

5 - Modularization of Interior Walls

5.1 - Introduction

The Detroit Integrated Transportation Campus (DITC) was to begin construction in October of 2008. However, due to complications with the General Contractor bid submissions, as of March, 2009 the project has yet to begin construction. Due to this delay, the State of Michigan will not only expect the construction to be completed within the expected one year construction period, but would find it beneficial to accelerate the construction to complete the job as soon as possible.

One of the current trends within the architecture and construction industry is leaning project delivery through the prefabrication of building systems. Prefabrication involves fabricating a system off site, bringing it to site in pieces, and installing those pieces on site. This process ensures quality because the systems are fabricated in shops; it also saves cost of on-site construction, and increases the rate of construction. The design of the Detroit Integrated Transportation Campus design currently has interior walls of gypsum board on metal stud, constructed on site. This interior wall system is currently on the critical path and if accelerated could decrease the overall schedule of construction.

Modular interior wall systems are prefabricated, and if substituted for the current interior wall system of the DITC could increase the speed of construction and add to the sustainability of the building. Interior building renovation is more sustainable and efficient with modular walls, because they can be easily deconstructed and reconstructed to suit new building spaces.

Environmental Wall Systems (EWS), located near Cleveland, Ohio, is a company which produces the IrisWall modular wall system. The IrisWall system was selected as the replacement for the typical gypsum board on metal stud on the DITC for this analysis. EWS was selected because of its close vicinity to the DITC, and their easy-to-install design of the IrisWall system. In order to fully evaluate the substitution of the IrisWall system its application to the DITC, cost, and schedule impacts were analyzed.

5.2 - Methods

1. Research the design of the IrisWall System.
2. Analyze the application of the IrisWall System to the DITC.
3. Compare the cost of IrisWall versus typical gypsum board on metal stud.
4. Determine the schedule impacts of the IrisWall System on the DITC.

5.3 - References

1. Detroit Integrated Transportation Campus, 100% Construction Documents
2. Environmental Wall Systems
3. R.S. Means Interiors Cost Data, 2009 Edition

5.4 - System Overview

The IrisWall system is not only sustainable because it reduces renovation waste and allows for flexible floor design, but it also utilizes sustainable materials. The IrisWall face consists of 95% recycled material, the aluminum is between 65-85% recycled content, and the standard finishes are water-based. Panel options for the IrisWall system include wall panels, window panels, and door panels. The panels can be made up to 10 feet high, and between 6-48 inches wide. IrisWall doors are full height and can match any existing specifications for width and finish. IrisWall doors come with finished locks, hinges, and doorstops. An example of the IrisWall system is shown below in Image 5.1.



Image 5.1, IrisWall System, Environmental Wall Systems

The IrisWall system utilizes continuous aluminum ceiling and floor tracks that allow for easy construction and renovation. IrisWall ceiling track connects to a typical ceiling grid system, and the floor track connects to carpet with carpet grippers. Each panel is connected to one another by an aluminum panel to panel connection. The system also connects to foreign walls and allows for variance by utilizing a spring loaded wall channel. An elevation of a typical office layout and typical IrisWall connections are shown below in Images 5.2 – 5.6.

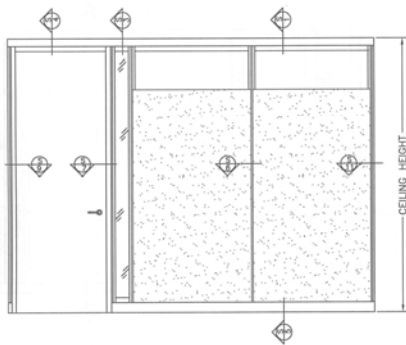


Image 5.2, IrisWall Elevation, EWS

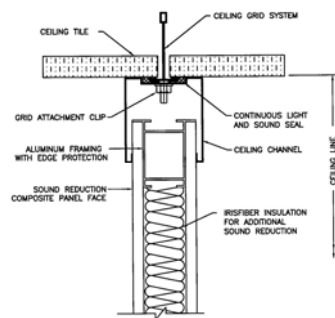


Image 5.3, IrisWall Ceiling Connection, EWS

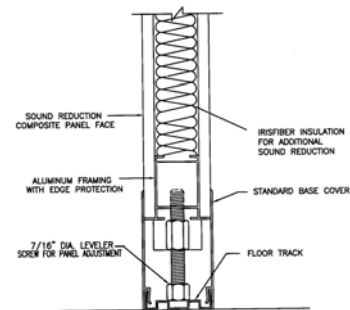


Image 5.4, IrisWall Floor Connection, EWS

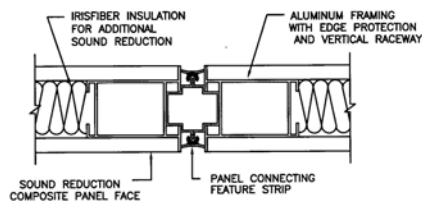


Image 5.5, Panel to Panel Connection, EWS

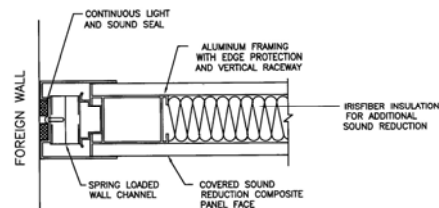


Image 5.6 IrisWall to Foreign Wall Connection, EWS

IrisWall system design allows for the inclusion of in-wall electrical and data connections. Switches, outlets, and data connections can be prefabricated in the panels, along with the conduit needed to run the wiring to these connections. Panels that require electrical and data connections must be noted so they can be prefabricated to meet the specifications. Conduit can be run down to the floor track from the electrical and data boxes. Wiring is pulled from above the ceiling into the vertical raceway, down to the floor track, and then up to the electrical and data boxes through the conduit. An elevation of conduit layout within a panel is shown below in Image 5.7.

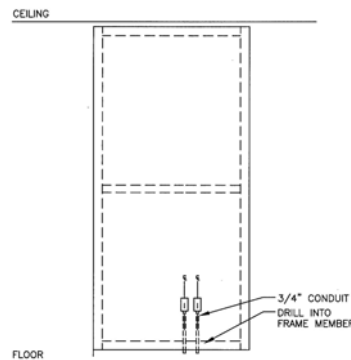


Image 5.7, IrisWall Conduit Layout, EWS

Because the design of the IrisWall system is flexible, the design of room systems with IrisWall should also be flexible. In order to obtain the ability to change room spaces the above ceiling systems should be designed so they also can be changed also. Ceiling diffusers should be connected with flex duct, in-grid lighting fixtures should be run with longer wiring, and sprinkler heads should be connected with adjustable piping to allow these systems to move.

The Iris-Wall system works well for the Detroit Integrated Transportation Campus because it is office building with an open floor plan. IrisWall could not be applied all interior walls of the DITC for multiple reasons. Some areas of the DITC were designed to have exposed ceiling and IrisWall could not be applied in such areas as it needs a ceiling grid to attach to. Walls in kitchen, lavatory, and toilet rooms have to remain typical gypsum board on metal stud due to the in-wall mechanical systems required. IrisWall also could not be applied to walls in permanent locations such as entries, stairwells, elevators, and mechanical chases. For the purpose of this analysis IrisWall was applied in all acceptable locations.

5.5 - Cost Impacts

An IrisWall system includes many different panels and connections, and in order to achieve an accurate estimate, a quote was obtained from EWS for the DITC IrisWall system. Floor plans, including IrisWall panels, windows, doors, connections, and in-wall electrical components, were created. An excel sheet quantifying these different elements was also created. The excel sheet, available in Appendix G, was then sent to EWS for an accurate estimate. A breakdown of the estimate received from EWS can be seen below in Figure 5.1. In order to check the costs received from EWS, similar modular wall cost were

compiled from R.S. Means 2009. The cost comparison can be seen below in Figure 5.2, and confirms the accuracy of the estimate received from EWS.

EWS Iris Wall System Cost		
Solid Panels	\$	76,743.00
Doors	\$	42,219.00
Windows	\$	15,466.00
Post Condition	\$	6,177.00
Installation	\$	39,625.00
Total Cost	\$	180,230.00

Figure 5.1, Iris Wall Cost Estimate, Estimate Received From EWS

Interior Modular Wall Systems - Cost Check		
System		Cost/LF
IrisWall Solid Panels - 10' high, painted finish	\$	137.93
RS Means Demountable Gypsum - 9' high, vinyl clad	\$	83.00
RS Means Demountable Gypsum - 9' high, fabric clad	\$	177.50

Figure 5.2, Modular Wall Cost Check, EWS & R.S. Means 2009

In order to effectively compare the existing drywall on metal stud to the proposed IrisWall system, a detailed estimate of the replaced drywall on metal stud system was generated. First, a detailed estimate of the drywall on metal studs, doors, and windows was compiled using cost data from R.S. Means Interiors Cost Data 2009. These estimate breakdowns include material, construction, and finishing costs; and can be viewed below in Figures 5.3 and 5.4.

Existing Walls (10' high ceiling)		
Total Linear Feet		786.00
Total Square Feet		8354
Add: 10 % Waste		9190
Subtotal (@7.96/SF)	\$	73,151.65
Total Incl. Detroit Cost Index	\$	76,809.23

Figure 5.3, Drywall on Metal Stud Estimate, R.S. Means 2009

Doors & Windows (Wd w/ clear, HM Frame w/ paint)		
40" w/o Lite		9
40" w/ 14" Lite		29
52" Double		1
Cost: 40" Door (ea.)	\$	310.70
Cost: 3'x7' frame	\$	245.50
Cost: 4'x7' lite frame	\$	338.00
Cost: glazing ea. (13.60/sf)	\$	95.20
Cost: 52" doors	\$	463.40
Cost: 52" Frame	\$	296.50
Cost: Hardware (\$345 ea.)	\$	345.00
Cost: Frame Paint	\$	16.00
Subtotal:	\$	41,778.80
Total Incl. Detroit Cost Index	\$	43,867.74

Figure 5.4, Existing Doors and Windows Estimate, R.S. Means 2009

Because the IrisWall system is prefabricated and designed to fit into finished spaces, there are some extra cost savings that come with using IrisWall. These savings were added into the cost of the existing drywall on metals stud estimate, as they would be subtracted from construction costs if the IrisWall system was used. Savings include clean-up costs for using a drywall on metal stud construction; carpet installation cost; and electrical switch and outlet costs. Clean-up savings include the dumpster costs for the drywall, metal stud, and carpet waste in areas of typical drywall construction; and include the periodic clean-up associated with these constructions. In areas where the IrisWall system is used, carpet installation savings incur, because the carpet can be installed continuously instead of on a room-by-room basis. Electrical savings are incorporated with the IrisWall system because the in-wall electrical boxes are installed as part of the prefabrication, and therefore can be installed more efficiently than on-site. The savings were generated from cost data received from Environmental Wall Systems, and can be seen below in Figures 5.5 – 5.7.

Clean-up Savings		
Wall Waste (10%) SF		835.446
* (.5 feet thick wall) CF		417.723
Carpet Waste (10%) SF		1224.8
* (.3 feet thick carpeting) CF		367.44
Total CF		785.163
Dumpster size CF		1280
Savings (Dumpster)		1
Dumpster	\$	500.00
Periodic & Final Cleanup (\$1.20/SF)	\$	1,469.76
Subtotal Savings	\$	1,969.76
Total Incl. Detroit Cost Index	\$	2,068.25

Figure 5.5, Clean-up Savings, EWS

Carpet Savings (Where Iris Walls Apply)		
Total SF		12248
Total SY		1360.89
Installation Savings / SY	\$	1.20
Total Savings	\$	1,633.07

Figure 5.6, Carpet Savings, EWS

In-wall Electrical Savings		
Switches		48
Telephone/Data		50
Outlet		99
EWS Switch Savings	\$	20.00
EWS Tele/Data Savings	\$	52.00
EWS Outlet Savings	\$	37.00
Total Savings	\$	7,223.00

Figure 5.7, In-Wall Electrical Savings, EWS

After performing both estimates the cost of the existing drywall on metal stud system came to a total cost of \$131,601.29, and the IrisWall system came to a total cost of \$180,230.00. The difference showed that the IrisWall system would cost \$48,628.71 more, a cost increase of 37%.

Cost Comparison		
Existing System	\$	131,601.29
EWS IrisWall System	\$	180,230.00
Additional Cost for IrisWall	\$	48,628.71
Percent Cost Increase		37%

Figure 5.8, Cost Comparison

The IrisWall system also offers a good Return on Investment because of tax and renovation savings. Tax savings are incurred because IrisWall is classified as furniture by the Internal Revenue Service, and this allows for a depreciation period of 7 years, compared to 39 years of depreciation for conventional drywall construction. Factoring in renovation savings, the Return on Investment can cover the up-front costs of using the IrisWall system. A Return on Investment spreadsheet was acquired from EWS, and applied to the DITC. With an assumed move rate of 10% per year, and an inflation rate of 5%, it was calculated that the payback period for using IrisWall on the DITC would be 60 months. This spreadsheet is available in Appendix G of this report.

5.6 - Schedule Impacts

IrisWall can be installed on-site more efficiently than typical drywall construction. Productivity info was received from EWS and applied to the IrisWall quantities in order to obtain the duration for the IrisWall installation. It was assumed that four IrisWall installers would be utilized for the construction. The duration calculations can be seen below in Figure 5.9. It was calculated that the IrisWall installation would take a total of 12 construction days.

IrisWall Schedule Duration	
Wall Panel Installation (LF/day) - 4 Installers	100
Total IrisWalls (LF)	786
Wall Panel Duration (days)	8
Doors (door/day)	10
Total IrisWall Doors	39
Door Installation (days)	4
Total IrisWall Duration (days)	12

Figure 5.9, IrisWall Durations, EWS

After the IrisWall durations were calculated, the decrease in duration of the typical drywall construction had to be calculated. Not all of the typical drywall construction was replaced by IrisWall, therefore instead of removing these activities, their original durations had to be decreased. Percent of the total drywall construction that was replaced by IrisWall was calculated, and these calculations can be seen below in Figure 5.10.

Percent Schedule Decrease for Wall and Door Activities	
Total Walls (LF)	2336
Total Non-IrisWall (LF)	1550
Total IrisWall (LF)	786
Schedule Decrease for Wall Activity (%)	34%
Total Doors	89
Iris Wall Doors	39
Total Non-IrisWall Doors	50
Schedule Decrease for Doors (%)	44%
Decrease Applied to Wall and Door Activities	33%

Figure 5.10, Duration Decreases for Typical Drywall Construction Activities

A duration decrease of 33% for all typical drywall construction activities was calculated and applied. The activities affected include Interior metal studs, drywall, paint, and doors. The duration decreases in these activities and the new durations can be found below in Figure 5.11.

Current Schedule Durations with Duration Decrease			
Activity	Duration (days)	Duration Decrease (33%)	New Duration (days)
Interior Metal Studs, Lev 2, Seq 1-6	6	2	4
Interior Metal Studs, Lev 2, Seq 7-11	9	3	6
Interior Metal Studs, Lev 2, Seq 12-17	6	2	4
Drywall, Lev 2, Seq 1-6	9	3	6
Drywall, Lev 2, Seq 7-11	12	4	8
Drywall, Lev 2, Seq 12-17	9	3	6
Paint, Lev 2, Seq 1-6	6	2	4
Paint, Lev 2, Seq 7-11	9	3	6
Paint, Lev 2, Seq 12-17	6	2	4
Hang Doors, Lev 2, Seq 1-6	3	1	2
Hang Doors, Lev 2, Seq 7-11	6	2	4
Hang Doors, Lev 2, Seq 12-17	3	1	2
Interior Metal Studs, Lev 1, Seq 1-6	6	2	4
Interior Metal Studs, Lev 1, Seq 7-11	9	3	6
Interior Metal Studs, Lev 1, Seq 12-17	6	2	4
Drywall, Lev 1, Seq 1-6	9	3	6
Drywall, Lev 1, Seq 7-11	12	4	8
Drywall, Lev 1, Seq 12-17	9	3	6
Paint, Lev 1, Seq 1-6	6	2	4
Paint, Lev 1, Seq 7-11	9	3	6
Paint, Lev 1, Seq 12-17	6	2	4
Hang Doors, Lev 1, Seq 1-6	3	1	2
Hang Doors, Lev 1, Seq 7-11	6	2	4
Hang Doors, Lev 1, Seq 12-17	3	1	2
Total:	168	56	112

Figure 5.11, Activity Duration Decreases

It is shown in Figure 5.10 that a total of 56 days were saved on the typical drywall construction durations. Subtracting the 12 day duration of the IrisWall construction, gives a total decrease of 44 days. In order to incorporate IrisWall into the schedule, the typical drywall activities had to be adjusted, and IrisWall construction activities added. Carpet installation had to be moved to follow drywall in the schedule, and IrisWall installation was added after carpet installation. After making the necessary changes and adding IrisWall to the CPM schedule, it was determined that the overall construction schedule of one year would be decreased by 6 construction days (based on a 5 day work week). The schedule was only decreased by 6 days, as compared to the 44 day duration decrease, because not all activities were on the critical path. However, more float was added to the schedule, which will allow for more leeway during construction. The project schedule that includes the IrisWall construction can be viewed in Appendix H.

5.7 - Conclusion

Substituting IrisWall for the typical drywall construction on the Detroit Integrated Transportation Campus adds to the buildings sustainability and flexibility, increases the project cost by \$48,628.71, and decreases the project schedule by 6 days. Assuming a 10% per year move rate, the upfront increase in cost for the IrisWall could be recovered in a 60 month payback period due to the tax and renovation savings.

The above ceiling MEP systems where the IrisWall system would be installed are already designed to be flexible for renovation. After speaking with Jan Miller, the State of Michigan's Project Manager on the DITC, about incorporating the IrisWall system, she noted that some of the furniture systems in the building were designed to be permanent. Therefore, the furniture systems would also have to be redesigned to allow the office spaces to be truly flexible, and achieve the full benefits of the IrisWall system.

It is recommended that the IrisWall system be substituted on the DITC in the areas identified, and the furniture system be redesigned to be more flexible. Jan Miller also said the State of Michigan would stay with the original design for the DITC; however, they are implementing a modular wall system on a current construction project, and will look into the idea for future projects.