

Historical Trends of Exterior Wall Materials used in US Residential Construction

James P. Bradtmueller, Ph.D. and Sean P. Foley, Ph.D.
Northern Kentucky University
Highland Heights, KY

Discussions concerning the inclusion of trends in the construction industry are common when contemplating curricular material in construction management programs; however, it is common that these trends are generally in relation to new or emerging trends—such as information technology, advances in materials, and new project delivery methods—rather than historical trends. Without reflecting on historical trends it can be difficult to fully understand where we are today and to possibly predict where we will be in the future. This paper explores the trends of exterior cladding systems for residential construction to better understand what exterior wall materials have been in use over a period from 1971 to 2012 and where these materials are currently being used or have been used in the past. Projections of the future use of exterior cladding systems is made based on the historical trends identified and described.

Key Words: cladding, exterior wall material, US Census Bureau Survey of Construction, residential construction, construction material

Introduction

Each month, the US Census Bureau conducts interviews and assessments to gather data for the Survey of Construction (SOC). This survey provides information on residential building activity in the US by sampling approximately 900 public offices that issue building permits and also by physically inspecting more than 70 land areas that do not require building permits. The results of the continuously ongoing SOC are analyzed and reported both monthly and annually by the US Census Bureau. Initial collection of information on housing starts dates back to 1959 and that for completion of new homes started in 1968. (US Census Bureau, 2013a) The rate of housing starts and completions is watched closely by many sectors of the economy and these are, and historically have been, considered to be harbingers of future economic conditions (CB13-166; US Census Bureau News, 2013).

This paper focuses on the trends observed in the principal types of exterior wall materials used in the construction of new single-family homes built throughout the United States since 1971. The primary types of wall materials used for exterior cladding were examined on a regional level as well as a national one. For the purposes of this paper, the only SOC data analyzed was that corresponding to new single-family residential homes where completion of construction was documented in the survey by including the designated month and year code.

Background on the Survey of Construction

The SOC provides an extensive amount of information—over 40 characteristics—about the construction of each residential structure being sampled. A partial example of these includes the following items: square footage areas of the lot and living space, foundation type, construction method, number of stories, exterior wall materials, number of bedrooms and bathrooms, heating and cooling systems installed, type of water supply and waste system, financing method and other financial information such as the contract and sales price. The residential construction information that is entered into the SOC comes from interviews conducted by the US Census Bureau every month in its four main national regions of Northeast, Midwest, South and West. These regions are further divided into nine divisions with each one comprised of a designated group of states. The **Region**, ***Division***, and State hierarchy are as follows:

- **Northeast:** ***New England*** (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and

Connecticut) and ***Middle Atlantic*** (New York, New Jersey, and Pennsylvania)
- **Midwest:** ***East North Central*** (Ohio, Indiana, Illinois, Michigan, and Wisconsin) and ***West North Central*** (Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas)
- **South:** ***South Atlantic*** (Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida), ***East South Central*** (Kentucky, Tennessee, Alabama, and Mississippi), and ***West South Central*** (Arkansas, Louisiana, Oklahoma, and Texas)
- **West:** ***Mountain*** (Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, and Nevada) and ***Pacific*** (Washington, Oregon, California, Alaska, and Hawaii)

In the 1975 Characteristics of New Housing Construction Report—Series C25-75-13 (US Census Bureau, 1976), the SOC was expanded to include the collection of information on multifamily structures. During the 1970s through 1980, approximately 3%, or 1 in 33 newly completed single-family homes were included in the survey's sample (US Census Bureau, 1981). Subsequently, the sampling rate was decreased to 1 in 40 new homes (C25-85-13; US Census Bureau, 1986; C25/99-A, US Census Bureau, 2000), but the same 840 areas requiring building permits were still being sampled. Currently, the overall national sampling rate is approximately 1 in 50 new houses, but there is considerable disparity among individual survey locations depending on the amount of residential construction activity. (US Census Bureau, 2013b). In the SOC, vinyl siding became its own category starting in 1992 and is no longer coded as *other* (US Census Bureau, 2013c). Additionally in 2000, aluminum siding was eliminated as its own category and was reassigned to be coded as *other*. A new identifier of *fiber cement* was included as a separate category and the corresponding SOC tables were modified beginning with the 2005 survey.

Study Objectives

The objectives of this study include the following:
1. Investigate historical trends in the principal types of exterior wall materials that have been used for residential cladding in the United States from 1971 to 2012 based on the Survey of Construction (SOC).
2. Evaluate these trends on a national basis and for the four main US Census Bureau areas known as the Northeast, Midwest, South and West Regions.
3. For each US Census Bureau region, analyze the SOC data from 1999 to 2012 to determine the historical trends of residential cladding materials used in each of its divisions.

Analysis

As previously discussed, the US Census Bureau periodically publishes the Characteristics of New Housing Construction report that is co-authored by the U.S. Department of Commerce and the Department of Housing and Urban Development. Over time, the parameters of what is included in the SOC and subsequently reported are subject to change as products and practices evolve in the residential construction industry. In the case of primary exterior wall materials, aluminum siding is no longer reported separately because of its low percentages of usage. In contrast, vinyl and fiber cement became their own material categories as justified by their increased usage in new residential construction. Figures 1 and 2 provide historical usage trends of all exterior wall materials that were ever included in the SOC from 1971 to 2012 and these will be discussed in detail in the following section.

The US Census Bureau makes raw SOC microdata available to the public annually in the form of an Excel file containing all of the information from the individual surveys that were completed during that year. In this research, a portion of the SOC database was reconstructed for the time period from 1999 to 2012 and contains over 400,000 individual survey records that represent over 18 million newly constructed single-family homes. This database was used to conduct new and unique analyses of cladding usage for each division within each US Census Bureau region. In US Census Bureau publications, such as the 2012 Characteristics of New Housing (US Census Bureau, 2013c), the results are broken down by region, but none are reported by division. For each of these regions and its corresponding divisions, Figure 3 contains the most commonly used cladding materials installed from 1999 to 2012. All results are based only on SOC records of new single-family home construction in which the corresponding year of completion was determined and included in the database.

Results

US Census Bureau SOC Cladding Trends by Material, Region, and Division

This study examines results from the US Census Bureau Survey of Construction concerning materials used to clad the exterior walls of new single-family homes built in the United States over the past four decades. Historical usage trends by material (brick, wood, stucco, and vinyl from 1971 to 2012) are presented in Figure 1. For the same time period, Figure 2 shows the trends of aluminum siding, fiber cement siding, and the other kinds of lesser-used cladding that were classified and grouped together within the *other* material type.

Trends by Primary Exterior Wall Material

Brick. Figure 1a presents the historical trends of the usage of brick as the primary exterior wall material in residential construction. Considering the entire US and the 1971 to 2012 time span, brick usage peaked in 1971where 38% of the newly completed homes were clad in it. Nationally, the usage of brick trended downward from 1971 until it reached a low of 17% in 1988 and 1989. Between 1991 and 2006, it stayed in the 19 to 21% range and it began an upward trend in 2004 that continues to its current rate of 24%. Brick is used most extensively in the South Region, where it went from a high of 65% in 1974 to a low of 30% in 1988 and 1989. From 1992 to 2012, its usage in this region has averaged about 38% with a near peak of 41% in 2011 and 2012. Among other regions, brick is well-suited for use in the South Region because it can withstand high wind loads, is an effective water barrier, guards against biological attack, can protect against fire damage, and does not promote combustion. In the Midwest region, usage dropped from a high of 29% in 1971 to a low of 11% in 1982 and has continued at relatively the same rate from 1975 to 2012 of between 11 and 16%. In 2012, the rate of usage was 12%. Usage of brick in the Northeast and West regions has remained moderately constant with slight downward trends for the entire time period studied. The Northeast varied between 2 and 10% with a mean of 3%, and the West was between 1 and 10% also with mean of 3%.

Wood. Figure 1b shows the usage trends of residential cladding made from wood and wood composites that was installed on new single-family homes completed from 1971 to 2012. In the US, the use of wood siding in new homes steadily increased from 28% in 1971 to 40% in 1981 and 1982. Since then, its usage has steadily decreased until becoming stable in 2003 at 8%, where afterwards it fluctuated between 7 and 9% until reaching a low of 6% in 2012. Among the regions, wood was initially used most extensively in the Midwest, where it increased from 39% in 1971 to a maximum of 67% in 1982. It then systematically decreased year-after-year to a low of 8% in 2004, recovered to 18% in 2008, and then dropped to 9% in 2012. The South Region utilized wood cladding less than the other regions, which is not surprising since it is the most susceptible to biological attack of the wood. It went from an initial low of 15% in 1974 to its highest usage of 38% in 1986 and 1988 and then it uniformly dropped to 4% in 2001 and subsequently has remained at an average 3.9%. Between 1971 and 1982, the use of wood siding in the West Region consistently rose from 28 to 49%, it subsequently decreased down to 11% by 2004, and then averaged 11.9 % including its low of 9% in 2012. Unlike all other regions, the use of wood siding in the Northeast Region peaked in 1972 at 58% and then trended downward to 9% in 2005 and averaged 9.7% thereafter. It is posited that the fall in usage of the wood cladding systems is due to the extensive use of engineered wood cladding such as high density fiberboard (hardboard), medium density fiberboard (MDF) and oriented strand board (OSB). A significant portion of these cladding materials subsequently failed due to a combination of manufacturing in some cases and improper installation in others that led to many lawsuits. The negative perception left by these lawsuits, either justifiable or not, has had a profound effect on the use of wood cladding and the wood industry in general. (Wall Street Journal, 1996 and 2000)

Stucco. Figure 1c contains the percentages of completed single-family homes built with exterior walls covered with stucco. This category includes traditional stucco made of lime, sand, and water, contemporary stucco where the lime has been replaced by Portland cement, and synthetic stucco such as exterior insulation and finish systems (EIFS). Nationally, the use of stucco generally shows a slow upward trend over the entire time period studied. The lowest usage of 8% occurred in 1982, the peak of 23% was in 2007, and most recently in 2012 the US usage was 19%. Figure 1c clearly shows that stucco is primarily used in the West Region, where the minimum annual usage of 32% was in 1982, followed by the peak usage of 65% in 2004, and then ending at 51% in 2012. The use of stucco for new home construction in the Northeast and Midwest Regions was very minimal and when used at all was typically no more than 1 to 3%. Years where usage of stucco was not included indicate that the amount contained within in the survey was too small to accurately report. The use of Stucco in the South Region has been slowly

increasing with highs of 18% in 2007 and 16% in 2012.

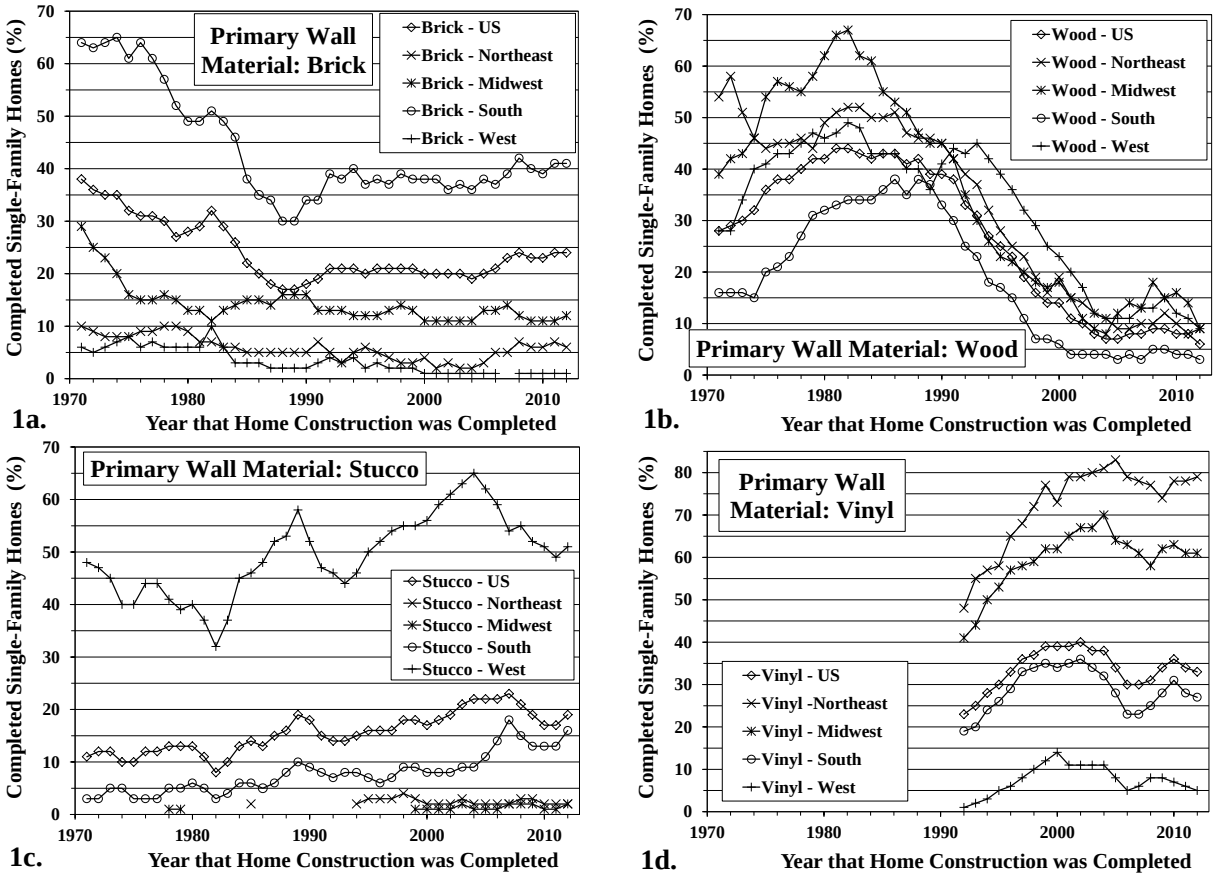

Figure 1. Historical trends in cladding of single-family residential construction: (a) brick, (b) wood, (c) stucco, and (d) vinyl

Vinyl. The usage of vinyl in new home construction was included into the SOC in 1992 as indicated in Figure 1d. Prior to this time, vinyl was coded as being in the *other* category, but, in hindsight, it should have been made into a separate category around 1980. The usage of vinyl as residential cladding is significant in the US. Based on the results from the SOC, vinyl was used in 23% of the newly constructed single-family homes in 1992 and rose quickly to its high of 40% in 2002. Its usage then dropped to 30% in 2006 and 2007, increased to 36% in 2010, and most recently was 33% in 2012. The usage of vinyl in the South Region closely mimics that of the national trends, but it is consistently lower by 4.9% on average. The Midwest Region followed the same general pattern with a start of 41% in 1992, a quick and steady increase to 79% in 2004, followed by a decrease to 46% in 2009, and a most recent usage of 61% in 2012. Vinyl siding is most extensively used in the Northeast Region. In 1992, usage was already at 48%, but that increased to 83% by 2005, decreased to 74% in 2009, and was 79% in 2012. The West Region used the least amount of vinyl siding having a rate of only 1% in 1992 that steadily increased to a maximum of 14% in 2000, and then generally decreased with lows of 5% in 2006 and 2012. The advantages of vinyl include low cost, low maintenance, and highly effective protection against water. In contrast, vinyl's disadvantages include: (1) its high coefficient of thermal expansion, which causes it to elongate and contract with changes in temperature; (2) it's a combustible thermoplastic with a relatively low service temperature; (3) it's not as stiff or strong as other cladding material; (4) requires periodic washing to remove dirt, mold and mildew; and (5) it fades over time. High-end cellular or wood-filled polyvinyl chloride (PVC) siding is beginning to have an impact on the siding market because it offers additional insulation from the rigid foam backing and increased stiffness and stability. (Schut, 2007) This type of siding is still classified as *vinyl* in the SOC.

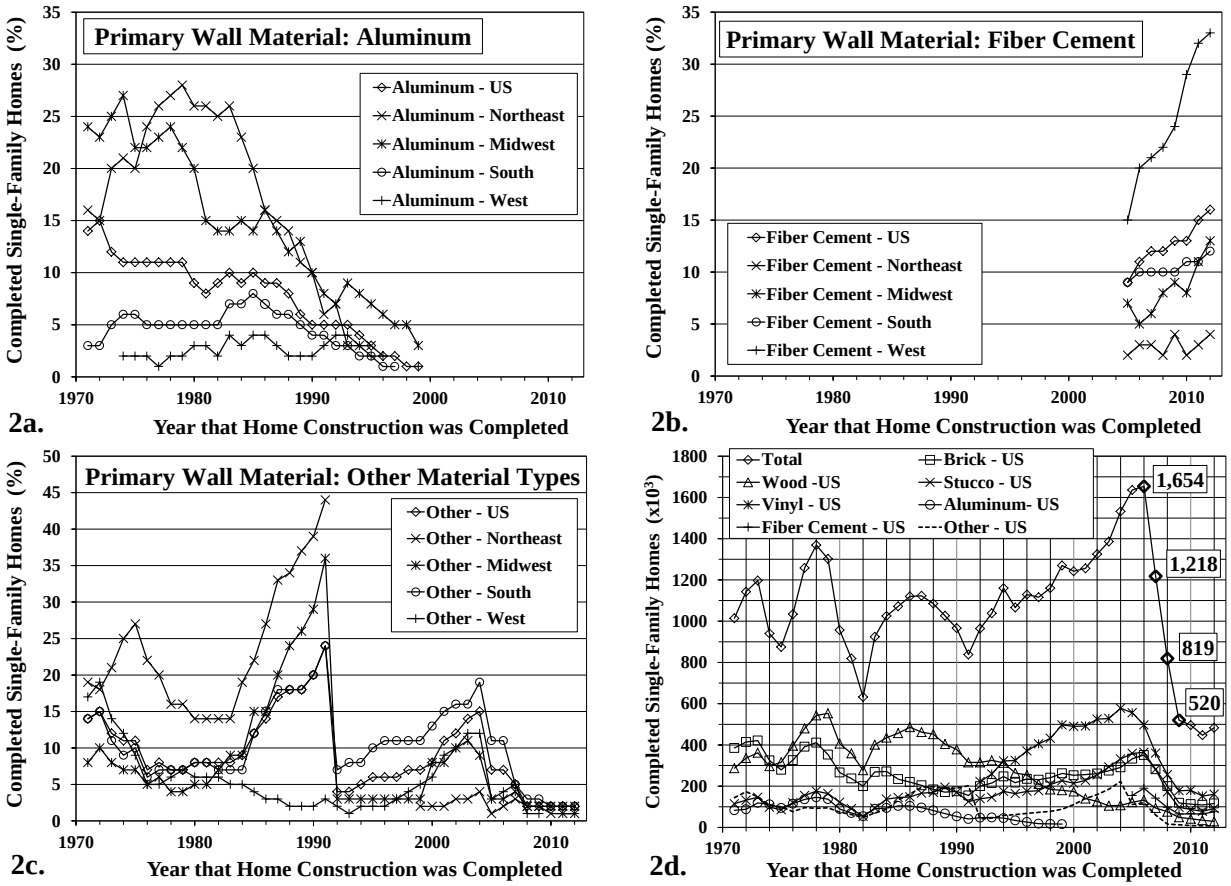

Figure 2. Historical trends in cladding of single-family residential construction: (a) aluminum, (b) fiber cement, (c) other material types, and (d) all of the United States.

Aluminum. As Figure 2a indicates, the use of aluminum siding has been decreased to a low percentage in all regions investigated. The last year that aluminum was included as its own category was 1999, so there is no data after this point. Considering all regions in the US together, the peak of aluminum siding usage occurred nationally in 1972, with 15% of the new single-family homes completed that year using it. For the US category, usage of aluminum siding decreased to 1% or below by 1998. Aluminum siding was most widely used in the Northeast and Midwest regions, where its highest usage rate was 28% in 1996 and 27% in 1974, respectively. Both of these regions saw a steady decline with a low in the Northeast of less than 1% occurring in 1996 and a low of 3% occurring in the Midwest in 1999. The South and West Regions used aluminum siding the least, where its use was never above 8 and 4%, respectively. Loss of market share can be tied, in large part, to the steep rise in aluminum's cost coupled with maintenance issues including susceptibility to denting and the formation of a chalky finish.

Fiber Cement. The usage of fiber cement siding as cladding for new single-family construction is documented in Figure 2b. In comparison to the other types of exterior wall materials, fiber cement siding is relatively new and was added to the SOC in 2005 after it was positively trending upward and became the dominant material in the *other* category. Fiber cement is also unique in that both the South and West Regions have shown year-after-year positive growth. On a percentage basis, the West region is where fiber cement siding usage was the highest. In this case, the West started at 15% in 2005 and climbed to 33% by 2012. By comparison, the Midwest and South regions started at 7 and 9%, respectively, in 2005 and were at 13 and 12%, respectively, in 2012. The Northeast region showed the lowest usage over the same time period, with a high of 4% in both 2009 and 2012 and an overall mean of 2.9%. As a protective exterior wall material, fiber cement is effective at resisting water intrusion, hail damage, and biological attack. The fiber cement material itself is fireproof and will not support combustion, its strength and stiffness

provide excellent protection against wind loads, it is dimensionally stable and has a much lower coefficient of thermal expansion than do wood and vinyl. Fiber cement appears to have good potential for continuing to increase its percentage usage in the residential cladding market.

Other. The *other* category consists of exterior wall materials such as: concrete block, cinder block, stone, asbestos shingle, fiber cement prior to 2005, vinyl siding prior to 1992, aluminum siding after 1999, and other types of less common materials. The cladding materials that were coded as *other* are graphed in Figure 2c. For the initial time period from 1971 to about 1980, the general downward trends shown are likely due to the decreased usage of cinder block, concrete block and/or stone. From about 1980 to 1991, the rapid rise observed for most of the regions is due to the identification of vinyl siding as *other* before it was given its own category in 1992. The absence of vinyl is also the cause of the precipitous decline in the *other* category from 1991 to 1992. The subsequent increase in the *other* category until 2004 is, in part, due to the increased use of fiber cement siding and the sharp decline from 2004 to 2005 is most certainly due to fiber cement siding being given its own category.

US Residential Cladding Trends

In Figure 2d, each different exterior wall material is plotted based on estimates from the SOC of the number of completed new single-family homes using that for its primary cladding. The top line identified as total would be a relative, but low, estimate of the number of the number of new single-family homes that were completed for each year. From 1971 to 1974, brick was the primary exterior wall material being used in the US with 385,000 homes completed in 1971, a subsequent peak of 421,000 homes in 1973, and 325,000 at the end in 1974. Brick was followed by wood and wood composites being the dominant cladding from 1975 to 1993, where the corresponding number of completed homes was: 1975 start = 316,000, 1979 peak = 553,000, and 1993 end = 325,000. After the reign of wood siding, vinyl siding has been the most commonly used type of cladding on homes completed from 1994 to 2012 as follows: 1994 start = 322,000; 2002 peak = 578,000; and 2012 study end = 161, 000. Figure 2d also clearly shows the precipitous drop in the completion of new single-family homes from a high of 1.654 million is 2006 to only 540,000 in 2009 and a succeeding low of 447,000 in 2011. Reported home completions in 2011 were only 27% of the high in 2006.

Cladding Trends within US Census Bureau Regions and Divisions

For a more regional perspective, Figure 3 contains the trends of the most commonly used cladding materials for each US Census Bureau region and its associated divisions.

Northeast Region: New England and Middle Atlantic Divisions. The primary cladding materials used in the Northeast Region are presented in Figure 3a. From 1999 to 2012, vinyl siding was the dominant form of cladding in both the New England and Middle Atlantic Divisions, where it averaged 68.4% and 81.0%, respectively. In the New England Division, wood siding was the second most common type, with a peak of 41.5% in 2000 and then a drop to relative stability starting 2005 and averaging 21.2% since. In the Middle Atlantic Division, brick and wood are the next two most often used exterior wall materials. Since 2005, brick and wood usages have averaged 7.7% and 4.4%, respectively.

Midwest Region: East North Central and West North Central Divisions. Figure 3b shows the cladding materials that are most frequently used in the Midwest Region. For the 1999 to 2012 period, vinyl siding was the principal cladding material in both divisions, with means of 65.2% and 59.4% for the East and West North Central Divisions, respectively. In the East North Central Division, brick and wood are the second and third most often used cladding types and their usage is relatively stable over time. For the 14-year time period studied, brick had a mean of 16.7% and wood had a mean of 9.2%. The use of wood siding in the West North Central Region appears to be generally declining over time from a high of 30.8% to a relatively stable mean of 16.4% since 2009. Fiber cement siding, however, is clearly increasing in use within this Division (0.5% in 1999 and 20.1% in 2012).

South Region: South Atlantic, East and West South Central Divisions. The primary cladding used in the South Region is shown in Figure 3c, where the South Atlantic Division consistently used more vinyl siding than any other type. In this case, peak usage occurred in 2002 and 2010, with 47.8% and 47.2%, respectively, and was at its lowest in 2006 (31.9%) and 2007 (32.2%). Stucco use in this division was very stable averaging 11.9% through

2004 and then it increased to a peak of 27.2% in 2007 and ended in 2012 at 25.1%. Although lower, brick usage has been relatively stable over the 14-year period and has averaged 17.4%. Although not shown on the graph, fiber cement cladding in the South Atlantic Division has increased from 2.1% in 1999 to a peak of 12.7% in 2007 and was 10.1% in 2012. In both the East and West South Central Divisions, brick is the most common type of cladding. Brick cladding in the East South Central Division appear to be slightly increasing with a peak of 68.6% in 2008, whereas the usage of brick in the West South Central Division is generally trending downward from a high of 76.6% in 2003. Since 2008, brick usage trends in both of these divisions have been very similar with the East and West being 62.4% and 63.7%, respectively, in 2012. Vinyl siding is the second most commonly used cladding material in the East South Central Division and it seems to be trending slightly downward with a high of 36.1% in 2003 and a low of 23.7% in 2008. In contrast, fiber cement siding in the West South Central Division has shown a slow, but steady, increase in usage from 2.5% in 1999 to 14.7% in 2012.

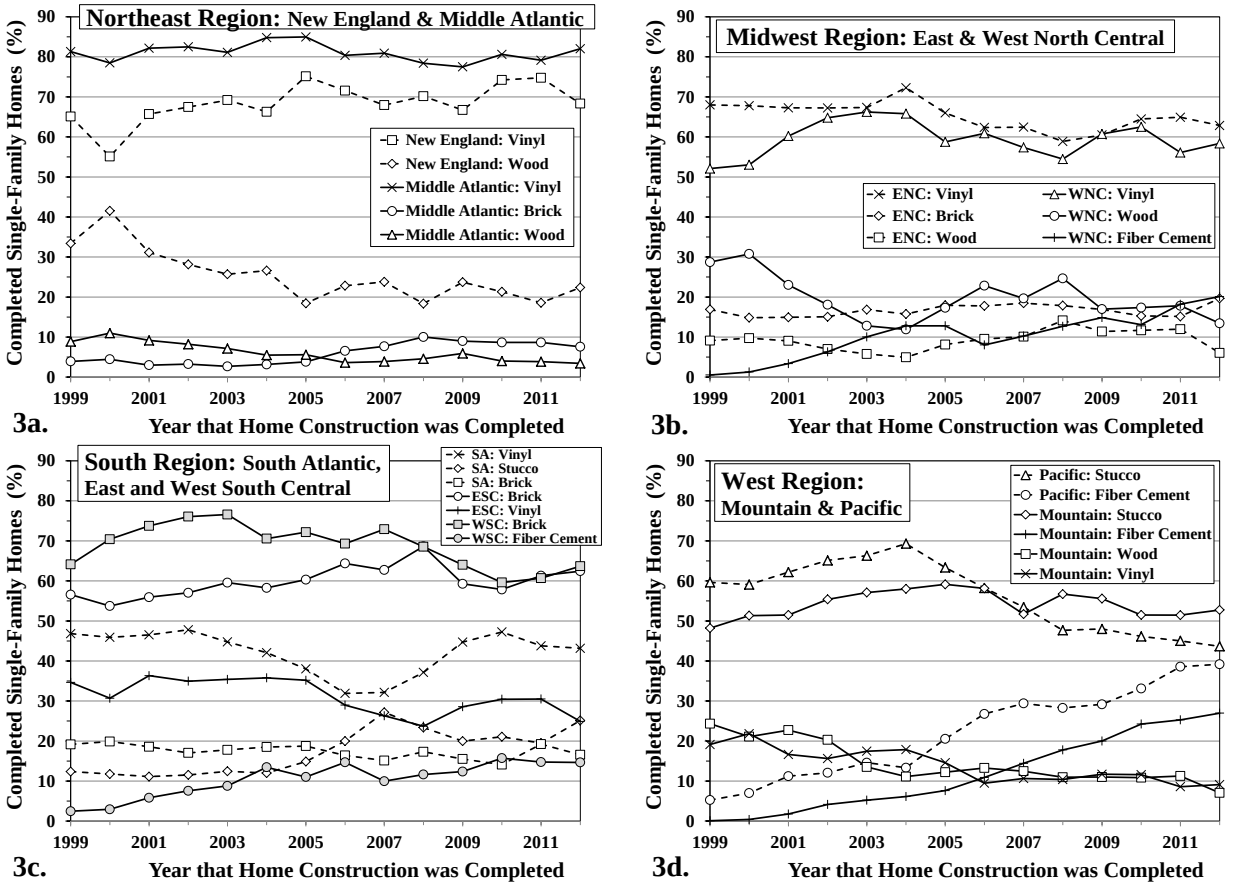

Figure 3. Primary cladding types used in new single-family residential construction by US Census Bureau Regions and Divisions: (a) Northeast, (b) Midwest, (c) South, and (d) West.

West Region: Mountain and Pacific Divisions. Cladding trends from 1999 to 2012 for the West Region are presented in Figure 3d. In the Pacific Division, stucco has been the primary exterior wall material used, but it has declined from its highest mean of 69.3% in 2004 to its lowest mean of 43.7% in 2012. By comparison, fiber cement siding has been steadily increasing from its low of 5.3% in 1999 to its high of 39.2% in 2102. Based on the current trends of these two materials, fiber cement siding will likely overtake stucco as the primary cladding material in use in the Pacific Division in the very near future. Stucco is also the predominant cladding material in the Mountain Division and is relatively flat in its usage with a low of 48.2% in 1999, a high of 59.1% in 2005, and a value of 52.7% in 2012 that was also very consistent in prior two years. The second most frequently used material in the Mountain Division is fiber cement siding, which has progressively increased from 0.1% in 1999 to 27.0% in

2012. Both wood and vinyl siding show a slight decrease in usage from 1999 to 2012, but both were also reasonably stable from 2006 to 2012 with means of 11.0% and 10.2%, respectively, for that time period.

Conclusions

Generally, the different types of cladding systems used in single-family residential construction have followed the national trend for Completed Single-Family Homes. There have been some anomalies primarily seen with wood, aluminum, fiber cement, and to some extent, vinyl. Some of these changes were linked to material economics, such as with the declining usage of aluminum siding, where high material prices for aluminum could not compete with the cheaper and easier to install vinyl siding, which ultimately took over most of the aluminum siding market. The use of wood and wood composite siding also dramatically decreased over time. The introduction of engineered wood cladding systems including hardboard, MDF and OSB were quickly adopted because of their low cost. The resulting rot and delamination of the siding products due to either mis-manufacturing or incorrect product installation damaged the image of wood as a cladding system. Concurrently, vinyl siding was emerging in the cladding market and was rapidly adopted by the residential construction industry because of its lower cost and relatively low maintenance requirements. Most recently, the use of fiber cement siding is steadily increasing, particularly in the Western Region, and it is competing well with vinyl siding because it is stronger, stiffer, mimics natural wood clapboard siding well, and is both fire and rot resistant. The current trends in fiber cement siding suggest that it appears to be on track to become a dominant part of the residential cladding market in the US.

References

Schut, J. H. (2007). Fighting Back (with Foam, Fiber Composites, and Even Paint! Plastics Technology. October 2007. Pp. 63-72. [WWW document]. URL http://www.ptonline.com/articles/the-future-of-vinyl-siding-fighting-back-with-foam-fiber-composites-and-even-paint

US Bureau of the Census. (1976). Construction Report Series C25-75-13 Characteristics of New Housing: 1975. US Department of Commerce, Washington, DC.

US Bureau of the Census. (1981). Construction Report—Series C25-80-13 Characteristics of New Housing: 1980. US Department of Commerce, Washington, DC.

US Bureau of the Census. (1986). Construction Report—Series C25-85-13 Characteristics of New Housing: 1985. US Department of Commerce, Washington, DC.

US Bureau of the Census. (1991). Current Construction Reports—Series C25-9013 Characteristics of New Housing: 1992. US Department of Commerce, Washington, DC.

US Census Bureau News—CB13-166. (2013). New Residential Construction in August 2013. US Department of Commerce, Washington, DC.

US Bureau of the Census. (1996). Current Construction Reports—Characteristics of New Housing: 1995, C25/95-A, US Department of Commerce, Washington, DC.

US Census Bureau. (2000). Current Construction Reports—Characteristics of New Housing: 1999, C25/99-A, US Department of Commerce, Washington, DC.

US Census Bureau. (2013a). Characteristics of New Housing: About the Surveys [WWW document]. URL http://www.census.gov/construction/chars/about_the_surveys/

US Census Bureau. (2013b). Characteristics of New Housing: Microdata [WWW document]. URL http://www.census.gov/construction/chars/microdata.html

US Census Bureau. (2013c). Characteristics of New Housing: Completed [WWW document]. URL http://www.census.gov/construction/chars/completed.html

US Census Bureau. (2013d). 2012 Characteristics of New Housing, US Department of Commerce, Washington, DC.

Court clears accord in Louisiana-Pacific class-action lawsuit. (1996, April 23). *Wall Street Journal - Eastern Edition*, Vol. 227 Issue 80, pA4. .

Weyerhaeuser Settles Class-Action Lawsuit, Plans to Take Charge. (2000, July 11).*Wall Street Journal - Eastern Edition*, Vol. 236, Issue 6, pA4.