potential through secondary materials, of the German building industry.

Currently, the demand cannot be covered by recycled materials leaving the building sector and further primary raw materials are needed. Potentially, only 18 % of the mineral raw materials can be substituted by recycled construction waste. In contrast, for steel and aluminium the substitution rate has reached levels over 40 %.

Keywords: material flow, self-supply potential, urban mining

INTRODUCTION

The overall aim of the PhD thesis is the analysis and capture of construction induced material flows and stocks in urban systems and the identification of control options. Material flows are not limited to a single spacial level (e. g. urban, regional, national) or an individual industry sector (e. g. construction, automotive, chemical). Depending on the regarded material, the system boundaries are flexible and can change over time, especially on a spatial level.

One of the project work packages was the focus on national construction induced material flows. The results of this work package are described within this paper.

APPROACH

The dependencies of selected materials and products used within the German construction industry were identified (Figure 1). Each of the materials and products where viewed as a black box at first.
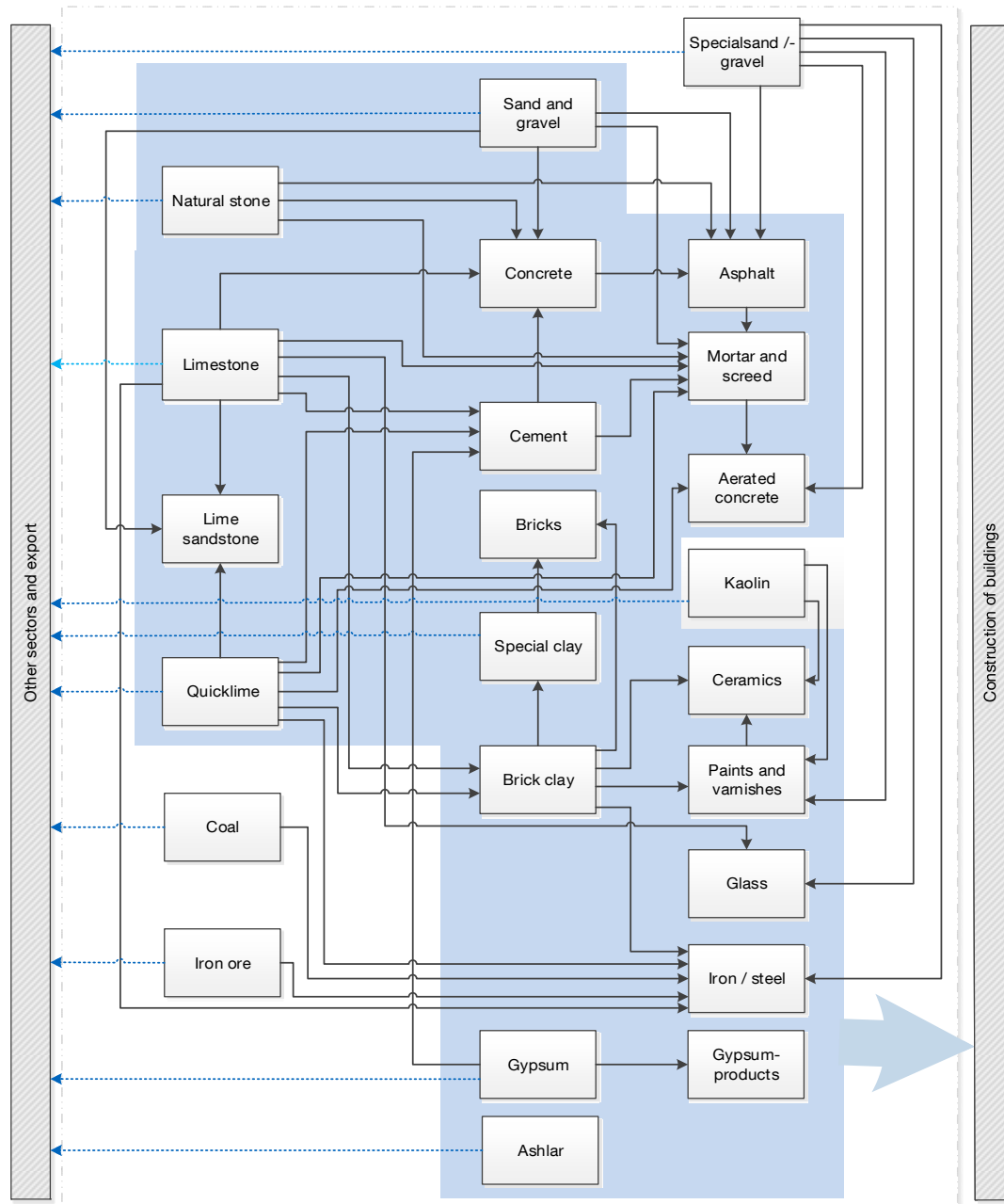

Figure 1. Material flow and interdependencies of selected construction materials

The black box view was extended to gain an insight into the individual flows on a material level (e. g. glass, steel). As an example, the material flow of glass is shown in figure 2. This extended assessment was continued for the other materials shown in figure 1 and integrated into the model.
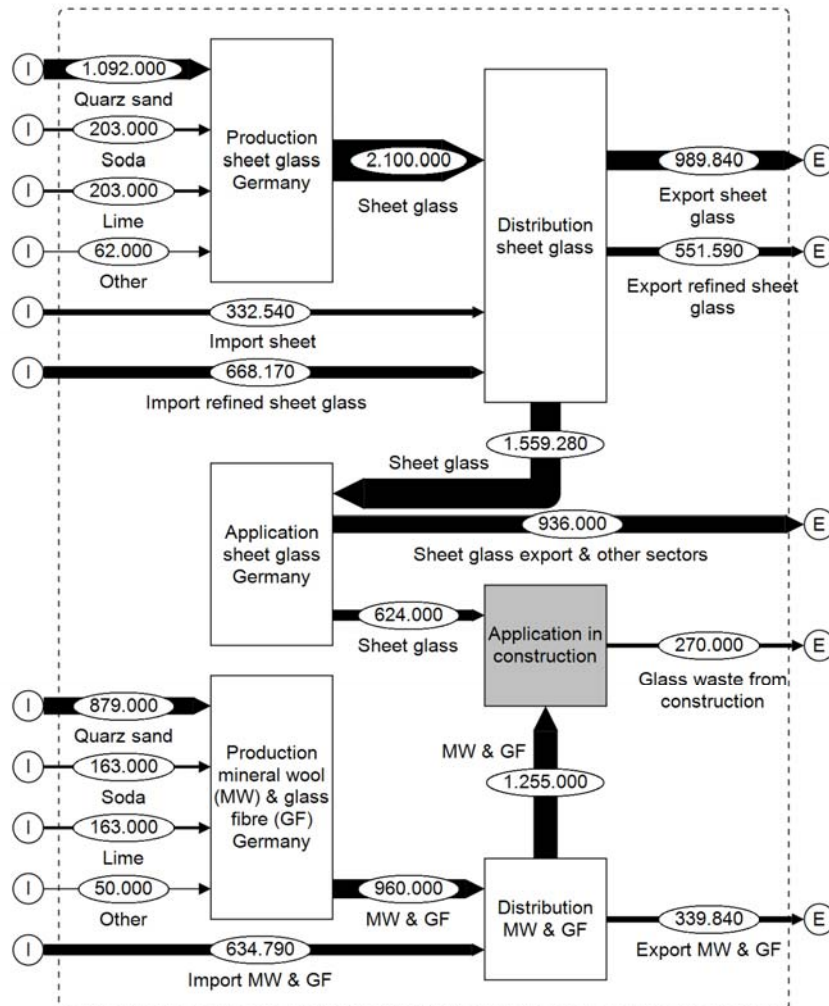

Figure 2. Material flow of glass within German construction sector (tons/year)

A large range of statistical data (e.g. production, import/export, waste etc.) was evaluated and disaggregated. Together with expert knowledge a detailed picture of construction induced material flows for selected materials could be identified.

RESULTS

Of the selected materials, steel has shown to have the highest self-supply potential through secondary materials of nearly 50 %, disregarding system losses. Also the demand of aluminium, lead and bricks used for construction purposes can potentially be covered by around 40 %, through the use of incurred construction waste. The results are summarized in Table 1.

Table 1. Self-supply potential with secondary construction materials within the German building sector for selected materials

Material	Year	National usage Mio. t/a	t/p/a	Building sector national usage Mio. t/a	t/p/a	Potential secondary materials through construction waste Mio. t/a	t/p/a	Self supply potential of building sector** (%)
Mineral raw materials	2013	540	6,70	450	5,58	78,8	0,98	**18%**
Sand & gravel	2013	236	2,93	211	2,62	*		
Specialsand & -sands	2013	9,7	0,12	3,5	0,04	*		
Natural stone	2013	207	2,57	196	2,43	*		
Limestone & dolomite	2013	23,7	0,29	7,1	0,09	*		
Gypsum & anhydrite	2013	4,5	0,06	3,9	0,05	0,6	0,01	**15%**
Clay & kaolin	2013	13,3	0,16	3	0,04	*		
Brick clay	2013	11,3	0,14	11,3	0,14	5,1	0,06	**45%**
Recycling material	2013	66,2	0,82	66,2	0,82	*		
Mineral products								
Concrete	2014	110	1,36	110	1,36	21,9	0,27	**20%**
Cement	2014	27,3	0,34	27,3	0,34	0	0,0	**0%**
Glass	2015	2,9	0,04	1,9	0,02	0,27	0,003	**14%**
Metals								
Steel	2015	44,4	0,55	13,8	0,171	6,5	0,081	**47%**
Aluminium	2015	3,1	0,04	0,5	0,006	0,2	0,002	**40%**
Zinc	2015	0,64	0,01	0,5	0,006	0,025	0,0003	**5%**
Copper	2014	1,47	0,02	0,7	0,009	0,067	0,0008	**10%**
Lead	2014	0,36	0,00	0,036	0,0004	0,015	0,0002	**42%**
* No data								
** No system losses								

CONCLUSION

Due to the continuous growth of the construction stock, a larger amount of materials is required than can be provided through construction waste. Metals, with the exception of zinc and copper, tend to have higher self-supply potentials than other materials.

For continuous monitoring of construction induced materials flows on a national level, an improved and integrated system of data collection and documentation is required, that uses the same terminology. The often incompatible statistics leave room for interpretation, which needs to be reduced.

REFERENCES

[1]   Internationaler Ressourceneffizienzatlas (2011), http://www.ressourceneffizienzatlas.de/beispiele/strategien/detail/article/urban -mining-staedte-als-rohstoffquelle.html (Accessed on 20.03.2015)