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Product-specific Life Cycle Assessment of ready mix concrete: Comparison between a recycled and an ordinary concrete

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ABSTRACT

Recycled concrete is one of the most efficient answers to the shortage of natural aggregate in highly populated and protected regions, such as Switzerland. Although the technology has evolved and today a number of certified recycled concretes are available in the ready mix concrete market, there are still many barriers to its use for structural purposes. These are caused by early tests that, analyzing non-optimized or non-commercial products, reached the conclusion that the performances of recycled concrete would not match the ones of ordinary concrete. Furthermore, early studies on the environmental impact of recycled concrete seemed to confirm an identical environmental impact for recycled and ordinary concrete (Viviani 2011; Viviani 2014). In this paper, is presented a thorough Life Cycle Assessment (LCA) for a commercialized recycled concrete and a commercialized ordinary concrete of the same strength class, both certified, both deeply characterized, showing virtually identical physical and rheological properties and sold at the same price (recycled concrete price being slightly lower than the ordinary). This LCA study shows that recycled concrete is only slightly better than ordinary concrete in terms of greenhouse gases emissions. This difference is yet not enough significant (1%) as well as for the cumulative energy demand (4%). In opposite, it performs better with around 12% less environmental impacts according to the Swiss Ecological Scarcity 2006 Method. So, current actions taken to promote their use are fully in the direction of a more sustainable construction industry if the transportation distance to the construction site is minimized and below e.g., 25 km as recommended in the Swiss Minergie ECO label.

1. Introduction

The extraction, use and end-of-life disposal (EoL) of construction materials are responsible of several environmental impacts (UNEP, 2009). A less known but critical impact of the residential and commercial building stock expansion is the scarcity of basic materials such as aggregates (both natural and crushed) (EC, 2014). This scarcity is generated by the difficulty to open new quarries or mines in a densely inhabited and protected land (DGE-GEODE, 2014). If natural resources become scarce, the volumes of construction waste to be disposed remain fairly constant. Horvath (2004) found that no other economic sector generates as many wastes as the construction sector. Furthermore, the average rate of recycling of construction waste is of about 20% (DES, 2007).

Concrete is the most used construction material in the world. Although it may present a reduced environmental impact per kilo-
that relationships between mechanical properties are not the same ones as ordinary concrete.

A series of previous studies have shown that a carefully designed recycled concrete is as reliable as that the ordinary concrete and is just another type of concrete (Viviani 2011; Viviani 2014). Companies from the recycling industry have shown that the price can be the same or slightly lower. European standards allow to certify the recycled concrete thus offering all the necessary guarantees concerning the performances and the chemical stability to the final users. Ecological labels may require the use of recycled concrete, such as Minergie-ECO in Switzerland, which is mandatory if a plant is less than 25 km far from the construction site.

Previous studies have mainly looked at the environmental impacts of alternative concretes by replacing virgin raw materials with secondary raw materials and by-products in concrete structures or pavements (Chen et al., 2010b; Giustozzi et al., 2012; Anastazio et al., 2015). Other studies have assessed the environmental performance of concrete whose mix included recycled raw materials, using the Life Cycle Assessment (LCA) methodology (Marinkovic et al., 2010; Knoeri et al., 2013). However, in these studies, recycled versus ordinary concrete were compared by only changing one variable, the recycled concrete aggregates substitution rate. As a result, they remain too generic to be representative of the market reality (Xiao et al., 2005; Viviani 2014), even if they proved to be useful in the development of the structural recycled concrete technology. In most cases, when a new aggregate (natural, recycled or lightweight) is used to produce a structural concrete, a new mix-design must be developed and optimized. In most cases the structural concrete will be tested in order to be certified. Therefore, a generic study on a hypothetical recycled concrete whose mix design is based on hypotheses such as the “need of more cement” in recycled concrete than in ordinary concrete, cannot quantify the environmental benefits of recycled concrete (Kytzia et al., 2013). The environmental benefits of recycled concrete can only be assessed by analyzing product-specific information from recycled concrete producers fulfilling all relevant standards and certifications requirements (Viviani 2014).

Indeed, there are more and more types of recycled concrete on the market and the calculation of product-specific LCA data is more and more conducted by LCA practitioners to distinguish the environmental performances of different products sold by building manufacturers (Lasvaux et al., 2015; Passer et al., 2015). The European countries develop product-specific and manufacturer-specific Environmental Product Declarations (EPD) see e.g., the EN 15804 standard (CEN, 2012) and guidelines are developed to ease the implementation of these standards into practice (Lasvaux et al., 2014). In parallel, several LCA databases exist to compile this product-specific information next to average or generic LCA data. In Switzerland, the KBOB database, based upon ecoinvent v2.2 methodology, provides both generic and product-specific data for the construction sector (Frischknecht, 2015; KBOB 2015). The database allows generic or average data representing a whole sector but also product-specific data to distinguish the LCA data depending on the producer, fuel type and material’s composition.

In this paper, the aim is to assess whether the use of recycled gravels led to a lower environmental impact for the ready mix concrete (Ecobeton®) compare to an ordinary concrete, commercialized by the same company (GCM®) and complying with the relevant standards and certifications. To that purpose, site-specific data were collected from a gravel plant and a cradle-to-gate LCA was conducted and results were compared with an ordinary concrete. A comparison is then conducted between company-specific LCA results and generic and literature data for both ordinary and recycled concrete. Secondary, the study consisted in conducting a sensitivity analysis on the “limit” transportation distances to determine above which distance the product-specific recycled concrete has more environmental impacts than an ordinary concrete produced on construction site. In this study, the Ecobeton® will be named as recycled concrete to distinguish it to the ordinary concrete.

2. Methodology

The methodology applied in this study is compliant with the ISO 14040 and 14044 standards (ISO, 2006a,b). All basic data concerning materials and processes were obtained directly at the GCM Company (GCM, 2010a,b,c). This includes raw materials, operating area (gravel mine area, construction area, etc.), type and distance of transport (train, lorry, etc.), type and amount of energy used, co-products, infrastructure and machine used, disposal of waste from process and emissions. The background environmental data were taken from the ecoinvent database version 2.2.

The formulation for both the Ecobeton® and ordinary concrete is according to the EN 206-1:2000 standard (SIA, 2000) and according to the SIA Technical Report 2030 (SIA, 2010a). The concrete used in this study is a certified C 30/37 concrete for usual structural and non-structural building applications such as columns, slabs and walls. Both concrete are manufactured for the same use.

2.1. System boundaries

Fig. 1 shows the cradle-to-gate system boundaries of the ordinary and recycled concrete production.

The required inventory data have been collected at GCM through different internal documents and reports at the manufacturing site (GCM, 2010a,b,c). To obtain the exploration permit, GCM has prepared an environmental impacts report, which provides the basic data for the LCA along with an annual inventory. The lifespan of the gravel site is evaluated at 20 years. By producing secondary materials, the number of years for exploitation can be extended.

In the case of the recycled gravel, neither upstream processes from the manufacturing of virgin concrete blocks nor from the end of life (building dismantling during the first life cycle) are allocated to the recycled gravel. Only the transport of crushed concrete blocks to the storage place before recycling is taken into account according to the “cut-off” approach for allocation burdens for recycled flows. Therefore, the crushing process is needed to obtain different co-products: the recycled gravel (53.6% in mass), the recycled sand (43.9%), and the reinforcing steel (2.5%).

In the case of the round and crushed gravel production, different process (extraction, sieving, washing and crushing) demand infrastructure and energy. Three co-products are outputs of this process: round gravel (29%), crushed gravel (30%) and sand (33%). Mud (8%) is also produce, but is internally recycled.

2.2. Life cycle inventory (LCI) of the gravel mine

The company wanted a site-specific data for their Ecobeton® production as the current generic data available in ecoinvent, to take into account a more representative gravel mine data (gravel mines are being smaller as previously) with a different function (recycled material production). For instance, the company produces about 16'000 m³ of Ecobeton® a year and this concrete is being used in new construction projects. It is thus important to assess the environmental impacts of this alternative concrete.

The company site comprises the following parts: the gravel mine and the recycled materials exploitation and three production areas: the first one for the natural gravel process (gravel diameters between 4 and 32 mm, sand 0–4 mm, mud), the second one for the recycled materials (bank gravel directly from the mine without sorting, recycled material such as concrete blocks or old tiles) and
the third one for the concrete production. Table 1 presents the distribution of the virgin and recycled gravel production of the gravel site company.

The production of natural gravel is estimated at 1,560,000 m³, including bank gravel, round gravel, crushed gravel, sand, and mud. Given a density of gravel of 1.9 tons/m³, 2,964,000 tons of gravels are produced across the assumed 20 years life span of the gravel site. From this amount, nearly 20% of the bank gravel goes directly to the recycled storage area, the remaining being used to produce round gravel (29%), crushed gravel (30%), and sand (33%). The last raw material is mud (8%) which is internally recycled as a closed-loop recycling.

The production of all recycled materials represents 1,622,026 tons for 20 years, based on the average results of the annual inventory from 2008 to 2010 of the GCM Company (GCM, 2010a,b,c). The site-specific LCA data to calculate concerns the B4-32 commercial reference recycled gravel with about 96,675 tons for 20 years. Those amounts are likely to increase the coming years with increasing of the deconstruction.

Table 2 presents the distribution of different inputs needed for the gravel mine depending if the mine is use for naturel gravel production or recycled materials production.

2.2.1. LCI of round and crushed gravels
The raw data of the ecoinvent v2.2 database “gravel, round, at mine” and “gravel, crushed, at mine” were adapted to correspond to the new company specific data. The company specific-process is close to the one modeled by the ecoinvent data, but is more up to date and the raw data information are more detailed. The data can be proposed either as a production mix of round and crushed gravel or as a separate dataset. The data has been calculated for 1 kg of natural gravel at the gravel mine.
2.2.2. LCi of recycled gravel

To calculate the specific company LCA data for Ecobeton®, we used the B4-32 gravel type. At the time of the study, the annual production was about 5,478 tons to produce an average of 16,000 m³ of Ecobeton®.

The data flows are calculated for 1 kg of recycled concrete containing 60 kg/m³ of steel. The co-products are: the recycled gravel (53.6%), the recycled sand (43.9%) and the reinforcing steel (2.5%). The total amount assumed in 20 years' exploitation is 335,664 tons of concrete block.

The impacts of the concrete block are due to the transport from the decomposed building to the storage unit at the company (Fig. 1). The assumed distance is 10 km. Finally, the input/output flows inventoried are the gravel mine, resources, vehicles exploitation, installations, energy vectors for process operation, equipment replacement, storage areas and emissions to air and liquid wastes.

2.2.3. LCi for ordinary and recycled concrete

The production of ordinary concrete or recycled concrete (Ecobeton®) slightly differ in terms of amount of raw materials in the concrete formulation. The Table 3 shows the amount of raw materials needs for each type of concrete. The data flows are calculated for 1 m³ of concrete with the following inputs: resources, infrastructures, installations, energy vectors for process operation, equipment replacement, storage areas and transport. Outputs are the heat to the air, rubber waste and sewage.

2.3. Life cycle impact assessment

Different LCI indicators have been developed in the LCA community. Recently, the new European standard EN 15804 considered more than 15 indicators including inventory flows indicators and mid-point indicators (e.g., the Global warming effect) (CEN, 2012). While increasing the number of indicators enables to have a more comprehensive interpretation, previous studies in the field have shown that the existing indicators can be highly correlated (Huijbregts et al., 2006).

In this study, the LCI indicators corresponds to the Swiss conditions in terms of legal and standardization framework. Three indicators were taken into account. The first two are the Global Warming indicator expressed as global warming potential (GWP) in kg CO₂-eq, accounting for all the greenhouse gas emissions and the total Cumulative Energy Demand (CED) expressed in MJ-eq, accounting for renewable and non-renewable primary energy.

As the current study was undertaken for a Swiss company, it was necessary to be also compliant with corresponding national standards. Those two previous indicators are also taken into account in the Swiss SIA (Engineers and architects society) technical report 2032 on embodied energy calculations for buildings for the non-renewable part of the CED (SIA, 2010b), in the Swiss national database of LCA data for construction (KBOB, 2015) and in the SIA 2040 technical report on the SIA Energy Efficiency Path with target values for construction, mobility and exploitation for GWP and non-renewable CED (SIA, 2011). In addition, the Ecological Scarcity indicator (version 2006) was calculated. This indicator is also part of the indicators required in the KBOB data list for construction. It is a single score indicator that quantifies the different ecological loads resulting from the use of natural mineral and energy resources, land use, water consumption, air, water and soil emissions and from the waste generation (including the radioactive waste). The ecological scarcity indicator aggregates the different inventory flows and is grounded on the Swiss public environmental policy (OFEV, 2009).

3. Results and discussion

3.1. Cradle-to-gate results of the company-specific ordinary and recycled concrete

Fig. 2 presents the LCA results per m³ of ordinary and recycled concrete based on the company specific data for the three indicators. The results are presented as total values in Table 4 and separated per unit process in Fig. 2 to perform a contribution analysis of the different processes. For the sake of clarity, the processes that contribute to less than 5% are grouped together to ease the reading of the Figures.

The results show that the environmental impacts of the Ecobeton® incorporating 28% of recycled gravel (formulation and recycled share used by the manufacturer to be compliant with Swiss standard and certifications for concrete) are slightly lower with 1% of impact reduction for the CED, 4% for the GWP and 12% for the total environmental impacts following the ecological scarcity 2006 indicator. Given that the type and amount of cement is the same for both concrete types, these differences are only due to the gravel production process. As an illustration Table 5 now presents the impacts of the two types of gravel for a functional unit of 1 kg for the GWP, CED and Swiss Ecological Scarcity indicators.

As shown in Fig. 2, it can be seen a substantial decrease of the impacts for the recycled gravel for the GWP and the CED (about 3 time lower) and for the total environmental impacts according to the ecological scarcity 2006 (more than ten times lower). It explains why the relative contribution of the recycled gravels are very small whatever the indicator. However, the overall differences at the concrete level remain small as the total impacts are dominated by the Portland cement production process with 92% for GWP, 75% for the CED and 66% for the Swiss Ecological scarcity indicators.
3.2. Comparison of the company site-specific ordinary concrete with existing generic data

Fig. 3 presents a comparison of the ordinary concrete impacts based on the ecoinvent data version 2.2 and the ordinary concrete based on the company-specific data (for concrete production). For all three indicators, the results from the GCM company-specific datasets are slightly higher to those of Ecoinvent. The higher impacts in the company product-specific data are due to the higher level of details of the GCM datasets and the different concrete mix. Indeed, the ecoinvent data is calculated with 6% less gravel and 15% less cement for the same density. The ecoinvent concrete contain more water to balance. Finally, ecoinvent only uses round gravel as primary material, which has lower impacts when compared to round and crushed gravel.

3.3. Comparison of the company site-specific recycled concrete with previous studies

There is not recycled concrete data in e.g., the ecoinvent database but previous studies in the literature have already looked at the environmental impacts of recycled concrete. For instance, Marinkovic et al. (2010) has analysed recycled concrete produced in Serbia. Differences of about +18% are noticed for greenhouse gases emissions compared to this study (320 kg CO2-eq/m³ vs. 271 kg CO2-eq/m³) while the differences in terms of primary energy use...
are much smaller (1613 MJ/m³ vs. 1564 MJ/m³ in our study i.e., +3%). These differences occur even if the cement content un the Serbian case study is about 5% less. As the GHG emissions are mainly driven by the cement’s impacts in any concrete, a higher share of fossil fuels in Serbia explain the higher GHG emissions compared to our study. The authors also reported similar conclusions in terms of GHG emissions i.e., there are no real benefits for using recycled concrete, assuming a transport distance to the recycling plant of 15 km (recycled aggregates) and 100 km (by ship) for natural aggregates instead of respectively 10 km and 0 km for this study.

Other comparative LCA studies are also reported in the literature such as Knoeri et al. (2013). They conducted a comparative parametric LCA study of conventional and recycled concrete. They consider lean, indoor and outdoor concrete applications with two different percentages of recycled aggregates (25% and 40%) and several mass of cement (between 150 and 360 kg/m³). For recycled concretes as closed as possible to the Ecobeton®, they found greenhouse gases emissions values between 226–261 kg CO₂-eq for outdoor conditions (strength class of C30/37) assuming transport distance of 15 km from dismantling site to the recycling plant (the same value for the conventional concrete see Table) using the same cement Portland calcareous (CEM II) type but with quantity from 320 to 360 kg/m³ and recycled aggregates from either concrete rubbles or mixed aggregates (Knoeri et al., 2013). Interestingly, the range of values for the recycled concretes fall within the conventional concrete value of 246 kg CO₂-eq/m³ in their study (using 300 kg/m³ of CEM II cement). So, even if Knoeri et al. (2013) considers different allocation rules for the construction and demolition wastes from the first life cycle (avoided impacts of the landfill of concrete) as in this study, the fact that it is not really possible to conclude that recycled concrete is better than ordinary concrete remains also valid in their findings. Finally, it is also interesting to note that the standardized and certified Ecobeton® needs more cement (350 kg) for 1 m³ concrete than the closest alternative in Knoeri et al. (2013) study. So, the absolute impacts for both ordinary and recycled are thus higher as in our study (closer to the current practices) even if the concrete class is the same (C30/37). Finally, ecological scarcity results in Knoeri et al. (2013) are also in line with this study’s results with all recycled concrete alternatives being better than the conventional concrete. However, the authors find differences about 15% to 30% when we have only reported 12%.

So, even if aggregates are one of the raw materials that can be optimized to lower the environmental impacts of ready mix concrete, this study’s and some literature’s results have shown that cement remains the largest contributor in the cradle-to-gate LCA of concrete whatever the data types (generic or product-specific) or the use of recycled gravels. The differences between ordinary and recycled concrete is not significant for the greenhouse gases emissions (GWP indicator) and the primary energy (CED indicator) with 1% to 4%. In opposite, the total environmental impacts indicator following the ecological scarcity 2006 method shows a reduction of 12% when using a recycled concrete. Indeed, the shift from virgin to recycled aggregates are better reflected in the total environmental impacts indicator following the ecological scarcity 2006 method. This indicator appears more sensitive to the mineral resources consumption and depletion than the usual fossil-fuel oriented CED and GWP indicators (Lasvaux et al., 2016).

3.4 Influence of allocation the dismantling activities in the LCA of the recycled concrete

It can now be argued that excluding the dismantling activities (cf. Fig. 1) lead to a better environmental profile of the LCA of recycled concrete. To quantify this alternative, we have used specific diesel consumption for hydraulic diggers of 0.0612 MJ/kg for reinforced concrete and 0.0437 MJ/kg for plain concrete available in a previous study for Switzerland (Doka, 2007). Considering 100% of reinforced concrete for the concrete waste fraction according to GCM (2010a), the impacts of the dismantling activities is about 3 kg CO₂-eq/m³, 56 MJ/m³ and 3788 points for the recycled concrete (Ecobeton®). It does not change the ranking but reduce even more the gap between the GHG emissions of the ordinary and recycled concrete (<1%), while the total environmental impacts are now reduced by 10%. So even if the system boundaries is defined in a way to allocate the building dismantling activities, it does not change the overall ranking of the study but strengthen the difficulty to conclude about the benefits of recycled concrete for fossil fuels-related indicators (GWP and CED).

The question of uncertainties is indeed important to discuss as we faced very low differences in the results. Because all the background data come from the same database (ecoinvent v2.2), the uncertainties of this comparative LCA solely come from the foreground data (e.g., data collected at the production plant for both ordinary and recycled concrete and the concrete mix). They are assumed to be very low because first the percentage of recycled gravel in the Ecobeton® is known with a high accuracy and the concrete mix has been deeply standardized and certified. However, other parameters may affect the results in this comparative cradle-to-gate study e.g., such as the transportation distance for the virgin gravels. As this parameter is defined on a case-by-case basis, a slight modification of the transport distances could change the conclusions. To that purpose, the following section analyses the LCA results changes to new virgin gravel pits for ordinary concrete and construction site locations.

3.5 Influence of the transportation distance for the recycled concrete

Cradle-to-gate results in Section 3 showed that the recycled concrete has slightly better results in terms of non-renewable primary energy consumption, greenhouse gases emissions and total environmental impacts than the ordinary concrete when gravels are extracted at the GCM’s gravel pit. However, the results for both ordinary and recycled concrete are sensitive to a number of parameters and subjected to change depending on the location of e.g., the gravel pit. For instance, the lack of available virgin gravels due to scarcity in existing pits (e.g., for legal constraints) may lead to the use of gravels from a more distant pit within the country due to the impossibility to find other virgin gravels within this urban area (no more quarry opening). Similarly, for economic reasons, it may be more interesting to choose virgin gravels from a more distant gravel pit located in a neighbouring country outside Switzerland and to prepare the ready mix concrete on the construction site. As an illustration, Table 6 presents the results of a sensitivity analysis comparing the recycled concrete of GCM and two alternative scenarios for the ordinary concrete all delivered at a specific construction site located at a distance of 10 km from the GCM production site near Lausanne (Switzerland) (see Fig. 4 for the three system boundaries):

| Table 6 greenhouse gases emissions (GWP), cumulative energy demand (CED) and total environmental impacts (ecological scarcity 2006) results for the distribution of 7 m³ of concrete ready to use (equivalent to two full loaded lorries) on a construction site in Lausanne. |
| GWP [kg CO₂-eq] | CED [MJ-eq] | Ecological scarcity (EcoPoints) |
| Ref | Scenario 1 | Scenario 2 | |
| 1920 | 11346 | 1500907 | |
| 1964 | 12180 | 1684937 | |
| 2041 | 13507 | 1769155 | |
• Reference scenario (Ref): production of the recycled concrete (Ecobeton) at the GCM company site and transportation to the construction site (10 km);

• Scenario 1: production of ordinary concrete at the construction site. All primary materials and the concrete central installation are transported to the construction site. The gravel comes from a more distant gravel pit located at 35 km north of Lausanne and the concrete central mixer located at 36 km. The other raw materials (cement and additives) come from the same production companies as for the reference scenario.

• Scenario 2: production of ordinary concrete at the construction site. Same transportation as scenario 1 except for the gravel who is coming from a gravel pit located in Pontarlier (France) at 72 km.

As expected, results show that the more cost optimal scenario 2 is also the scenario with the highest environmental impacts while the scenario 1 is in between the reference case and the scenario 2. Indeed, the environmental benefits of using recycled gravels for a construction site remain sensitive to the transportation distance between the recycled concrete manufacturing plant and the construction site.

From an environmental point of view, it exists a "limit" transportation distance above which it is no more interesting to use the GCM recycled concrete compared to the use of ordinary concrete based scenarios 2 or 3 assumptions. Table 7 presents these "limit" distances from the company site for each environmental indicator. It is assumed that only the location of the recycled concrete plant changes (the GCM in our study), all other parameters' values remaining identical.

Results show "limit" transportation distances for the GCM recycled concrete between 20 km to 50 km in scenario 1 and between 39 km to 68 km in scenario 2 depending on the indicator. They are found higher for the UBP. As expected, "limit" distances for transporting the recycled concrete are higher in scenario 2 as it is the...
ordinary concrete scenario with the highest environmental impacts (virgin gravels coming from Pontarlier, France).

Based on these sensitivity analyses, it is recommended to choose the available resources that generate the lowest environmental impacts. It seems that recycled concrete can be a relevant choice if the construction site is closed to the recycled concrete plant. In that case, all other scenarios with ordinary concrete show higher impacts. The situation is less obvious if the construction site gets much farther than the recycled concrete plant as it exists “limit” transport distances above which it is no more beneficial from an environmental point of view. It is here important to recall that concrete is a material which is not transported over long distance (for technical and suitable implementation reasons), the radius of transport after manufacturing being at last 25 km. So, the “limit” transport distance is a rather easy concept to only illustrate the sensitivity of this parameter on the choice of a recycled concrete vs. a virgin concrete.

Some limitations exist in this study. As it was assumed that the GCM company can always provide enough virgin gravels for the recycled concrete, we do not take into account the case of the recycled concrete made with virgin gravels coming from another pit than GCM. It can be explained by the fact that the recycled concrete properties. In the end, in practice, the choice should be done with a cost effective approach by minimizing both costs with the environmental impacts.

4. Conclusions

A cradle-to-gate LCA of ordinary and recycled concrete was conducted to analyze if the shift from generic to product-specific LCA data led to substantial differences and to compare the company-specific results between ordinary and recycled concrete. To that purpose, the environmental impacts were calculated for an ordinary and a recycled concrete (Ecobeton®) based on manufacturer’s data (GCM). Results showed that recycled gravels have less environmental impacts compared to virgin gravels. However, results for 1 m³ of recycled concrete display slightly less greenhouse gas emissions but with a not significant difference (less than 2%) compared to the ordinary concrete. Cumulative energy demand differences are slightly higher (about 4%). Differences are finally higher for the total environmental impacts following the ecological scarcity 2006 with 12%. The results between the generic and the company site-specific data remain small while the comparison to the literature data for the recycled concrete confirm this study’s findings. The inclusion of building dismantling activities do not change the results and the ranking that much. Finally, differences in results (GWP, CED or total environmental impacts) are highly sensitive to the choice of the construction site for delivering the recycled concrete. It exists a “limit” distance for each environmental indicator above which the environmental benefits of the recycled concrete are offset. Finally, it is recommended that further LCA studies, comparing recycled and ordinary concrete, be based on real data on specific and existing market products. Given the specificities of ready mixed concrete industry, which uses as much as possible locally available raw materials, have its own certified mix designs and production method, the real environmental impact of a concrete is different in all regions and is mixture intensive even though all concretes might be certified in the same strength class and used for the same purposes.

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