Timber frame housing construction

Timber frame housing a viable alternative to masonry Construction

1. 1 Introduction

Chapter one of this dissertation will review relevant articles of primary and secondary data to evaluate the hypothesis: Timber Frame construction a viable alternative to masonry construction.

The main objective of this literature review is to increase the knowledge and understanding of the research and to critically apprise all that has been researched on timber frame construction in comparison to masonry construction.

The literature review will be categorised into the following areas:

- Environmental impact
- Factors effecting Construction Costs. (time savings, prelim costs
- Barriers effecting timber frame
- Fire resistance, acoustic, Thermal etc…

The literature review compares the opinion of other researchers and what they have discovered and done in relation to such aspects in timber frame construction

1. 2 Environmental impact of timber frame construction in comparison to masonry construction.

1. 2. 1 Materials

Roaf (2004 p. 13) quotes “ buildings are our third skin. To survive we need shelter from the elements using three skins the first is provided by our own skin, the second by a layer of clothes and the third is the building. In some

climates it is only with all three we can provide sufficient shelter to survive, in others the first skin is enough. The more extreme the climate, the more we have to rely on the building to protect us from the elements. Just as we take off and put on clothes as the weather and the climate changes so we can alter our buildings to adopt climate change”

Therefore one must investigate which method of construction is best suited to ones needs taking into account costs, environmental consequences and aspects such as thermal, acoustical and fire resistance so therefore they can life in a comfortable dwelling

There appears to a be a huge demand in the construction industry to improve the efficiency in buildings, therefore to control climate change and to make this happen one must look firstly on the construction of our buildings and what method has the best impact on the environment.

The author feels there is a strong case for investigating the timber frame approach as it has a potential for creating sustainable homes.

“ Practices such as energy efficiency, recycling and the use of sustainable materials and products need to become inherent parts of the design and construction process and in some cases, displace traditional construction process and practices” sustainable homes (2000), As Some materials used in construction can damage the environment: they can create pollution, while others are produced in an energy intensive process. Reclaimed material and products made from recycled material are less likely to cause environmental damage. It is important that materials should be judged on their lifecycle and their performance once they are installed.

Buchann and honey, (1994) also suggest that there is a growing awareness that in the choice of building materials, the designer must not only consider the traditional requirements, but also the resource base and the effects on the environment of extraction, manufacture and processing of the building material, as the amount of primary energy used can have huge effects on greenhouse gas emissions.

Borjesson and Gustavasson (2000) agrees with this statement as he suggests that,

“ The substitution of sustainability produced wood material for other construction materials can reduce net Co2 emissions”, Quack (2001) is in support of this statement with after the results of his study show that the life cycle of each house is independent of the construction materials.

Sustainable homes (2000) discuses that timber is possibly the only renewable resource in the construction sector.

According to Timber construction (2007) timber frame construction is the only environmentally friendly material available, as it claimed to be a carbon neutral. Claiming 800 kg of carbon dioxide is saved for every cubic meter of wood used. Stating that when comparing a 100m2 timber frame and masonry house, a total of 4 tonnes of carbon dioxide could be saved as a timber frame dwelling contains 5-6 cubic meters mores timber

IPCC (1996) agrees that the manufacture of wood products normally requires less energy than that of alternative product which in results compares to the statements made above.

Noren (2001) studied timber frame and traditional masonry houses over their lifecycle and claims that timber frame houses are a better environmental change to implement as carbon dioxide is reduced on every stage of the buildings life. Sutton (2007) is in agreement with this statement, claiming timber frame emit 16. 5 % less carbon dioxide over the life of the building in comparison to its counterpart masonry construction.

But However Brunklaud and baumann (2002) suggest after having examined reports on the environmental impacts of different materials on timber frame and masonry construction that wood has the lowest environmental impact in terms of embodied carbon dioxide emissions, but however over a complete lifecycle, building operational emissions is the most important factor regardless of the materials chosen, and that it is improvements to reduce operational emissions that will benefit the overall environmental impact of a building.

Bjorklund and Tillman (1997) also agree as results show that timber frame has a better environmental impact at manufacture stage but however masonry can match timber frame over the life of the building

Sustainable homes (2000) indicates that buildings accounts for 50% of all co2 emission and on average a house produces 7. 5 tonnes of co2 every year, four tonnes if built to current regulations.

“ It is not therefore, difficult to see the benefits of increasing the insulation capacity of the building envelope as one mechanism for reducing the amount of fossil fuels required in running our homes”

This statement above agrees to such statements from the majority of authors such as Buchann and honey, Borjesson and Gustavasson, Brunklaud and baumann, that much thought should be put into materials such as the fabric, structure of your house and your insulating materials therefore reducing the need of burning fossil fuels

Although timber frame has a better environmental impact at manufacture stage from reports above it can be argued that masonry can achieve as a good an impact on the environment as timber frame over the life of the building.

1. 2. 2 Waste Impact

A dictionary definition of environment waste is that of any substance, solid, liquid or gaseous for which no use can be found by the organisation or system that produces it for which a method of disposal must be devised. (RICS, 2009)

However (Mnyani 2003, pg4-5) describes it as any waste that is generated during the process of construction, leftovers that are to be disposed post construction and this includes demolition debris.

The construction industry is one of the largest industrial sectors in the UK,

Construction and demolition waste represents roughly 17 per cent of total waste production in the UK, making the construction industry the largest generator of controlled waste in the country (DETR, 1999). It is estimated that some 70 million tonnes of construction and demolition waste arise annually (Environment Agency Website, 2000).

Ekanaye & Ofori 2000 indicate from their study on 230 different building sites, they found that waste levels for specific materials is consistently higher than the estimated level for all materials studied. New purchases to replace wasted materials rework to correct mistakes, delays and dealing with generated waste cause heavy financial losses to the contractor.

Therefore the author feels the use of timber frame construction will play a good role in reducing waste as the timber frame panels arrive on site and are erected in a matter of hours in support of this (Glynn, 2000) points out that " Arrival on site timber frame kit and erected in less than a week, approx 1 – 4 days"

This therefore cuts out on materials been damaged as a result of lying around the site, but however (Johnson, 1981p6) states that Waste occurs on site for a number of reasons, most of which can be prevented, this waste can occur form the Misinterpretation of drawing, Overestimating of quantity required, Faulty workmanship and Careless handing of materials.

From this statement timber frame construction exceeds masonry as wastage on site can be reduced significantly by the maximum use of prefabricated units. As well as reducing wastage, quality control and efficiency during manufacture of standard materials in the factory means that the net amount of material required for production of the final component is minimised. Factory conditions make the use of off cuts more likely.

Recycling and reuse of materials have long been associated with wise construction practises. Experienced contractors are now reaping the economic advantage of construction waste management. Many of the

contractors that have embraced waste management have made changes to their operation and practices to take advantage of reduced waste disposal costs and revenues derived from recycle, reuse and salvage materials. Utilizing, reuse and salvage methods on site reduces materials that end up in the landfill, creates a cleaner and safer project site and improves community relations.

1. 3 Factors effecting costs.

Mark Windsor spokesperson for Design and Materials Company suggests that costs for masonry are the same for timber frame houses http://www. designandmaterials. uk. com/materials/brick-and-block. html

To evaluate this statement Glynn (2000) demonstrates a construction programme in the following charts.

Timber Frame Programme

1. Foundations for kit are prepared, approx 1. 5 weeks.
2. Arrival on site timber frame kit and erected in less than a week, approx 1 – 4 days.
3. External doors and windows fitted to seal house from external elements, approx 1 week.
4. During phase three the roof is erected, felted and battened and tiled, approx 1. 5 weeks.
5. External cladding completed approx 1. 5 weeks.
6. During phase five, first fix electricity, plumbing and carpentry can begin, approx 2. 5 weeks.
7. Internal wiring and pipe work to be complete, approx 2 – 3 days.
8. Drying out period, approx 2 – 4 days.

9. Start second fix services, approx 2 – 3 weeks.
10. Decoration can now begin and client takes over.

This concludes timber frame programme at twelve weeks.

Source (Kenneth Glynn, Prefabricated timber frame construction, 2000)

Traditional masonry programme

1. Foundations for kit are prepared, approx 1. 5 weeks.
2. Masonry envelope can commence approx 4 – 5 weeks.
3. About one week after envelope commenced, fixing and glazing the doors, approx 3 weeks.
4. During phase three, the roof is erected, felted and battened and tiled, approx 1. 5 weeks. Note scaffolding will be on site for the majority of the above.
5. During phase five, first fix electricity, plumbing and carpentry can begin, approx 2. 5 weeks.
6. Internal wiring and pipe-work to be complete, approx 2 – 3 days.
7. Start second fix services, approx 2 – 3 weeks.
8. Decoration can now begin and client takes over.

This concludes traditional masonry programme at about twenty weeks.

Source (Kenneth Glynn, Prefabricated timber frame construction, 2000)

In examination of the construction programmes, there is a large differential in time scale between inception and move in dates. It is possible to come to the conclusion based on the solid facts that the programmes portray to us that the development of the timber frame house is by far the most efficient in terms of speed in completion. The difference in weeks is quite substantial

with the programme of development comprising of the timber frame method of construction far more efficient with an overall saving of about eight to nine weeks. A timber house is usually watertight by week five of the build; by contrast a traditional masonry house is not watertight for nine or ten weeks. Traditional construction methods are extremely vulnerable to inclement weather conditions. Such inclement weather conditions will cause delay to the overall completion of the project, this is not a factor for timber frame construction as all internal works can began at week five, despite any external weather conditions.

By Glynn 2000 contrasting these two construction programmes it shows that the timber frame programme would offer a rapid development construction to meet market demand thus providing a return on your development almost of immediate effect.

In support of Glynn an article in built it magazine states “ When comparing timber frame to masonry, masonry is generally the slower of the two.”

However this article indicates “ one must factor in time it takes to get a timber frame onto site from the date it is ordered, which can take up to 16 weeks” (Build It magazine, published May 2008.)

However from examining Glynn 2000 construction programme there are direct costs saving advantages such as reduced construction time, overheads and less waste. Other factors that should be considered when carrying out a cost benefit analysis are the preliminaries costs as early off-hire of cranes and scaffolding due to reduced construction times and also reduced on site labour which saves money. With brick and block, build costs

are spread over a longer period of time. However one must consider the overall programme cost reductions by timber frame construction.

Timber Frame is touted to have the following advantages:

- That it is a faster method of construction with the ability to halve the total on-site construction duration;
- That it requires less on-site labour;
- That large number of units can be constructed within a short time;
- That the faster construction and reduced on-site work brings financial benefits to the developer in terms of shorter period of financing the project and completed buildings being put up for sale much faster.

Factory-produced homes are usually erected on site in a matter of days. Once up, the internal finishes can be started right away, which can produce further time savings. However, there may be lengthy delays involved in getting the frame built. Also bear in mind that thin-joint masonry promises many of the speed advantages of timber frame. The NHBC estimates up to a three-month time saving by choosing timber.

On Price

For many years, timber frame used to be thought of as a little more expensive, but advocates claimed that you could claw back any extra expense by shortening the length of the job overall, thus reducing overhead and finance costs. However, more recently the picture has become confused. Blocklayers became very expensive, eroding the cost differential; while timber frame factories became very busy, lengthening the time taken to process the orders, and thus losing much of the speed advantage. The fact is that there really isn’t that much cost difference. As a rule, masonry sits

better (and cheaper) behind a brick or stone skin, whilst timber frame comes into its own behind a lightweight external skin such as timber.

Representatives of both timber frame and brick and block would agree that there is relatively not much of a difference in the cost between the two constructions techniques. If timber frame is chosen for its quick build time,

One believes that overall the cost benefits of timber frame houses offer better value as the proposed development would include rapid construction to meet market demand thus providing a return on your development almost of immediate effect. . The speedy construction of timber framed houses enables the contractor to construct a large number of houses in a relatively short period of time. A timber frame house owner would also have the added benefit of a more energy efficient home

1. 4 Perception of timber frame and its barriers:

The use of timber frame construction of houses has faced many challenges in recent years as other materials such as sandcrete blocks, concrete blocks and brick replaced timber as main building construction materials due to many barriers such as psychological barriers mainly form general public.

The public perception of timber frame construction in comparison to the traditional masonry construction. B. k. Baiden, E. Badu, F. S Menz (2004) is as follows

- Timber can consumed by fire if used in building construction,
- Durability is relatively poor
- structural ability

The lack of understanding and cynical views expressed by the public on the fire resistance, durability and structural properties of timber frame structures initially made Timber frame construction to received negative comments throughout the last few decades and has came under scrutiny which has influenced the negative perception the general public have adopted

“ The timber frame industry was effectively killed off overnight in the early 1980’s, after the ‘ world in action’ programme raised a number of doubts about the standards of construction” Barry’s (2002)

Timber frame construction has received negative comments throughout the last few decades and has come under scrutiny which has influenced the negative perception the general public have adopted. Some members of the public associate timber with been a fuel for fire and therefore timber frame structures are more liable to ignite. The author feels this is a harsh and unjust assessment, which has restricted the growth of timber frame housing during the 1980’s and the early 1990’s when it could have gained a valuable foot hold in the housing market during this period. However in recent years the only slight concerns remain in the public domain and this has helped timber frame housing to gain a 30% share in the domestic housing market. Many professionals in the timber frame industry believed that consumers no longer had doubts regarding fire, which will be illustrated later in the questionnaire conducted by the author.

Government reports indicate that “ There are some residual reservations about timber frame among architects, engineers, builders, administrative bodies, financial institutions and insurance companies as well as with end

users. Perceived problems with timber frame construction in the housing market from both the end users and local authorities would include a perceived greater risk of fire, issues of sound attenuation in a timber structure and the impact such a structure might have on the security of the end user.”

however Narty 1971 states that Timber constructed houses can be built to last for a period of 40-100 years, this suggests that timber frame construction is every bit as good as the traditional masonry method.

“ Most people perceive a brick & block house to be more ‘ solid’ than timber frame”

http://www. buildstore. co. uk/mykindofhome/events/different-building-systems-weekend-in-detail. html

Traditional masonry cavity walls, most commonly brick with an inner structural leaf of concrete block, have dominated house building in the UK for the past eighty years, but there are a number of other systems that are gradually making inroads, including timber frame,

http://www. cyprus-property-buyers. com/files/constructionmethods. pdf

One question that perpetually raises its head is ‘ which is cheapest’ of the two most prevalent systems – timber frame or brick and block?

The author will look in great detail at the properties in timber frame buildings to evaluate the perception in the industry towards timber frame and why they think masonry is the better construction overall.

1. 4. 1 Fire resistance:

Barry (1998) states that although timber is a combustible material, it can function as a structural member for a longer period than an unprotected metal member provided it is of adequate section

White (1999) agrees with this statement saying

“ The relatively good structural behaviour of timber in fire is due to the fact that it has uniform strength through the mass. The load bearing capacity is therefore reduced in proportion to the loss of the cross section, the unburned section, however, retains a full high strength

Forest products research institute (1988) also agrees with this; as the results from a study showed that timber of sufficient size is difficult to burn because of cross sections decompose relatively slowly due to its low thermal conductivity and the formation of charcoal on the outer sections

Sustainable houses (2000) agrees with the above as it states that “ timber frame homes tested to BS476 demonstrate that they exceed these requirements

BRE structural survey (2002) indicates that in the TF 2000 BRE project “ no evidence to suggest that timber frame construction suffers disproportionally form problems of poor workmanship or that it is exposed to higher risks of fire spread” than traditional masonry counterpart.

In support of this TRADA and BRE fire safety research concluded that “ Timber frame performs as well as other construction in fire and life safety is at no greater risk”.

1. 4. 2 Thermal:

Sustainable (2000) suggests that one of the most commonly identified advantages of timber frame systems in relation to thermal performance, The most important factor by far being the structural envelope.

“ The most basic timber frame home will exceed current building regulations requirements”

In support of this statement Doran (2008) BRE states timber frame insulation solutions lend themselves to going significantly beyond the minimum thermal performance requirements

Timber frame can easily meet current regulations by increasing stud size therefore increasing the amount of insulation, giving a better U-value.

With the governments publication of new regulations in 2006 part L relating to energy conservation and ventilation in new homes

Timber frame uk suggests that with the introduction of these new part L regulations for new built homes timber frame housing has increased because of its suitability for modern building and it can comply with the new regulations so easily and cost effectively

With timber being a poor conductor of heat Barry (1993), the thermal conductivity is very low making it a natural insulator which is two to four times of common insulating materials Simpson (1999)

However Doran 2008 indicates that to achieve the expected thermal performance in timber frame dwellings requires good workmanship

1. 4. 3 Acoustic:

Sound is a form of energy which can be transmitted over a distance from its source through a medium, such as air or a solid element of construction e. g. a wall or a floor.

A construction based website Homebuilding. Co. uk indicates that heavyweight building techniques have a clear advantage here. But in detached housing, the chief area of concern is noise between floors and most masonry homes actually have timber intermediate floors, so in this respect there is little difference

http://www. homebuilding. co. uk/feature/construction-systems-masonry-vs-timber

Sustainable (2000) indicates that timber frame masonry outperforms masonry party walls by some margin

In support of this Trada (2000) agrees with this statement indicating " lightweight timber frame party walls between semi-detached or terraced houses and flats and party floors between flats meet the current requirements of the building regulations for sound insulation. However many authors argue this (….????) stating that building mass is the only way to provide high sound insulation.

An article by Clive Fewins, published in home building and Renovating magazine agrees with the above statement with regards to the public perception, where the public perception of masonry built is strong and durable

“ A masonry structure gives a house a feeling of solidity, as the density of the blocks provides a high level of acoustic mass”

Trada state It’s interesting that even our standard 140mm timber frame walls are 20 per cent more thermally efficient than current building regulations demand. Sound insulation is more efficient too with a timber frame, compared with other methods of construction.

This public perception of the acoustic performance of timber frame has also played a role in hindering the growth of timber frame housing but these unsubstantiated views have been contradicted by a number of independent assessments within the industry.

However BRE are in favour of timber frame building stating, “ If all dwellings had sound insulation as good as that measured in party walls of timber frame homes, the problems of noise from neighbours would be greatly reduced.”

Just like any other new homes, when built with good standards of workmanship, timber frame homes will meet all current Building Regulations and Standards on sound insulation and acoustic performance. It is commonly assumed that only solid walls that are found in traditional masonry houses can guarantee you peace and quiet. In 2003 tests were carried out by (BRE) the Building Research establishment on ‘ Robust Details’ that can be used by any designer and house builder, this research proved that timber frame houses performed best out of any construction method. This research was also reviewed on the UK’s largest database of test cases on sound performance going back over 17 years, by Dr Sean Smith of Napier

University who also stated the superior sound performance of timber frame houses.

A statement from Dr Sean smith in a recent website article on timber frame construction shows after researching on acoustical performance how he personally feels timber frame can easily outperform current regulations “ Our research shows that timber frame party walls are the best performing in the industry – for current and future regulations.”

The (Irish timber frame association) suggest the importance of mass has always been perceived as been vital to achieve good sound insulation, however reliance on mass alone would be impractical and a largely unpopular method of improving sound performance. In recent years other characteristics have became more important such as isolation, stiffness, absorbency and air tightness. Isolation makes it more difficult for sound to propagate through the building by introducing physical breaks, this is an important for good sound insulation, and the cavity walls in both house types perform this function. Stiffness of structural members, gives greater resistance to structure borne vibration caused by sound. Absorbency in voids helps dampen sound and finally by ensuring the separating structures are totally sealed, sound leakage through gaps is avoided. It is widely accepted that timber frame construction is exploiting these characteristics and is well ahead of other methods when the regulations change in the future.

Noise nuisance within homes is becoming a more widespread concern in modern times as ownership televisions, stereos and game consoles are at an all time high and this is causing conflict among neighbours. The findings of

BRE have contradicted the public perception that mass is essential to gain high-quality acoustic performance.

Durability: Narty (1971) argues that The Durability of timber is often discussed with reference to fungi, or insect attack. In absence of these, timber is remarkably resistant and will survive for long periods of time; the author has found such evidence as the Egyptian tombs which are over 200 years old.

BRE (1996) conducted two large scale independent surveys and found no instances of rot caused by water ingress. And all timber exposed areas (Cavity) that are preservative treated shall cause little trouble

In support of this Simpson (1999) agrees with this statement suggesting that timber kept constantly dry does not decay and a large proportion timber used is kept dry and can last for very long periods

1. 5 Advantages of timber frame over masonry:

Timber frame offers a number of advantages compared to most other forms of construction

The previously stated the u – turn for the rise in popularity for timber frame methods of construction has not been unfounded, with large benefits to the client and contractor been identified as the basis for this success. Many of the country’s contractors in the housing are now seriously considering this technique because it,

“ provides high quality houses, quickly and cost effectively”

Source (Prefabrication-solution to an overstretched industry, Nov 2001, The Irish construction Industry Magazine)

” The greater use of well-designed timber frame houses will help ease the pressures on traditional construction trades, it also has the benefit of helping to speed up projects and help ensure cleaner and safer sites”

Source (Webb, M., The construction magazine, Prefabrication Report)

On Speed

Factory-produced homes are usually erected on site in a matter of days. Once up, the internal finishes can be started right away, which can produce further time savings. However, there may be lengthy delays involved in getting the frame built. Also bear in mind that thin-joint masonry promises many of the speed advantages of timber frame. The NHBC estimates up to a three-month time saving by choosing timber.