

## Abstract

The aim of this piece of research is to identify the implications that will occur with the introduction of the Code for Sustainable Homes. Three specific areas were identified and researched in order to complete this piece of work. A case study was done for 'New Products', a survey of 'New Home Buyers' and a technical case study on 'Construction Technology'. After conducting the research, the first findings that was identified was that there are many products out in the market but the reluctance of developers to incorporate these in new builds are preventing a widespread use of these products. The next finding was that home buyers are aware of the environmental issues but have a lack of awareness of the Code for Sustainable Home which has a large overlap with their buyer's environmental concerns. The final finding was that construction technology has changed so that the homes would comply with the energy requirements set out in the Building regulations that were updated in October 2010.

## Contents

List of Figures .....	4
Chapter 1- Introduction .....	5
Introduction.....	6
Chapter 2 -Literature Review .....	9
Changes in Building Regulations L1A.....	10
Reaction from the leading House Builders.....	12
What information is given to buyers in relation to the Code? .....	16
What is the feedback from buyers of homes which meet the Code? .....	18
Chapter 3 -Research Methodology .....	20
New Products .....	21
New Home Buyers.....	23
Construction Technology.....	25
Summary.....	26
Chapter 4 -Presentation and Discussion of Findings .....	28
Case Study- Eco-Slab .....	29
Case Study-Discussion .....	33
Survey- New home buyers .....	35
Technical Case Study- Construction Technology.....	43
Technical Case Study- Discussion .....	47

Chapter 5 -Conclusions .....	49
Conclusion .....	50
Chapter 6 -Recommendations .....	54
Recommendation .....	55
Reference/Bibliography .....	56
Appendix.....	65

## List of Figures

Figure 1.1-Code for Sustainable Homes timeline

Figure 2.1- Table showing new energy requirements

Figure 4.1- Eco-Slab product illustration

Figure 4.2- Block and Beam illustration

Figure 4.3- Block and Beam installation

Figure 4.4- Eco-Slab installation detail

Figure 4.5- Eco-Slab Installed

Figure 4.6- Chart showing results for survey question 1

Figure 4.7- Chart showing results for survey question 2

Figure 4.8- Chart showing results for survey question 3

Figure 4.9- Chart showing results for survey question 4

Figure 4.10- Chart showing results for survey question 5

Figure 4.11- Chart showing results for survey question 6

Figure 4.12- Chart showing results for survey question 7

Figure 4.13- Chart showing results for survey question 8

Figure 4.14- Traditional roof and wall detail

Figure 4.15- Modern wall detail

Figure 4.16- Modern roof detail

# Chapter 1

Introduction

## Introduction

The Code for Sustainable Homes is a government legislation that sets out standards which need to be achieved in order to design and build sustainable homes. The main aim of the Code is to reduce carbon emissions and build more sustainable homes. The Code will be implemented via the Building Regulations, particularly Part L1A-Conservation of Fuel and Power. The Code applies to the United Kingdom apart from Scotland, which has a separate body in relation to their Building Regulations.

The timeline that has been adopted in achieving the Code spans over eight years. It has been split between public and private sectors. As this is a government led initiative, the requirements are stricter for the public sector in relation to timescale than private developers. The end goal is to achieve level six homes which are 'Zero Carbon' by 2016. Below, the illustration indicates the timeline of key requirements for both the public and private sectors.

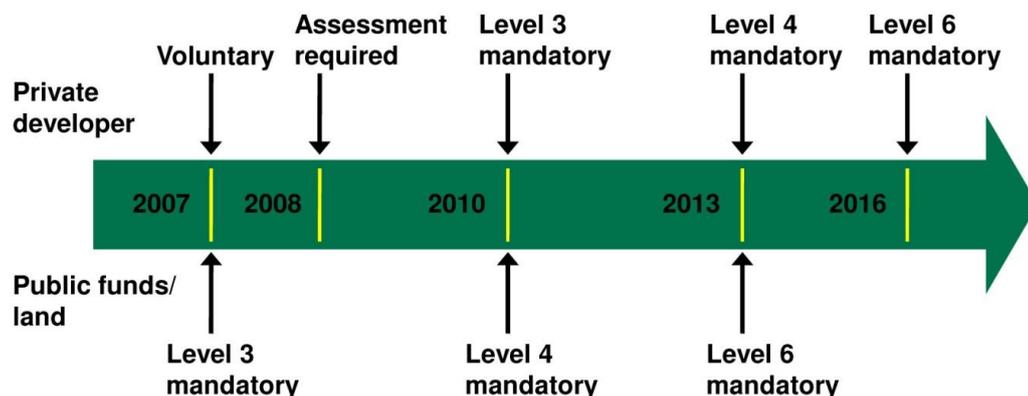


Figure 1.1-Code for Sustainable Homes timeline (Tarmac, 2009)

After the Code was initially announced in December 2006, it took effect in April 2007 for the public sector. Over the past 4 years, many homes have been built to this standard as well as private sector companies studying how the implementation of the Code would affect them. In addition, government

departments have also produced technical guidance and projection of how much it would cost. Cost models have also been made by the private sector to explore and identify the additional costs required to achieve the Code in new homes.

Feedback has been given in general to the Code from the private sector expressing their general views. An area of feedback that is lacking is the real implications of the Code. This is an area which lacks feedback from home owners, designers, suppliers and developers. With the limited information available, this creates the possibility of conducting a research project to investigate more about this area of study.

With a research area identified, aims, objective, key questions and a hypothesis have also been identified.

### Aim

The aim of the research is to identify the affects and implications of the Code for Sustainable Homes on new build housing in relation to construction technology, product selection, developers and occupiers.

### Objectives

- To investigate whether construction technology will need change and if so, how
- To examine the affect on product selection
- To investigate how developers will be affected
- To identify the implications for the buyers

### Key Questions

- How have technical construction details changed to accommodate the Code requirements?
- What are the cost implications of the Code for developers?
- Do home buyers need to pay more for Code accredited homes?

- What kind of new products are used in accredited homes?
- What are home builders doing to achieve the Code?

### Hypothesis

The key findings that are predicted from the outcome of this research project may be:

- Construction Technology will change but not rapidly. An increase of the dimension of the building envelope will be a result of the Code requirements.
- Home buyers will ultimately pay more for the property that has achieved a Code standard.
- New products are available on the market but house builders are wary of using them. A period of testing them is required prior to implementing these products and materials across a broad spectrum.

With the aims, objectives, key questions and hypotheses identified, the process of this research project may begin. With the research topic identified and the scope of work that is being researched laid out, the title of this research project will be called “The Code for Sustainable Homes, the real implications”.

# Chapter 2

## Literature Review

Changes in Building Regulations L1A

Reaction from the leading House Builders

What information is given to buyers in relation to the Code?

What is the feedback from buyers of homes which meet the Code?

## Changes in Building Regulations L1A

The Code for Sustainable homes came into effect on the 1<sup>st</sup> October 2010 in both public and private sectors. This was in line with the new changes in the Building Regulations in particular Part L1A. The Code works hand in hand with the regulations as the targets for the code are set from the requirements in the Building Regulations.

The updated Building Regulations lays out the new energy performance requirements for new builds. It is stricter and the levels that have to be achieved are now higher, thus reducing the amount of energy wasted in a house. For a building to get a completion certificate, the construction must have adhered to the Building Regulations and are in accordance with the technical drawings provided by the Architect.

The Building Regulations only identify the requirements for a building to pass the inspection. It is the role of the Architect or Designer to ensure that the construction detailing of the property will meet the requirements. This can be done by computer analysis, modelling as well the most common method at present, the Standard Assessment Procedure (SAP). This software allows the designers to model components of the structure, such as the wall, and check whether it meets the standards.

Below is a list of the top 10 key changes of Part L1A of the Building Regulations 2010 as identified by CIBSE, the Chartered Institution of Building Services Engineers.

- '25% less CO<sub>2</sub> emissions than in 2006
- A flat Target Emission Rate (TER)
- Cavity party walls – insulating/ sealing them does not count towards the 25%
- Thermal bridges – a standard  $\psi$  value will no longer be an option
- Air permeability – more pressure testing in dwellings

- Low energy lighting – 100% counts towards meeting the TER
- Electric secondary heating – no longer penalised in DER
- Design submissions now part of Regulation – alongside as built submissions
- Addressing the performance gap in relation to Zero Carbon 2016
- New limiting U values – including for party walls’ (CIBSE, 2010)

Element	2006	2010
Roof	0.25	0.20
External Wall	0.35	0.30
Party Wall	N/A	0.20
Floor	0.25	0.25
Windows	2.20	2.00
Air Permeability	10	10

Figure 2.1- Table showing new energy requirements (CIBSE, 2010)

These key changes address the issues that will arise in the near future in reaching Zero Carbon by 2016. Design and testing are at the forefront of these changes as everything has to be documented accordingly and calculated on paper as part of complying with the regulations. This is the first step of changes to the regulations with the next set of updates due in 2013 in line with the legislative changes in relation to the Code for Sustainable Homes.

Overall these changes in the Building Regulations have been quite significant as it has become much stricter and the design parameters have focussed on the reduction of emissions. These are good initial measures to complying with the Code for Sustainable homes and aims to run parallel with the timeline of the Code. The regulations look specifically at the performance of the building and in this section of the Code, it is assisting in getting new homes compliant within that specific area. The changes in the Building Regulations have been a positive step in achieving the aim of new built homes reaching the standards set out in the Code for Sustainable Homes.

## Reaction from the leading House Builders

The Code indicates the direction the government wants new build housing to go: more sustainable, energy efficient and green housing. The parties that are responsible for making this vision into reality are the house builders of the country. They are the groups of companies who have to turn what is required in the hundreds of page of guidance into an end product. It is a large task for them to take on, so a small investigation was done to find out what their reaction was in relation to the Code.

The top five house builders in the UK were investigated to identify their view on the topic. Below are the five companies and a summary of their reactions.

### Taylor Wimpey

After reading their analysis of the Code, they believe in the importance of building better homes that are more sustainable and energy efficient. The main problem is that the requirements set out to reach different levels of the standards will have additional cost implications. A major worry for Taylor Wimpey is that the government calculations provided were totally unrealistic in reaching the different levels.

‘We have concluded that the costs of the different levels of the Code for Sustainable Homes are significantly higher than those published in the Government’s Cost Analysis of the Code for Sustainable Homes Final Report (July 2008).’ (Wimpey, 2009, P4)

The overall view that has been identified is that the economic implications of the Code for this particular house builders was too high in some cases which is why more discussion is needed between all parties involved.

## Barratt

A more optimistic approach had been taken by Barratt in relation to the Code. When the Code was initially introduced in 2007, Barratts commissioned a competition challenging architects to design the homes of the future. Subsequently, the winning zero carbon design was built at the BRE site in Watford.

‘Following development with Barratt, the design meets the highest Level 6 of the Government’s Code for Sustainable Homes and will therefore emit no carbon on average over the course of a year. It is the first home by a mainstream house builder which is so environmentally friendly it would meet the criteria for zero stamp duty.’ (Barratts, 2010, P3)

It was thoroughly tested and used different products to achieve the Zero Carbon Standard. With this approach, Barratt has already started building Level 4 compliant home from January 2010 and aim to build Level 6 (Zero Carbon) homes by early 2013 in preparation for the target of 2016. Overall Barratt has taken a more proactive approach to the Code.

## Persimmon

Persimmon has started to build homes which are compliant to the Code. In 2009, 19% of homes that were sold achieved Level 3 standard/Eco-Homes Excellent standard. As part of their sustainability report, it was identified that building sustainable homes was high on the agenda.

‘We recognise that sustainability is one of the most significant issues facing house builders today. We support the Government’s Code for Sustainable Homes and are well prepared for the challenges that it has given to our industry. In 2009, we built more homes than ever before that were successfully assessed against this standard.’ (Persimmon, 2009, P4)

The company plan to increase the number of homes which comply with the Code and have already started building Level 4 homes. Persimmon has taken a good

step in the ultimate goal of building zero carbon homes by slowly developing their portfolio of the assessed homes.

### Bellway

Due to the recession, Bellway had lost a lot of work. With this in mind, the management took the opportunity to assign designers to redesign layouts and develop house models which would comply with the Code. One of the benefits of the recession was that costing for materials greatly reduced so they were able to calculate a robust cost breakdown of what it would cost to build houses that meet the different levels of the Code. With this research done, Bellway are now building homes which reach Level 3&4 across the UK.

‘The government’s Code for Sustainable Homes will require all new private homes to achieve the new Code Level 3 Energy Efficiency Standards from October 2010. In moving towards these new requirements the Group has delivered 428 homes to these new standards in the financial year (2008 – 09).’

(Bellway, 2009, P6)

### Berkeley

In 2010, the company built 64% of all homes compliant with Eco-Homes Very Good/Excellent and Level 3 of the Code. In general all 64% reached the Level 3 standard of the Code. This was the best out of the top five house builders by a considerable margin. A large push was made in 2010 to build as many homes to be compliant and the company achieved that.

‘Since implementing our targets, we have committed over 17,000 units to Code Level 3 (99% of all units taken to planning).’ (Berkeley, 2010, P26)

Out of the 64%, 18% was built to the methodology of the Code. That is almost 1/5 out of all house built by Berkeley. The company will soon offer an additional package to buyers to add sustainable features onto their homes, giving buyers the option of being more sustainable. Overall Berkeley has put sustainability at

the core of the business and strives to provide high quality homes which meet all the requirements.

From this small investigation into the reaction of the top five house builders, different perspectives have been identified. Some companies are more comfortable with it than other and some companies have really embraced it and have tried to do the best they can so far in this past few years. Overall, all the companies have taken some action to prepare themselves for building homes which comply with the Code. A majority have already started building compliant homes which gives them an advantage as they can analyse what has been successful and what hasn't.

## What information is given to buyers in relation to the Code?

As the Code for Sustainable Homes is for new build housing, it allows developers a marketing opportunity to promote their homes. By informing potential buyer's key facts regarding the house and energy efficiency, it may enhance the impact of the house on the potential buyers.

Research was conducted by contacting agents representing new build homes that met the Code. After identifying what information was given to buyers in relation to the Code, the results show that very little information is provided initially but additional information was available if the buyers requested it. The initial information available varied from the different agents. Some agents marketed the Code to enhance the property and listed features of the property whereas some just stated that the property met the Code and the respective level that it attained.

After exploring many property brochures that comply with the Code, below is a typical way in which agents just inform the reader that the homes comply with the code.

'The house has been extremely well designed and is built to Code Level 3 standards for energy efficiency.' (Primelocation (PL), 2010)

'Code level 3 Sustainable Homes' (PL, 2010)

On a few occasions, the agents gave more information to the reader and gave a description of some of the features that the properties had. Below are examples of two occasions in which the marketing brochures gave more information.

'The houses have been built to code level 3 for sustainable housing which not only benefits the environment by reduced greenhouse gas emissions but also benefits home owners by increasing energy efficiency. All the homes in Sirdar Mews have a 'Sedum Roof' which not only have a visual appeal but also reduce the environmental impact of the building, it provides solar shading and space

cooling in the summer, absorbs rainwater and helps suppress water runoff.'

(PL, 2010)

'Eco-home built to the Code for Sustainable Homes (CSH) level 3, includes

- \* Highly insulated
- \* High-efficiency boiler
- \* Heat recovery system
- \* Water-saving fittings
- \* Rainwater harvesting
  - \* Water butts
- \* Low environmental impact and recycled materials
- \* Secure cycle and garden storage' (Rightmove, 2010)

As you can see, the level of information is more descriptive and gives the potential buyer an idea of the benefits of a home that complies with the Code.

Overall the information that is given to potential buyers regarding the homes and what level it has attained varies from agent to agent. Depending on the marketing strategies by the agents, the level of information varies. With this approach, the buyers may get a better insight into what the Code means and features that are present to attain the level. This is apparent when the brochures are more informative. Brochures that just state that a home has reached a specific level prevent the buyer initially from knowing what it means to have a home that is accredited. What it may allow is that buyers could request further information so that they could learn more about what the Code means. With many agents just stating the home is accredited, it may represent what the buyers want to know about the property when looking at it initially. They may not want to market the property so it informs the reader of all the key features required to attain accreditation. Therefore the marketing approach may have been designed to just inform the potential buyer of the accreditation and if they are interested, provide additional information if requested.

## What is the feedback from buyers of homes which meet the Code?

As the Code for Sustainable Homes was mandatory for both Public and Private sector in 2010, at the present time, occupants have only lived in their homes for just over a year. Therefore post occupancy feedback is limited but a study by the Department of Communities and Local Government does give an insight into how occupants feel about their accredited homes.

A majority of the occupants were extremely happy with their properties especially in the context of bills. All occupants saw a reduction in their energy bills as well as a reduction in their water bills.

‘Another occupant of one of the three-bedroom houses was interviewed and expressed considerable satisfaction with the property, particularly due to the fact that their new home meant that they had lower energy and water bills.’

(Code for Sustainable Homes (CSH), 2009, P20)

In addition to all the reduction in energy bills, occupants like the green features that have been incorporated into homes and feel they are important as they know they are making a conscious effort to reduce their impact on the environment.

‘These homes are fantastic, especially with all the green features that have been built in. We feel that we are actively taking measures to reduce our impact on the environment.’ (CSH, 2009, P20)

Although there are many benefits to the Code, some developments are designed to remove the need for individual boilers in each property. Replacing these boilers is a central boiler that runs on biomass. As this is a fairly new technology that is used to heat multiple properties, issues have come up with the reliability.

‘There has been a problem with the heating system [the biomass boiler] – when the heating works, it works well, the flat warms up quite quickly. But there have

been times when the flat has been quite cold when the boiler has stopped working.' (CSH, 2009, P26)

Overall buyers of homes that have achieved accreditation from the Code for Sustainable Homes have benefitted from their new more energy efficient homes. They are better off financially from savings in energy and water bills as well as reducing their impact on the environment. The psychological effect of knowing that the buyer has green products implemented in their properties makes them more aware of how they are being more efficient in the way they live. When each home is built and attains the required level, by implementing individual green solutions in the property, all the systems work in harmony and if there is a problem, it will only affect the residents of that specific property. From reading the post occupancy feedback of a level 3 development, when services are made communal, such as the biomass boiler, if there is a fault, multiple homes would be disrupted. This is the main downside that has been identified by residents that have been in this situation.

# Chapter 3

## Research Methodology

New Products

New Home Buyers

Construction Technology

Summary

## New Products

There are hundreds of products that have been developed in mind for low carbon and sustainability. With many products designed to replace its counterpart that are being utilised in new builds in the current market, deciding which product to use, is dependent on the developer. Like many different products, whether they are used or not in new builds are completely up to the developers to decide.

To find out more about the selection of products that are available in the market that have been designed to help achieve energy reduction and provide a key function of a home to attain the accreditation of the Code, research will be conducted to get more information regarding these products and their performance in comparison to present products and materials in the current market place.

To find out more about the products, a method to conducting the research has to be adopted in order to do so. Three different types of research techniques have been identified which could be suitable for the purpose of this specific research area: Case Study, Desk Study and Interviews.

Conducting a case study will provide details of the products and analysis them. The case study will also give information on how the products and materials rates in terms of performance as well as practical examples of them being implemented in real life. This research method looks like it could be suitable for this topic.

Conducting a desk study will provide information, but it will be from a secondary source. For the purpose of this specific topic, this would not be suitable as a research method.

Interviews with manufacturers of products could possibly be the method selected for this topic. The main problem with this is that it would be time

consuming contacting multiple manufacturers. The other main problem that may occur is that manufacturers would possibly be biased towards their products. Therefore it is not the best research method.

From exploring the three options identified, there are two possible methods that could be used: Case Study and Interviews. The problem that has been identified is the data and information that is collected from the interviews may be biased. To keep the research as impartial as possible, conducting interviews will not be used as a method of research for this specific topic. Therefore the research methodology selected for the topic is going to be Case Study. From the analysis, the case study allows information to be gathered independently and analysed without any bias. It also has a large scope of work as it allows multiple areas to be researched and then presented in the case study.

## New Home Buyers

Building homes that comply with the Code is the responsibility of the developers. There is another group of people that are more important, the occupants. These people will have to live with the results of the Code as they are the new home buyers. The question is, do they know what the Code is or what it means? These are just some of the questions that need to be asked as they are directly affected by the Code.

In order to find out what this group of people think, I need to research this. Three different research methods have initially been identified to accomplish this research task. The methods are Questionnaire, Survey and Interviews.

Conducting a questionnaire will provide good valuable data as the people completing them will be able to give valuable information from their perspective. The downside of the questionnaire is that from the size of the group that conducts the questionnaire, there may be many different answers which will make data analysis difficult.

Surveys are another form of research that may be suitable for finding out what buyers think of the Code. With preset questions with a selection of answers, the survey will provide valuable data that could be collated and analysed as direct comparisons can be made between answer. This method will show the results clearly after data analysis.

Conducting interviews is the final research method that was identified that could be used to find out what buyers think. By conducting an interview, it will give the opinions of all those who participate. The main problem is that the same situation may occur as to the one identified in the questionnaire. Different opinions may be identified and it will be problematic for data analysis. Categorising opinions is subjective to the person doing it and is biased to that person's interpretation. Due to this issue, interviews will not be suitable for this topic.

From the research methods that have been explored, only one of the methods seems to be best suited for this topic. A survey will be conducted to capture the opinions of home buyers and what they think about the Code. The survey was the best option as it could provide valuable data. Not only would the data be valuable but most importantly, it would be credible. With the need for interpretation like the other two methods, the data that will be collected could be interpreted into quantitative data and produced into graphical form. The other two methods, questionnaire and interviews, were unsuitable as the need for interpretation would be required. Different people interpret things in different ways therefore it was deemed that these two methods were unsuitable.

## Construction Technology

Implementing the Code to all new developments means that changes need to be made for the construction of the homes. With all the new changes that are set out in the updated Building Regulations Part L1A, changes need to be made so the homes can achieve the accreditation.

In order to find out what has changed, research needs to be conducted to find out exactly what has been developed. To research this, there are two methods that can be used to find out what has changed: Interviews and a technical case study.

By conducting a technical case study, it allows for data to be collected for both traditional construction details and new details that have been adopted to achieve the energy requirements. With the data collected, it will provide the opportunity to compare both forms of construction as well as visually seeing the difference as the data will allow for illustrations to be drawn. This method allows for primary data to be transferred into visual illustrations to see the difference.

An interview with builders who construct these homes would provide first hand information about the changes. These are the individuals that turn paper drawings into a finished product. If an interview was to be selected as the method of research, multiple builders would need to be interviewed to get a broad spectrum of views. This may be difficult and time consuming.

From the research methods that have been identified, the best method to research how construction technology has changed is to conduct a technical case study. This will allow for data to be collected and then analysed through illustration so it can be clearly differentiated between the two details. The interview technique is extremely time consuming and there is no guarantee that builders will have time for an interview, thus rendering it unsuitable for this topic.

## Summary

In summary, the three areas identified of which research has to be conducted, a methodology has been identified in order to conduct the research. The methodology selected for each area has been compared and contrasted with other forms of research strategies and the selected methodology has been chosen as it best fits and is most suited for the purpose of the research. Below is a small description of each of the selected methodologies and reasons why it was selected for that specific area.

### Case Study- New Products

A case study on new products will be conducted. It was decided to do a case study as it will allow the investigation of new products out in the market to assist in achieving the requirements for the Code. It will also allow the opportunity to compare the performance of materials and products. By comparing the performance, it may show that in the near future, a product can be replaced with a newer product that has a better performance rating.

### Survey- New Home Buyers

New home buyers are the people who will be living in these houses that comply with the Code. It is important to find out if the Code is as important to them then it is for the government. To do this, a survey will be conducted in order to find out. A sample of 25 people will be taken to get a large range of perspective. The survey will present findings to express whether the principal of the Code is important to the buyers and whether it plays a part in choosing their next house.

### Technical Case Study- Construction Technology

With the new Code, construction technology will be developed to ensure that the homes comply with the updated Building Regulations in particular Part L1A. This part of the building regulation is fundamental to the Code for Sustainable Homes as it is designed around the whole ethos of reducing energy consumption

and making homes more sustainable. Therefore, it has been decided that a technical case study will be conducted on this. The aim of this research methodology is to identify and compare the difference in construction detailing. This will visually show how the Code has affected construction detailing.

With all the research methodologies identified, the next step is to conduct the research. With a clear understanding of what is being researched, the data collected should provide a good platform to discuss and analyse the findings.

# Chapter 4

## Presentation and Discussion of Findings

Case Study- New Products

Survey- New home buyers

Technical Case Study- Construction Technology

## Case Study- Eco-Slab

A product that has been introduced to the market is Eco-Slab. Eco-Slab is a modular polystyrene system that can replace the need of a block and beam floor on the ground floor level. This is how the manufacturer describes Eco-Slab.

‘An environmentally responsible and cost effective alternative to block and beam. Eco-Slab is a modular system consisting of 1m sq interlocking rafts & a thickened edge beam. The undersides of the rafts have egg-box style legs that create a void beneath the completed slab for services and ventilation. The top has a unique lap & ledge system that forms a uniform insulation layer. 35% cheaper, 10 times faster and greener.’ (Eco-Slab (ES), 2009)



Figure 4.1- Eco-Slab product illustration (ES, 2009)

The product has been used on private developments and has been given extremely positive reviews from the architecture community, having featured in the RIBA Journal and the Observer newspaper. A key finding that was identified by both these organisation was that the reluctance of volume house builder to implement this type of product as they come in cheaper per square metre than an alternative systems. In this case, the systems would be a traditional block and beam floor.

A block and beam floor, is a system which compromises of precast concrete beams which are supported at either ends. The beams are placed so that concrete blocks can be placed in between. This is repeated throughout the floor and creates a floor. Below are an illustration of how the system works and a picture of the system being installed.

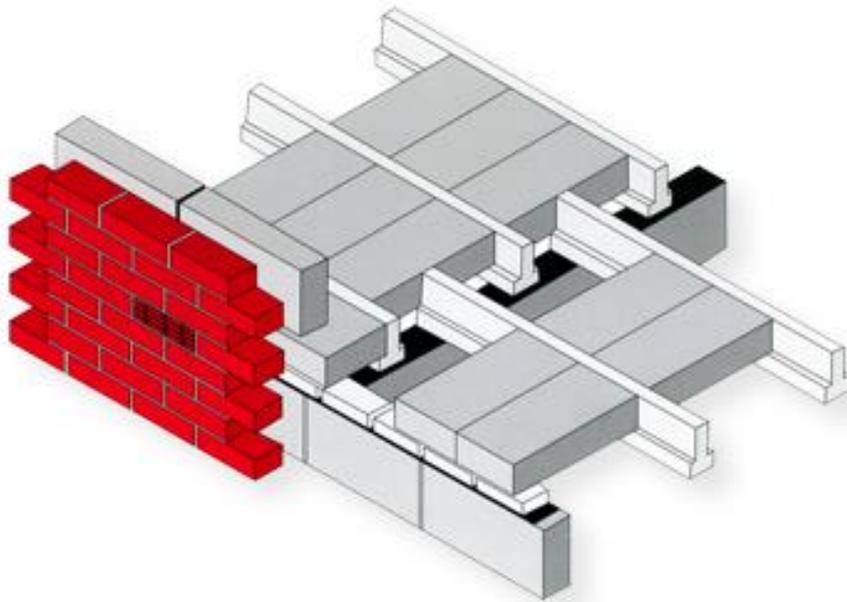


Figure 4.2- Block and Beam illustration (Litecast, 2009)



Figure 4.3- Block and Beam installation (Floorspan, 2009)

The product that can replace the traditional block and beam floor is the Eco-Slab. The product works in a way which removes the need for the block and beams which requires a high embodied energy to make the components. The product is placed on firmly compacted ground to create a highly insulated polystyrene formwork in which the concrete floor could be poured directly onto it. This creates a highly insulated ground floor slab with an extremely low U-value. This reduces the amount of heat lost through the slab. Below is a section of how the system works and a picture of the system laid out on the ground.

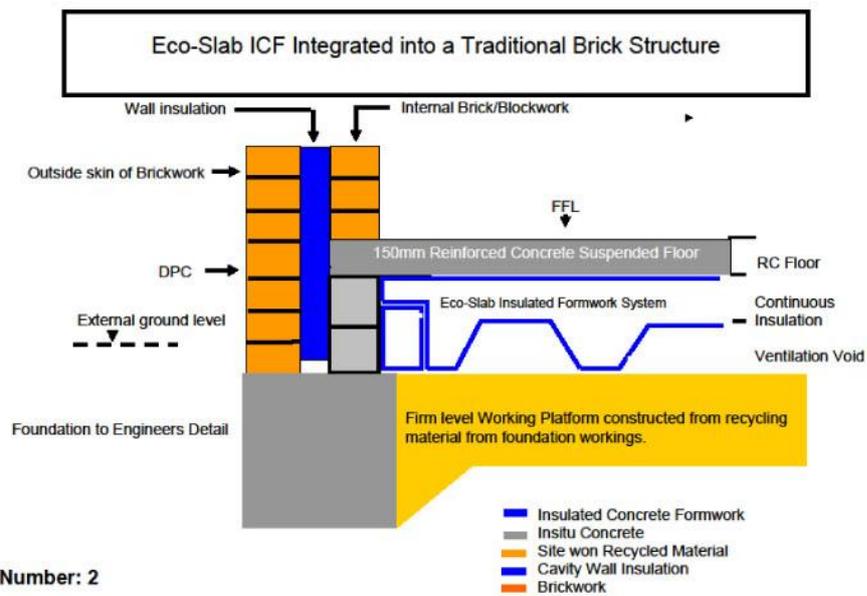


Figure 4.4- Eco-Slab installation detail (ES, 2009)



Figure 4.5- Eco-Slab Installed (ES, 2009)

With this innovative product available on the market, which is cheaper to buy and install as well as savings three tonnes of CO<sub>2</sub> emissions, it is only a matter of time until house builders will start to use the next generation of innovative products.

## Case Study-Discussion

The case study on the Eco-Slab showed the innovative types of products that are coming into the market to help solve the problems of heat loss within homes. This is just one of hundreds of products out in the market to help make buildings more eco-friendly, energy efficient and sustainable.

This product has proved what it can achieve in real life after thorough testing by the Building Research Establishment. The next step is for it to be implemented into a small scale development to see how successful it would perform. It has been tested on a small scale but not on the larger scale. This is where the inherent problem is. House builders are not using these innovative products that have been specifically designed to assist achieving high levels of thermal performance and complying with the Code. The question is why aren't they? When the RIBA Journal asked Alasdair Young, whose position at Buro Happold is a Senior Sustainability Engineer, this was what he thought the problem was.

'The trouble with volume house builders is that ultimately they're building to a minimum standard, which is a de facto maximum. Entrepreneurial innovations are great, but volume house building is a risk-averse industry – and nobody in it wants to be the guinea pig.' (Kucharek, 2009, P65-67)

One of the current systems that are used for ground floor constructions has been identified as block and beam. Although, the method is very good and can create a platform fairly quickly, the material used for this method, concrete, is one of the biggest pollutants in the world. The embodied energy used for creating the constituents of a block and beam floor has a carbon footprint which is massive. With alternatives available on the market, house builders should start to use these products. By changing over to these newer products, the environment will benefit through a smaller emission rate and thermal performance for occupiers. Both will benefit financially as savings would be made.

Implementing this product is not a difficult task as the details show the difference. Sooner or later, house builder will need to adopt these products because to comply with different levels of the Code, all the sourced materials in the home have been given a rating by the BRE. To comply with different levels, a higher rated material has to be used as this is one of the key requirements to gain accreditation. These new products are the future of sustainable homes.

## Survey- New home buyers

A survey was conducted to find out what new home buyers knew about the Code. The number of people surveyed was 25 and their responses were noted. The following data was collected after the questions were answered.

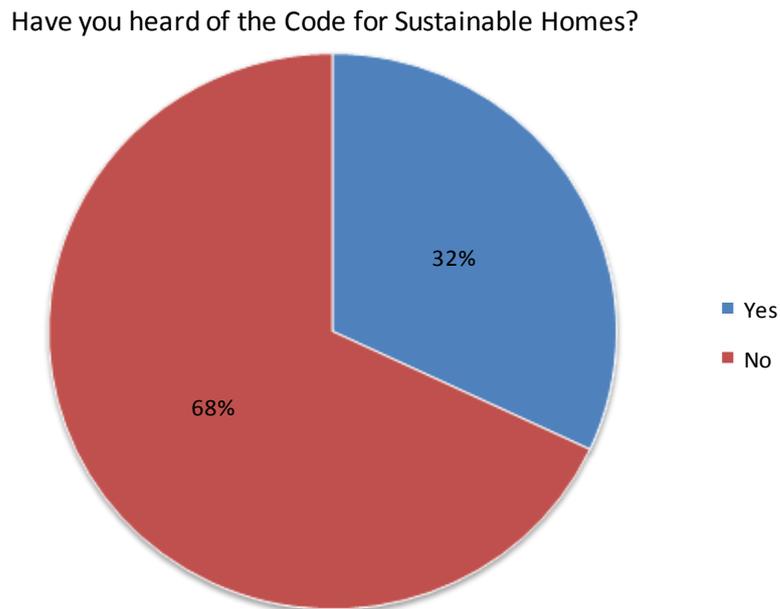


Figure 4.6- Chart showing results for survey question 1

When this question was asked, only 32% of the people surveyed knew what the Code was. This was surprising as all new build developments in both public and private sectors have to be built to the standard of the Code as of 2010. This result shows the lack of awareness of the Code to home buyers. This issue must be addressed whether it is by the Government, Developers or property agents. The awareness must increase so buyers know exactly what they are buying and understand what it means when a property is marketed as 'CSH Level 3 Home'.

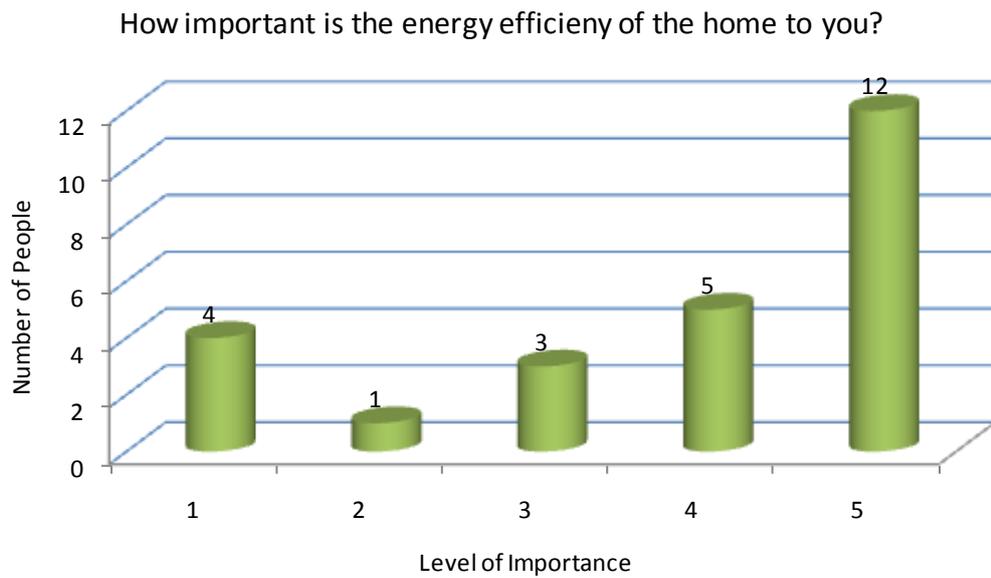


Figure 4.7- Chart showing results for survey question 2

When the question of energy efficiency in the home was asked, the results showed that a majority of the surveyed people gave an answer between three and five in the scale of the importance. This was slightly surprising as it was not expected that 80% of the people surveyed found the energy efficiency of the home important to them. This shows that with a greater awareness of the environment, people are taking a keener interest in issues such as this. With these results, it really shows that the way the Code is being implemented in new homes being constructed, buyers are really appreciating that the energy efficiency of the homes are to a high level.

Are you looking for a home which is sustainable and eco-friendly?

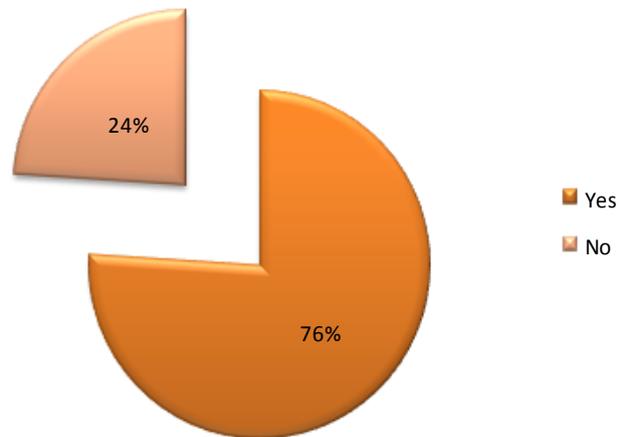


Figure 4.8- Chart showing results for survey question 3

When the question of buying a sustainable home was asked, over three quarters of the people asked said yes. This was a very encouraging result as it shows that a majority of the surveyed people wanted a house that had been designed well and with the environment high on its agenda. It also shows that a majority of buyers are aware of their carbon footprint and are looking for homes which will enable them to reduce it. Overall, the results for this question are very promising and indicate that buyers are now looking for more sustainable and eco-friendly homes.

Would you pay more for a sustainable and eco-friendly home?

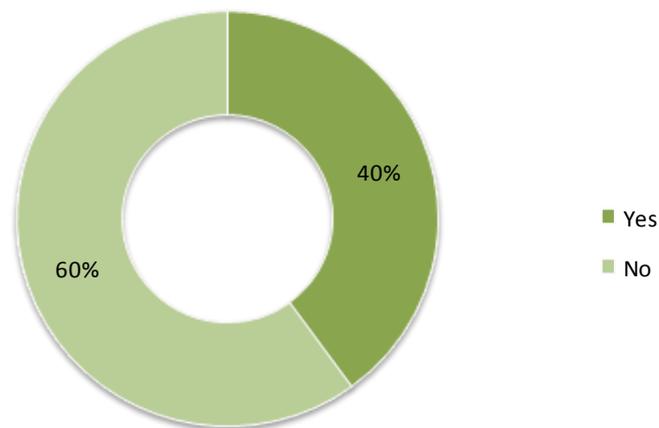


Figure 4.9- Chart showing results for survey question 4

The question of paying more for a sustainable home was designed to get an idea of how willing a buyer would be to invest more money so they could get a sustainable and eco-friendly home. The results collected showed that only 40% of the people asked were willing to pay the extra money required to buy a home. This also shows that although homes are being built to the Code standard, due to the increase in building cost, the finished home will most likely be more expensive so the developers can still achieve their margins by passing off the extra cost to the buyers. With this increase, buyers may be put off from purchasing the homes due to lack of funds or any other reasons. This is an issue that will need to be looked at to see what can be done to assist buyers in attaining these properties without the need to pay thousands of pounds additionally.

Are you looking for a new build?

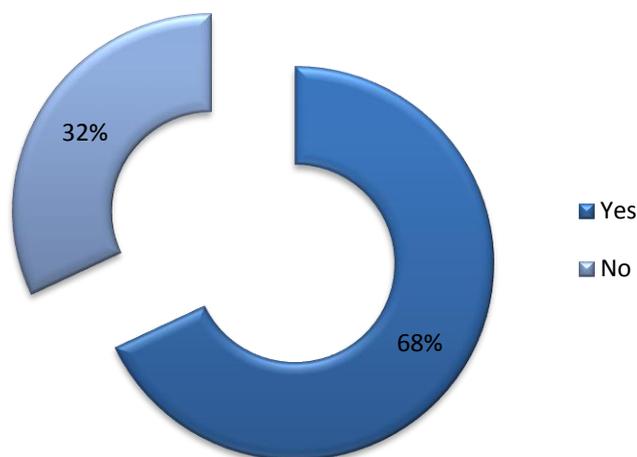


Figure 4.10- Chart showing results for survey question 5

The Code is mandatory for all new build homes so the question was asked whether or not the buyers were interested in buying new build instead of existing. The results show that 68% of all people asked were looking to buy new build. This is encouraging as they would be living in a Code accredited home which is at least level 3. A reason why a large proportion on people asked may be looking for new builds is that they know exactly what they are buying. It may be the case that they want to avoid the problems that may come up in an existing property. The idea of problem free living may be why a high percentage of people want new builds.

Would you buy a home with a smaller carbon footprint than a standard home?

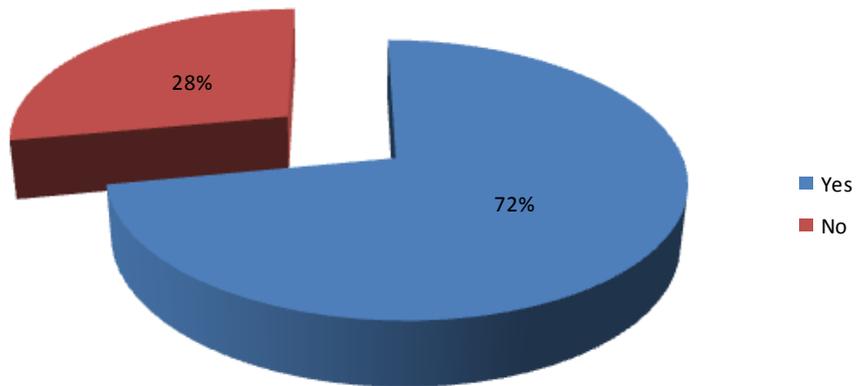


Figure 4.11- Chart showing results for survey question 6

When asked if the buyers would buy a home with a smaller carbon footprint, 72% agreed and said they would. This is a clear indication that the buyers are very aware of the environment and will make lifestyle decisions to reduce their personal impact on the environment. It also identifies that buyers are looking into a new aspect of a home in relation to its carbon footprint. It is apparent that environmental issues are more important than ever and buyers are aware of this and taken it into consideration.

Have you tried to reduce your energy consumption?

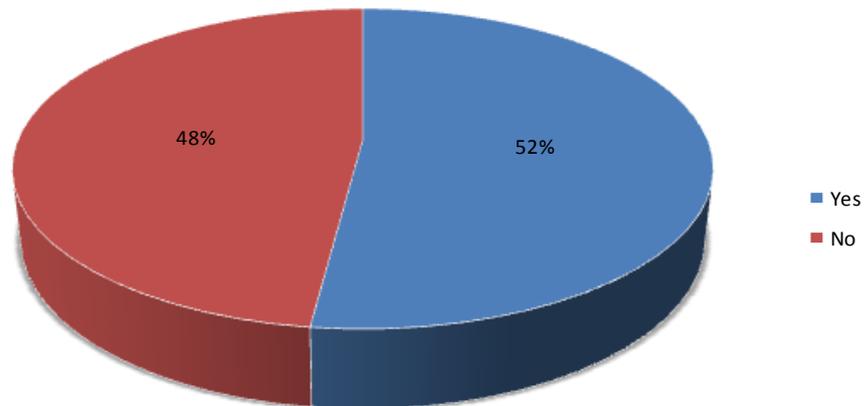


Figure 4.12- Chart showing results for survey question 7

When the question was asked whether the individuals had made an effort to reduce their energy consumption, the results were fairly even with 52% saying yes they did. Although it seems like this result shows that some are consciously trying to reduce their energy consumptions and other are not, it does provide the opportunity to assist individuals to reduce their energy consumption. By implementing a Building Management System (BMS), this may assist all users to manage their energy consumption. This system may help the cause in reducing energy consumption.

Will you find out more about the Code after this survey?

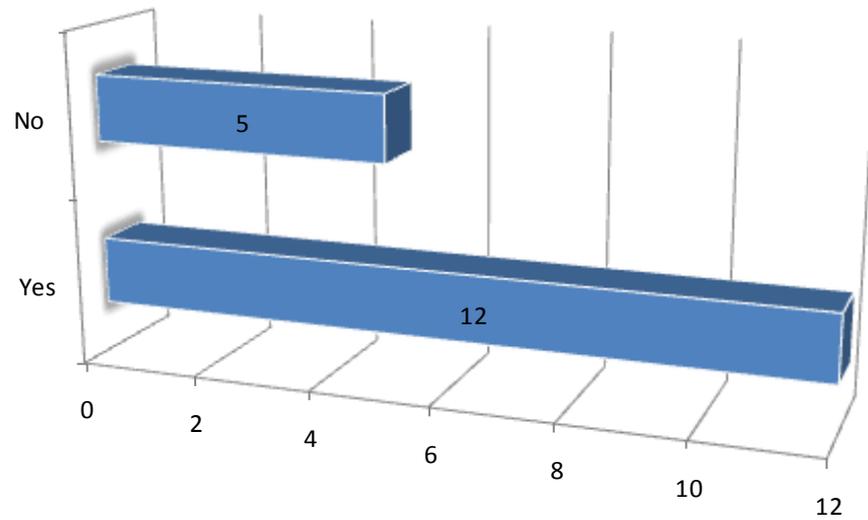


Figure 4.13- Chart showing results for survey question 8

After the main questions in the survey were complete, a final question was asked to the people who did not know what the Code was. The question asked was whether or not the individuals would find out more about the Code after the survey finish. Out of the initial 17 that didn't know what the Code was, 12 of them said that they would look further into what the Code is. This represents just over two thirds of people who were not aware. This shows a positive sign that the buyers are interested in what the Code means.

## Technical Case Study- Construction Technology

Construction technology has changed in line with the Code. A technical case study was conducted to identify the current traditional construction details and how they have evolved and have been adapted so they are compliant with the current Building Regulations and meet the Code standards.

Below is a drawing of a traditional roof and wall construction. Prior to the Code coming into effect, this is how thousands of homes may have been constructed. Now with the more strict energy performance requirements, detailing has developed.

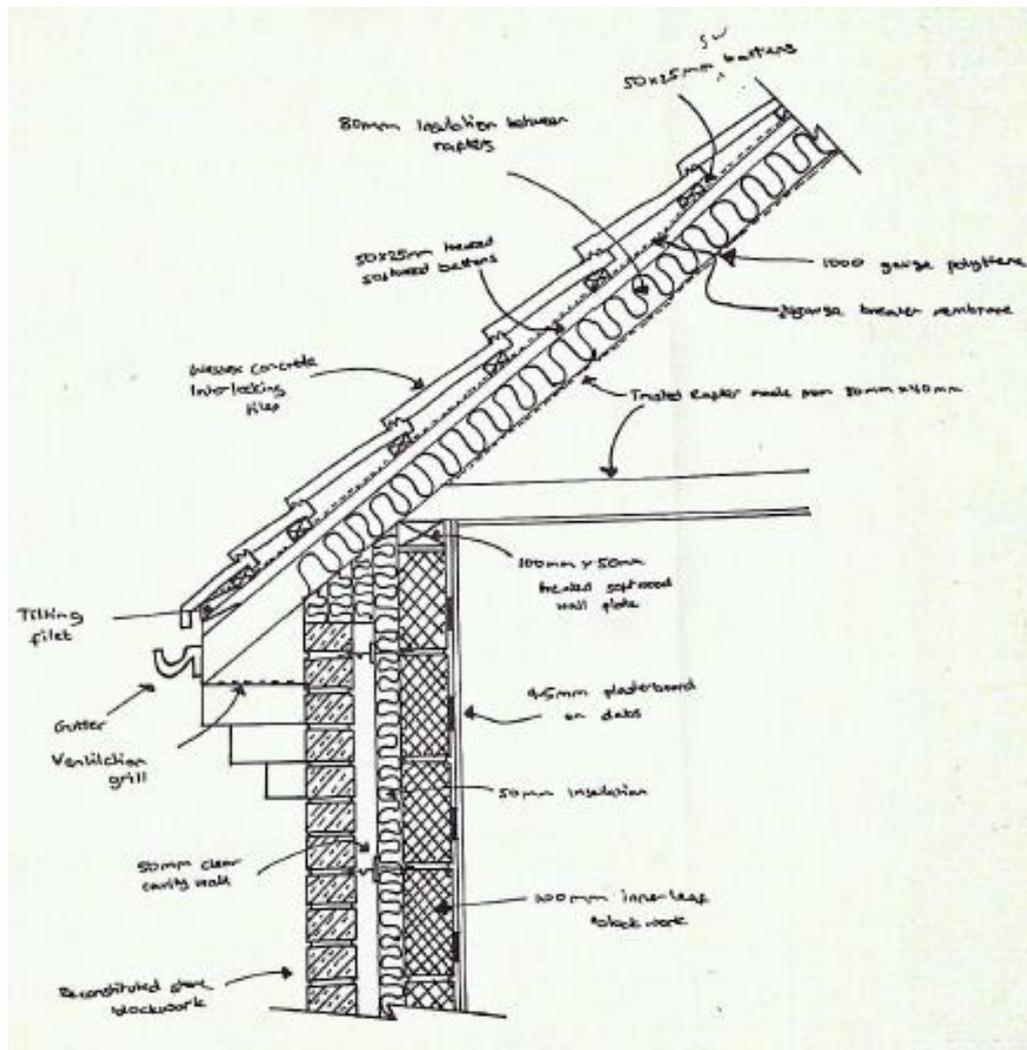


Figure 4.14- Traditional roof and wall detail (Ali, 2009)

The wall construction is of cavity wall construction. The external leaf is brickwork with a partially filled cavity with a 50mm air gap followed by the same in insulation. The internal leaf of the wall is of lightweight concrete blocks and is finished with plasterboard on dabs. This is very common on housing developments.

The roof construction consists of a truss roof sitting on a wall plate which is screwed together. Insulation is placed in between the rafters of the parallel trusses. The roof covering is designed so it could accommodate any covering. In this particular drawing, battens and cross battens are connected to the truss with a breather membrane in between to accommodate the concrete interlocking tiles.

With the building Regulation changes that occurred to part L1A in October 2010, the thermal performance and energy efficiency of the building had to increase. This resulted in details being redesigned. The drawings below are results of these re-designs and how construction technology has changed so accredited homes could be achieved.

Below is an illustrative drawing of an external wall which is connected to the party wall. The wall consists of an outer leaf of brickwork with a cavity. Timber construction is then used with plywood sheathing connected to timbers which are closed within the building with the plasterboards. All relevant membranes are incorporated. What this does is that it creates an empty carcass which can be filled completely with insulation.

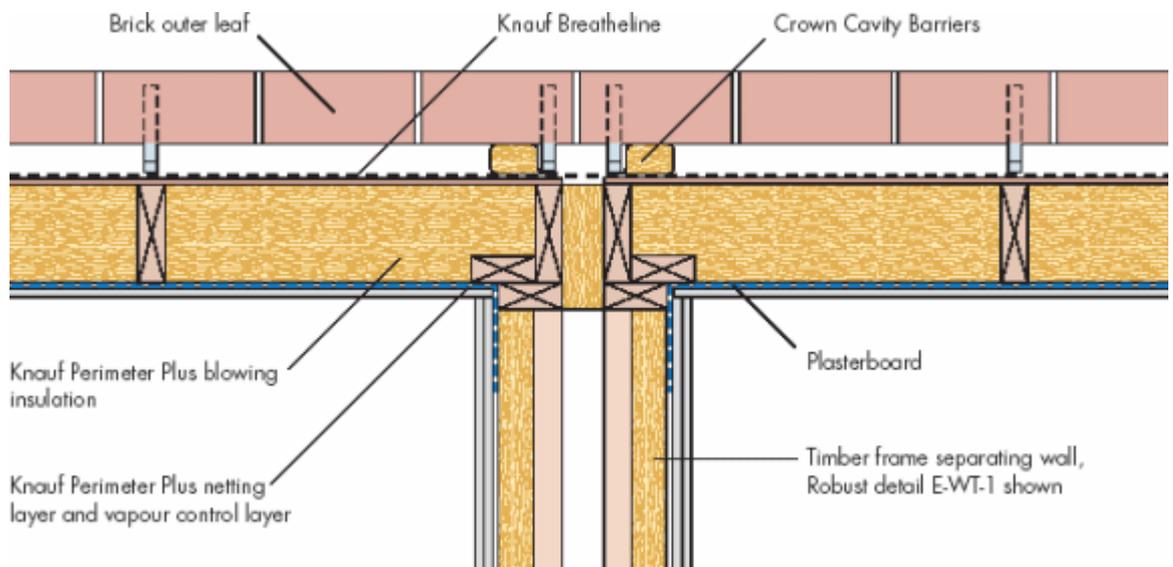


Figure 4.15- Modern wall detail (Knauf, 2009)

Below is an illustrative drawing of the construction of the roof. Many of the details are the same to the first drawing but there is one fundamental difference, the level of insulation on the floor. There is anything between 100-300mm of insulation additionally between the ceiling joists. The roof is the primary area for heat loss in a property. This is due to hot air rising. The thickness of insulation is such that it prevents as much heat within the property from escaping via the roof.

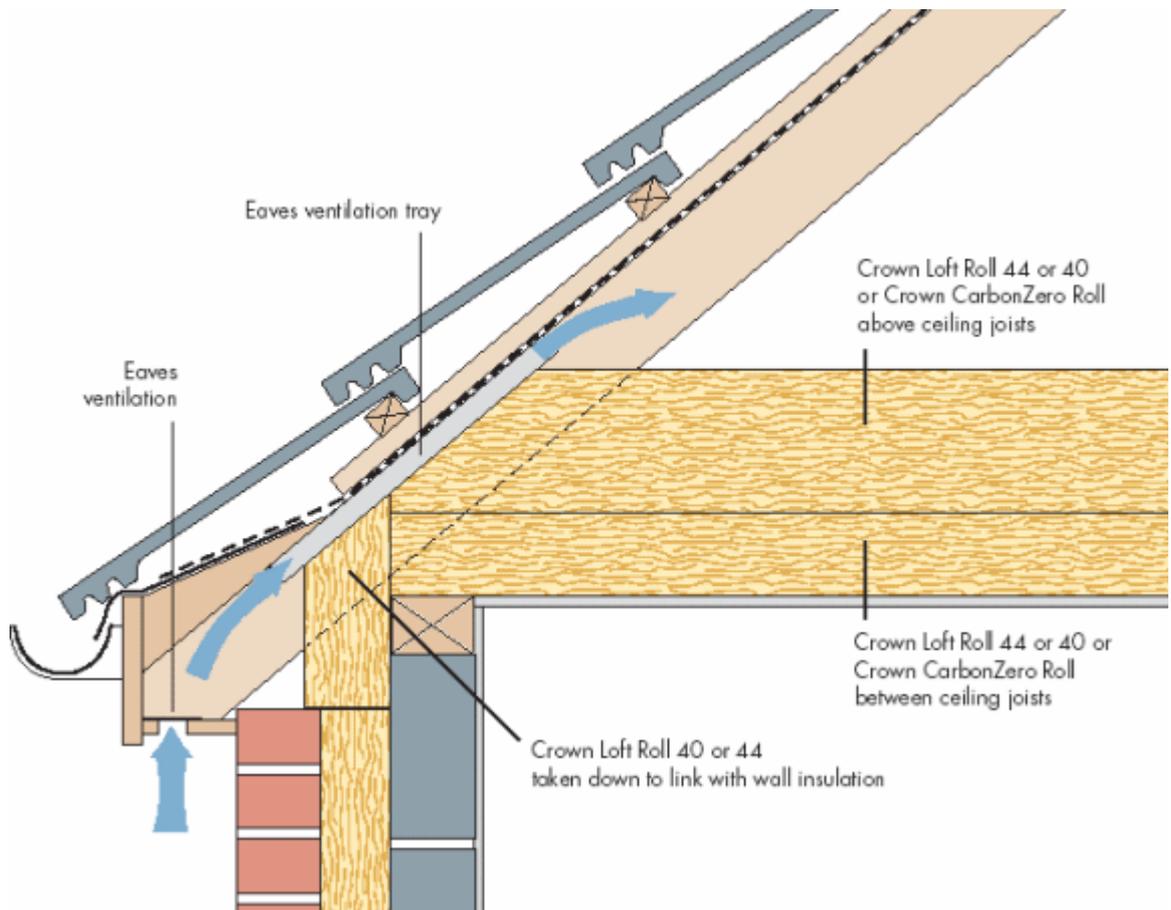


Figure 4.16- Modern roof detail (Knauf, 2009)

The two drawings show how construction technology has changed majorly and in the case of the roof, very little. One key area that can be seen is the level of insulation that is present. With the increase of insulation within the building structure and envelope, thermal energy is restricted to escaping, thus increasing the energy efficiency of the house.

## Technical Case Study- Discussion

The technical case study has shown how construction technology has changed. From looking at both the traditional drawing to the newer drawing, it is apparent that big changes in construction have occurred so that the homes could achieve the required levels to be accredited. The emphasis on thermal performance can be seen by the increase in insulation for both the wall and roof details.

The change in wall construction is something that has been very popular to creating sustainable homes. Sustainably sourced timber and workability are key features why timber is being used in a large number of developments. From researching, it has been noticed that many of the homes which are compliant with the Code, use timber construction with a brick facade giving the illusion that it is a brick built home. Adopting this convention, the carbon footprint to build the house will be lower than one which is traditionally built with brick and blocks. The thickness of insulation in the cavity wall reduces thermal energy escaping the home through the fabric of the building. This is beneficial to the home owners as savings will be made through energy bills. A convention that wasn't used often was the implementation of vapour barriers and breather membranes in the wall construction. It is now very common in wall construction for homes complying with the Code.

The roof construction has stayed fairly similar from the traditional to the newly design for the Code. The fundamental structure of the roof is a very good design. The problem that occurred was that traditionally, there was a lack of insulation in the roof space. With the updated Building Regulations, an emphasis was made to reduce the amount of energy lost through the roof space. A way of doing this was to increase the amount of insulation in the roof space. For a home that complies with the Code, insulation would be placed between the rafters with an Aluminium Thermal foil stapled to the rafter to secure it in. In addition, multiple layers of insulation would be placed between the joists for extra insulation. With

these measures, the amount of energy lost through the roof space would be greatly reduced thus saving money for the occupants.

Ultimately, with the implementation of the Code, construction technology has had to develop and change so it can conform to the requirements set out in the Building Regulations. What has happened as a result is that the developers cost have increased with the increase of different materials and products required. These costs will have to be covered from somewhere and from what has been previously researched; it looks like the buyers will have to cover the additional costs. This would most likely be done by the increase in value of the property.

# Chapter 5

## Conclusions

## Conclusion

After the process of reading, investigating, researching and analysing a lot of information, data and findings have been identified. At the start of this research project, aims, objectives and key questions were identified so that in the process of this project, these would have been answered.

Four objectives of the research were acknowledged and this is how they were answered.

### To investigate whether construction technology will need change and if so, how?

From conducting a literature review on the changes to the Building Regulations particularly in relation to Part L1A, the energy efficiency of the home had to increase to the new levels from October 2010. With this change, construction technology had to change in order to achieve the new energy requirements. From conducting a technical case study, it was clearly identified that the typical construction details had developed. This could clearly be seen in the wall construction as it had completely changed from the typical detail that has been around for many decades. The main change in both details was the level of insulation. The increase reduces the amount of energy lost through the fabric of the building, and allows for the buildings to achieve the new energy requirements set out in the Building Regulations. This research conducted has been successful in answering the objective and has allowed the key question 'How have technical construction details changed to accommodate the Code requirements?' to be answered.

### To examine the affect on product selection

Due to the large scope of this objective, it was decided that a single product would be identified and a case study was done on it. The product selected was Eco-Slab. This product could be used in any house development and replace a common method of block and beam construction. It had been used in a smaller

development that reached Code level 6. This just shows the potential of this product and hundreds of others. Through the case study, it was identified that the cost and energy performance was better than the traditional method as well as having a fraction of the carbon emission required to make the product. What was also found was that although the product is excellent and a very good example of the types of products available on the market to help reduce the amount of energy lost from a home, the main problem was that developers were not using these types of products as they have not used them before. It would be very new to them and change is something that developers do not like but have to deal with as identified when researching what the house builders thought of the Code. To answer this objective, yes there are products out there that could be utilised but the problem is that they are not being selected by the developers. Although through the cases study, a product was identified that was used in a Code developed, not enough products were investigated so therefore it would be fair to say this the key question 'What kind of new products are used in accredited homes?' was partially answered.

#### To investigate how developers will be affected

Developers reacted differently to the Code as it was identified in the literature review on the house builder's reaction. In general, most of the house builders that were researched took active measures so that they could start building homes that were compliant. It was identified that there would be a cost implication to implement Code standard homes. Only one of the house builders took a slightly negative stance regarding the Code. Overall, a majority of the researched companies took active measures to ensure they were ready for the mandatory changes and have already started to build compliant homes. By conducting this research, the key questions of 'What are the cost implications of the Code for developers?' and 'What are home builders doing to achieve the Code?' were answered.

### To identify the implications for the buyers

Throughout the project, the research compiled has given a good insight into what the implications are for the buyers of Code compliant homes. With the change in specification of new builds, companies have analysed and identified that to build compliant homes; a greater financial investment was required. This additional cost is the biggest implication for the buyers. With developers still trying to keep their profit margins healthy, the only way to recover these costs is to unload it onto the buyer. This results in a more expensive property. This is the negative implication of the code on the buyers. The benefits are that an energy efficient home will be made that will reduce the amount of energy required, thus reducing utility bills and saving the buyer money over the long term. These are the key implications for the buyers and also answer the key question 'Do home buyers need to pay more for Code accredited homes?'

With the key questions and the objectives answered in a majority of the case and the research project coming to the end, it provides a good opportunity to look back at what the initial hypothesis was at the start of the project. Below is the list of points that were in the hypothesis.

- Construction Technology will change but not rapidly. An increase of the dimension of the building envelope will be a result of the Code requirements.
  - In some cases this was correct as the roof detail did not change much but in the case of the wall construction, it was partially correct. The overall thickness of the envelope was increased to accommodate the insulation but the whole wall structure was very new and had a modern design to it.

- Home buyers will ultimately pay more for the property that has achieved a code standard.
  - This has been proven correct. With the change in design, it has resulted in an increase in the cost it takes to build homes. This cost will ultimately be met by the home buyers.
  
- New Products are available on the market but house builders are wary of using them. A period of testing them is required prior to implementing these products and materials across a broad spectrum.
  - From conducting the case study on Eco-Slab, it identified that this was the very case. With lots of innovative products available, the house builders were not willing to use them. It was a case that was summed up very well by the article in the RIBA Journal 'nobody in it wants to be the guinea pig'. (Kucharek, 2009)

The main aim of this research project was the following: 'The aim of the research is to identify the affect and implications of the Code for Sustainable Homes on new build housing in relation to construction technology, product selection, developers and occupiers.' Through all the processes that have occurred during this research, it could be said that the aim has been achieved as all the aspects of it have been answered as well as the other objectives and key questions. This has led to the conclusion that the research carried out has been successful and has achieved all that was intended.

# Chapter 6

## Recommendations

## Recommendation

The findings from this research have identified three key areas in which action needs to be taken in order to benefit all in relation to the Code for Sustainable Home.

Firstly, assistance needs to be given to buyers as the additional cost of buying a home which is compliant to the Code is more expensive than one that isn't. With the difficult economic situation that is present at the time of writing this research paper, getting a mortgage is as difficult as it has ever been and with the banks restricting the amount, it is even more difficult to get the extra thousands of pounds which is required to buy a home which is accredited by the Code.

Secondly, developers have to start using more new products that are out there in the market. The only way to build better homes is by experimenting with different products to achieve the best. This cautious attitude is the wrong way to go about this issue. It shows a negative attitude to change and it implies that they are more worried about their profit margins than building good quality homes that have a good energy performance regardless of what they claim in their company reports that they publish.

Lastly, it is apparent that there is a lack of information that is out there in the public. This must be improved so that the public are getting educated on what the Code is and how they would benefit from it. By doing this, there would be a greater appreciation for the Code and better understanding so that all are aware of the advantages it holds.

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# Appendix