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THE MARK V PROJECT
PART II: CHANGES TO REDUCE COSTS

by

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(This Housing Note presents a brief summary of the second part of this study; the first is summarized in Part I, Housing Note No. 29. Information on the complete study is contained in report # NRC 9590 of the Division of Building Research, NRC, Ottawa, and may be obtained for 50 cents by writing to the Publications Section of DBR.)

THE MARK V PROJECT:

Part II: Changes to reduce costs

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In 1965 the Division of Building Research, National Research Council, conducted a cost study of a typical three-bedroom wood frame bungalow and found the on-site construction cost of $10,586 to be made up of 24 per cent labour, 74 per cent materials and 2 per cent equipment rental. The following year a second house was built, almost identical with the first, but incorporating changes in the construction that offered a potential saving of nearly $400. This Note describes most of the changes that were made. The changes did not significantly affect the over-all quality or appearance and all of them conformed to the requirements of Residential Standards.

The houses were built at Connelly Developments Limited, Glen Cairn Subdivision, near Ottawa. Central Mortgage and Housing Corporation supplied the services of two of their Building Compliance Inspectors to assist in the collection of field information. The research project was undertaken in cooperation with the National House Builders Association, forming part of their experimental house program as Mark V of the series.

The potential savings offered by these changes were not fully realized in practice for several reasons. Due to a shortage of mortgage money, the second house was the only house under construction in Glen Cairn when it was built. Tradesmen were not able to proceed in an orderly fashion from one house to another and develop a regular rhythm of work, as was the case in the first house. As a result, many unchanged operations in the second house required increased labor time. In addition, many of the changes were revisions of regular work procedures and this no doubt affected productivity. About 21 per cent more man-hours were required to complete the second house, even though the amount of materials was substantially less. About half of this increase was due to increased idle time.

In assessing the cost saving potential of the following changes all labour has been assumed at $3.50 an hour. Materials costs are based on 1965 prices and on unit prices supplied by the builder.

Basement

The first change was the use of 6 mil polyethylene film beneath the basement slab as a substitute for crushed rock (Figure 1). This saved $28 in materials.

When the crushed rock fill is not used, the footing trenches have to be dug after the main excavation. In this second house, they were dug by hand. Extra labour was also required to dig pipe trenches and to level the base for the slab. Taking all this extra labour into account as well as the labour to lay the plastic film, there was still a saving of $6 in labour over that used in spreading the crushed rock.

The footings were placed in trenches without forms (Figure 1). This saved almost $19 labour in forming and stripping, not to mention the cost of wear and tear on the forms. Altogether, the use of polyethylene and the elimination of footing forms offered a potential saving of $53.

If the full savings are to be achieved, however, the base for the slab must be accurately leveled and the footing trenches dug to the minimum required dimensions; otherwise the potential savings will disappear in the extra concrete required. An extra inch of concrete over the total basement floor area amounts to over $50, which illustrates the necessity for accurate grading.

Sill Plates

Mortaring the sill plate on top of the wall is a time consuming job and delays the start of the framing after the foundation is stripped.

In the second house the sill was set on edge and nailed inside the wall forms complete with anchor bolts before the concrete was placed (Figure 2). In addition to saving time, the sill acted as a screed to level the top of the concrete. This saved $6.50 in labour and $4.00 in materials. About $3.00 of this saving was due to a saving in concrete displaced by the sill (about 1/5 cu yd).

Floor Framing

Reducing the header joist from 2 by 8 in. to 1 by 8 in. (Figure 2) saved $7. Other changes to the floor framing included the relocation of the basement beam. In the first house the beam was located directly in the centre of the house. This made the joist length such that a foot had to be cut from each joist, amounting to $12 of scrap. By relocating the beam a few inches to one side, it was possible to use 12-ft joists on one side and 14-ft joists on the other thus eliminating this waste. Figure 2 illustrates how the new sill detail helped in this since the new sill arrangement reduced the clear span by about 4 in. Additional joists were saved in replanning the floor framing so that the total saving in floor framing material was $27. There should have been a corresponding saving of $4 in labour for a total saving of $31.

Wall Framing

In the first house, studs were spaced 16 in. o.c. in the outside walls and 24 in. o.c. in the partitions, and doubled top wall plates were used

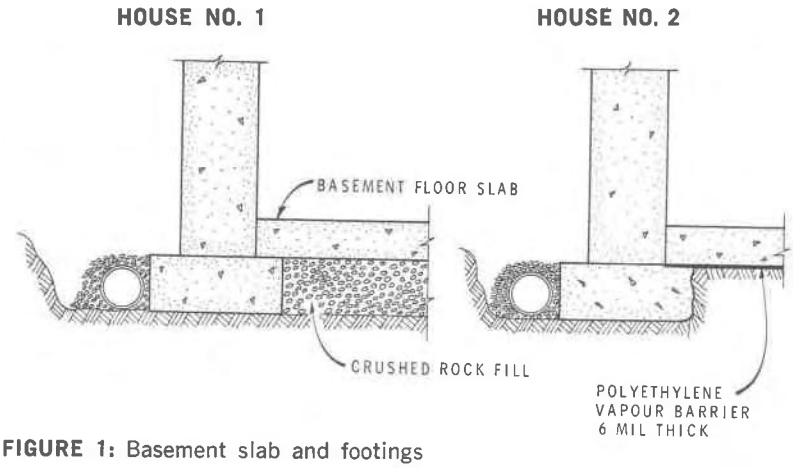

FIGURE 1: Basement slab and footings

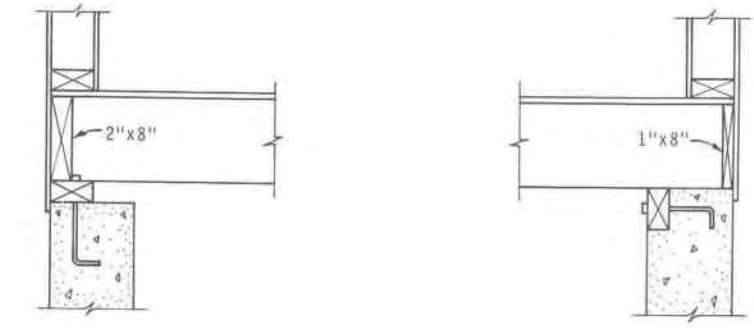

FIGURE 2: Sill plate and floor framing

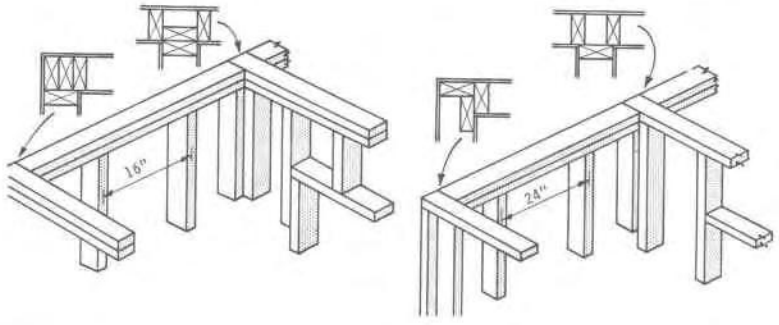

FIGURE 3: Wall framing

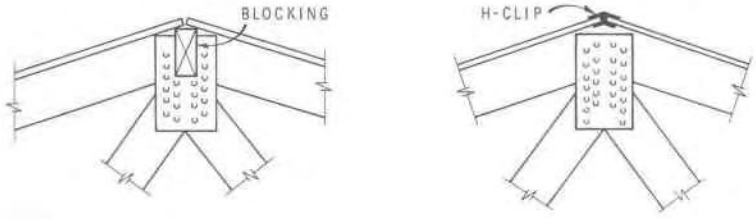

FIGURE 4: Roof framing

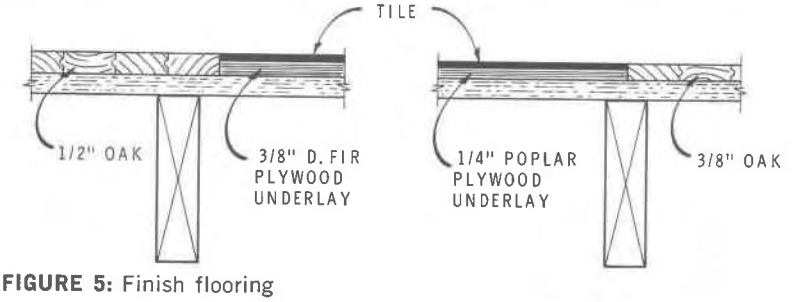

FIGURE 5: Finish flooring

throughout. In the second house, all studs were spaced at 24 in. o.c., and single top plates were used in all partitions and the two end walls. Because a trussed roof was used, these were considered as non load-bearing. Single studs were used at partition doorways and cripples were eliminated over the tops of the partition doorways. Wall and partition corners and intersections were framed with 3 rather than 4 studs (Figure 3). These changes saved $25 in materials on the outside walls and $16 on the partitions. Had the proportion of labour to materials cost been the same as in the first house, there should have been an additional labour saving of about $12, making a total saving of $54 for the wall and partition framing.

Wall Sheathing

Sheathing was omitted on the wall protected by the carport. This wall had a brick veneer face; the omission of sheathing is permitted in Residential Standards. This saved $11 in materials. The labour to install the extra layer of sheathing paper that is required when sheathing is omitted was about equal to the labour required to install the sheathing. Omission of sheathing, however, has certain drawbacks, particularly in winter construction when it is desirable to enclose the building rapidly. It is debatable, therefore, whether this change is advantageous in the long run.

Roof Framing

Ridge blocking at the peak of the roof was eliminated and H clips were used instead to support the plywood edges (Figure 4). This saved 30 pieces of blocking and reduced the cost by $5. (The H clips were bent to conform to the roof slope.) Several rows of stringers were used in the first house to align the bottom chords of the trusses for wallboard and insulation application. Eliminating these 2 by 4 stringers and substituting 1 by 4 strapping only in those areas where the partitions did not keep the trusses aligned saved $14 in materials and labour.

Roof Shingles

In the first house asphalt shingles were attached with 6 nails per shingle. By reducing the nails to 4 per shingle it was possible to save $4 in nails and $7 in labour, a total saving of $11.

Carport

In the first house ⅜-in. sanded plywood was used for the carport ceiling. By substituting 5/16-in. thick select sheathing grade plywood, $27 in materials was saved. The same substitution in the carport storage shed saved an additional $16.

Relocating the attic access hatch to the carport ceiling rather than inside the house saved about $5. When located inside the house, the hatch must be insulated, trimmed and painted, all of which breaks up the normal continuity of the ceiling construction. By locating it in the carpot, the trim was eliminated, insulation was not necessary and the stippled interior ceiling finish was uninterrupted.

Flooring

The first house used ½-in. thick oak flooring over most of the floor area. Where resilient flooring was used (kitchen, foyers) ⅜-in. D. F. plywood underlay was used to bring the finished floor up to the same level. In the second house, the oak flooring was reduced to ⅜-in. thickness and the plywood underlay changed to ¼-in. poplar (Figure 5). These changes saved $23 in flooring, $11 in underlay and $3 in labour for a total saving of $37.

The ceramic tile bathroom floor in the first house was laid over a mortar base. This required the subfloor to be dropped between the joists in this area to bring the finish flooring to the same level as the adjacent flooring. In the second house the ceramic tile was applied with an adhesive to a separate plywood underlay. This saved approximately $5, mainly because the subfloor did not have to be recessed.

Heating System

In the first house, the basement was heated with 3-branch ducts running out from the main duct. In the second house, these branch ducts were eliminated and registers were installed directly on the main duct (Figure 6). Another important change was in the return air system: whereas four return air inlets were used in the first house, only one large one was used in the second house. These changes instituted a potential saving of $28.

Plumbing

In the second house, the waste and vent pipes above the basement floor level were changed from copper to plastic. In terms of 1965 prices this saved only $4. In terms of 1966 prices, however, the plastic piping was $21 cheaper than copper piping, considering materials only. Increased labor, however, considerably reduced this potential saving. The increased labor was believed to be largely due to the inexperience of the plumber with plastic piping, and since this study was made the installation time is reported to have decreased significantly.

Basement Stairs

A savings in material of $14 was achieved by substituting spruce for pine in the basement stairs.

Fireplace and Chimney

The flues in the two houses were enclosed in a 7-ft wide chimney. In the first house, the chimney was built as a solid unit. In the second house, the chimney was built with the minimum required masonry thickness around each flue and the remainder left hollow (Figure 7). The first chimney was found to be 8 in. higher than required. These and other minor changes potentially saved $42 in material and $22 in labor, a total of $64.

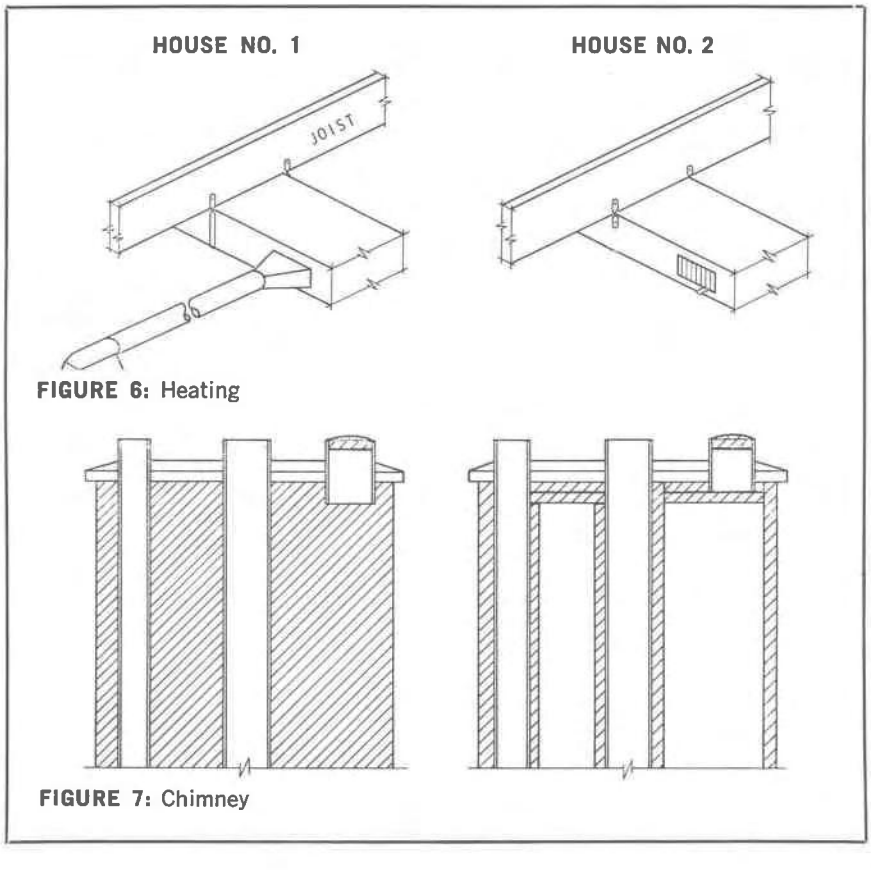

FIGURE 6: Heating

FIGURE 7: Chimney

Conclusion

This study showed that the potential savings from any individual change were relatively small, but when these were totaled they amounted to about 4 percent of the on-site cost. To a builder this would mean constructing 125 houses a year, a potential saving of about $50,000 a year.

Although some of the changes that were made are applicable only to this builder's operations, many of them could have general application, and all are examples of what may be looked for in an exercise to reduce costs.

Finally, no attempt was made in this study to determine the effects on costs of job organization or material handling techniques. It is quite conceivable that further savings could have been brought about through refinements in these areas.