Role of BIM in Plumbing System

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Abstract

As we look at the plumbing industry, especially in the building sector from design stage to operation & maintenance, huge amount of man power is required for System Design, quantity estimation, coordination, costing, scheduling and operation & maintenance of facilities & services. These different stages have different expertise involved in carrying out these activities. In addition to this lot of problems arise due to lack of coordination.

Using Building Information Model (BIM), from the beginning of a project, helps engineers and designers make better decisions earlier in the process. Thus BIM provides a complete solution from designing to operation & maintenance. BIM is not just a software but it is a collaboration of different softwares, which consists of 3D, 4D, 5D, 6D and 7D in a single module with which all the activities with respect to the project completion can be made easy. BIM provides a complete solution for plumbing which can help in design the system, costing & quantity estimation, time estimation, visualization & clash detection, operation and maintenance of plant.

Fig 1: Rendered 3D model

Introduction:

Building Information Modeling (BIM) is a process involving the generation and management of digital representations of physical and functional characteristics of places. Building information models (BIMs) are files (often but not always in proprietary formats and containing proprietary data) which can be extracted, exchanged or networked to support decision-making regarding a building or other built asset. Current BIM software is used by individuals, businesses and government agencies that plan, design, construct, operate and maintain diverse physical infrastructures, such as water, electricity, gas etc.

With the increase in urbanization and standard of living, the quality in building sector has also increased and to meet this quality the building water supply and sanitation also have to be improved during the planning stage for the better maintenance of the system. The quality can be achieved by BIM. Thus the tool can be used from designing stage to operation and maintenance of the system.

3 Dimension

Collaborative Design:

In building water supply and drainage design, BIM is useful to build the 3 dimensional building model, which can contain all the data relating to water supply and drainage such as pipe material, size, type of pipe like soil pipe or

Fig 2: 3D model with sanitary pipes outside

cold pipe, elevation of the pipe, slope of the pipe, pump power, etc.,. The model can be updated automatically when changes made in one view, automatically gets updated in all views. There is a possibility for all the professionals to work at same time through a central system, and thus it reduces coordination issues and improves the work flow efficiency.

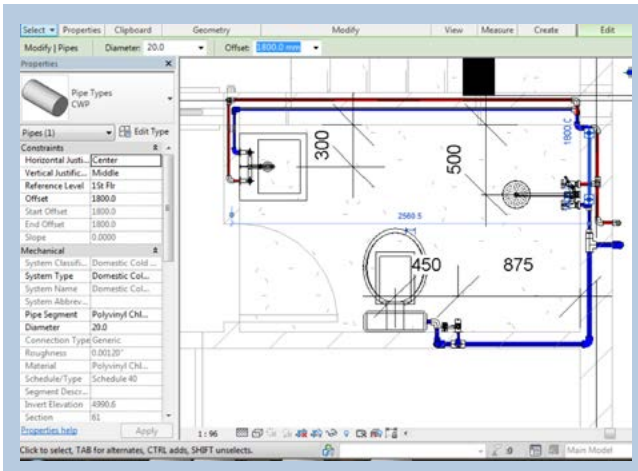

Fig 3: Water supply lines with properties of pipe

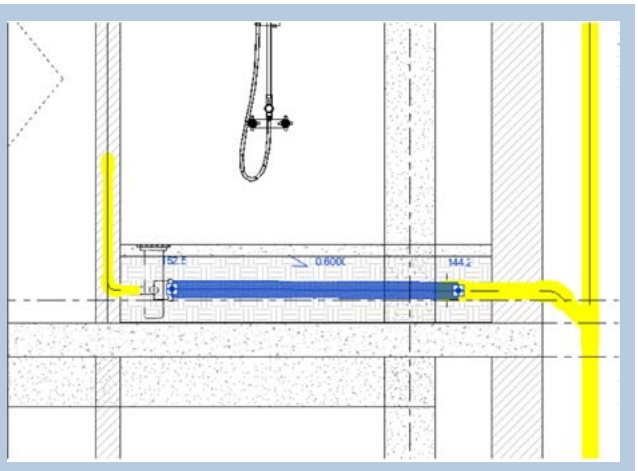

Fig 4: Waste Water pipe with slope 1:60

Optimizing Design Issues (Visual design):

Earlier there were no computers and hence engineers have to manually design the system which needed huge man power and was a time consuming process. After the invention of computers CAD came into existence. This tool gave the designer some feasibility in designing, but this tool has limited visualization as it is only a 2 dimension drawing even though time consumed was somewhat less compared with manual drafting. BIM technology can effectively solve the problems in the traditional design, the data among the professionals can be seamless docking and the three-dimensional model can be established. If complex building structures were encountered, and the duration need to be compensated, in this case the transmission of data is likely to cause data distortion. If three-dimensional building information data was transferred by the BIM technology, which was intuitive, it can achieve good transmission. If there is a certain degree of difference in the design of the model, the model usually divided the design floor wise, and building water supply and drainage design mainly based on civil/ architectural engineering design. With the use of BIM technology, with changes locally, the other data would be automatically updated, and the system control is very convenient.

Pipe Designing:

Water supply and drainage lines can be created easily. The software takes all the pipe fittings like bends, tees, elbows, etc., according to the network of the pipe as we direct. When coming to drainage, the pipe slopes are drawn according to specified inputs and it automatically calculates the level, and hence time can be saved as compared to the 2D drawing where one needs to calculate the slope and indicate the level.

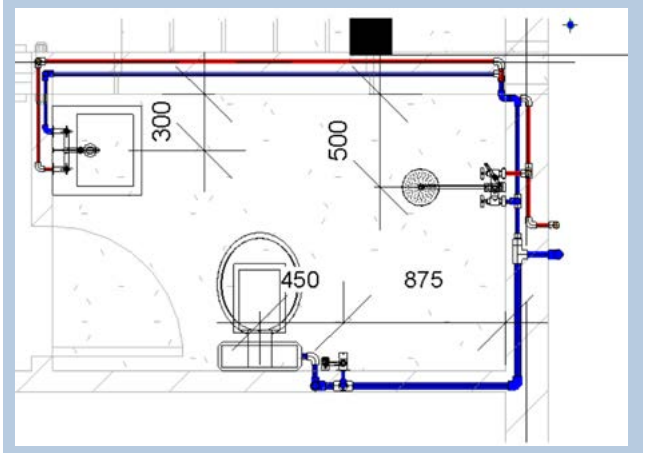

Fig 5: Water Pipes are created as per the requirement

To avoid the confusion, the pipes can be assigned color coding in the application as per standard. This color coding can minimize the wrong pipe installation - e.g. in place of supply pipe, drainage pipe can be considered, and this type of mistake causes error in quantities.

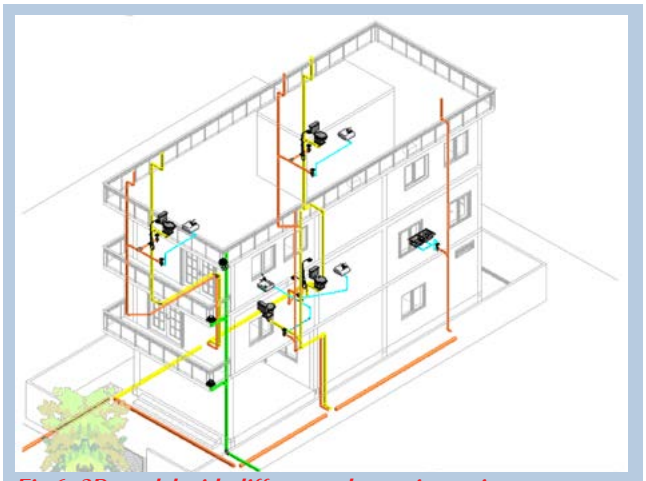

Fig 6: 3D model with different color sanitary pipes

Parametric Families:

This application has readymade parametric families like water tank, water closet, urinals, etc., and also information like inlet & outlet diameter of pipe, flow rate, pressure loss methods, etc., The size and pipe diameters can be changed according to requirements.

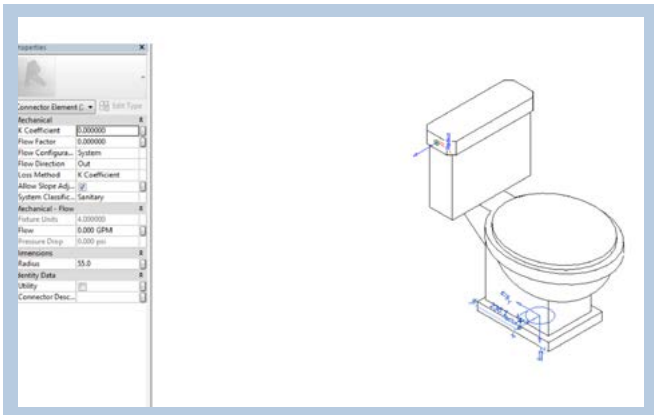

Fig 7: Water closet with properties

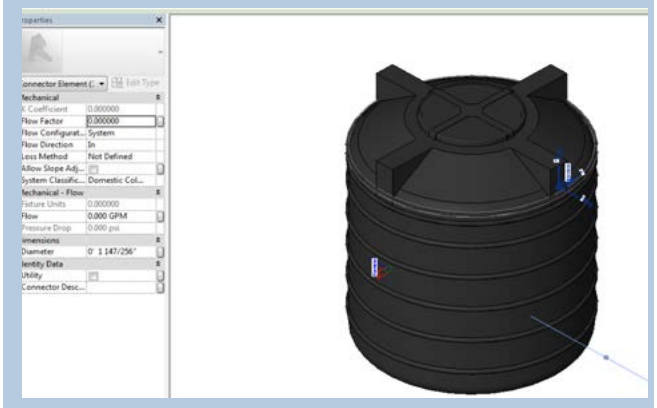

Fig 8: Water tank with properties

The application has unique features. If there is no sufficient space between the fittings of the pipe, then the connection will not take place. This is similar as working at the site where it is not possible to join pipes due to little or no space. This option is not possible in 2D drawing. The designer has to have a lot of experience and visualization in making the drawings so that no issues will arise at the site while execution. In case of 3D, a beginner can start designing easily; if there is any issue he'll get warnings. This application will also generate a pressure loss report where the pressure is reduced at fittings due to roughness of the material or any other reason.

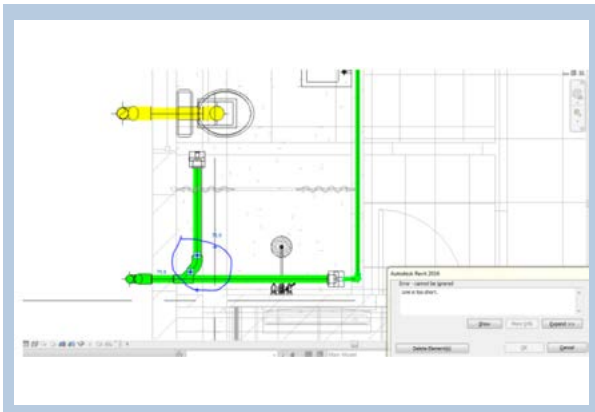

Fig 9: Pipes with less space for fitting

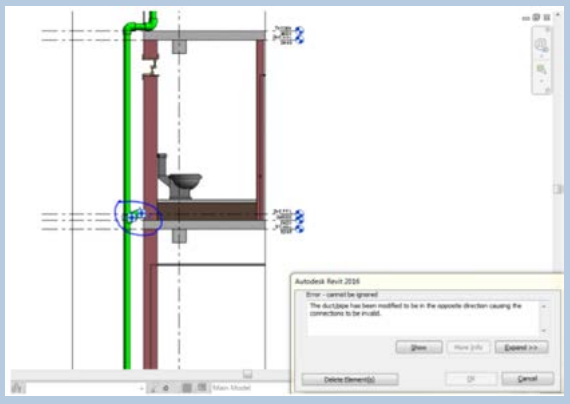

Fig 9A: Pipes with less space for fitting

Clash Detection:

After completion of all the services, including architecture and structural modeling, the drawing has to be imported to Navis Works, where a detailed report can be generated of each and every clash with the locations. The location can be known with the help of grid coordinates. This is somewhat difficult in 2D drawing as MEP coordinator has to run through complete design and attach and every point he has to visualize the design at site. Thus it is a time consuming process and requires more man power if the project is of larger size to detect the clash. Sometimes there is a chance of encountering issues related to clashes and space constraints at the site even after doing clash free drawing due to lack of coordination. Whereas in BIM, as per the report generated, changes can be made in the model to make it clash free.

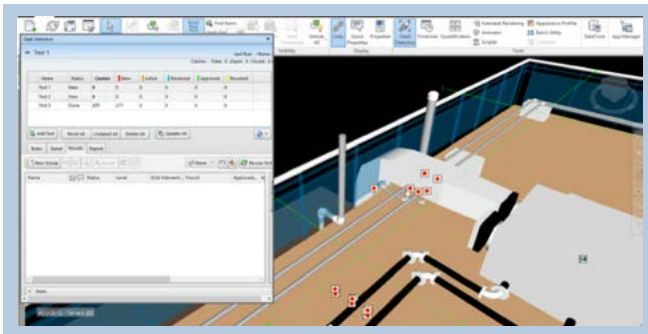

Fig 10: Pipe clash with duct

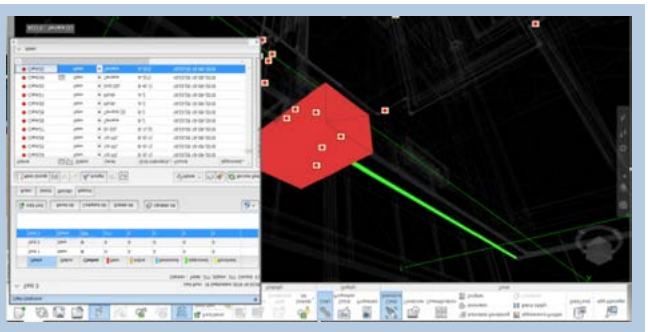

Fig 10A: Pipe clash with duct

4 Dimension (Scheduling)

Time estimation and scheduling is another dimension which can be given by the tool with the help of Microsoft project. This tool by Microsoft project can give the time estimation for the installation of plumbing service for the project after the tool is fed with the activities of the work to be done. This report can be plugged-in in Navis work and the scheduling of the work to be carried can be prepared. Fig shows us the time consumption by the various activities to be done and the planning of scheduling as per the time consumption is shown.

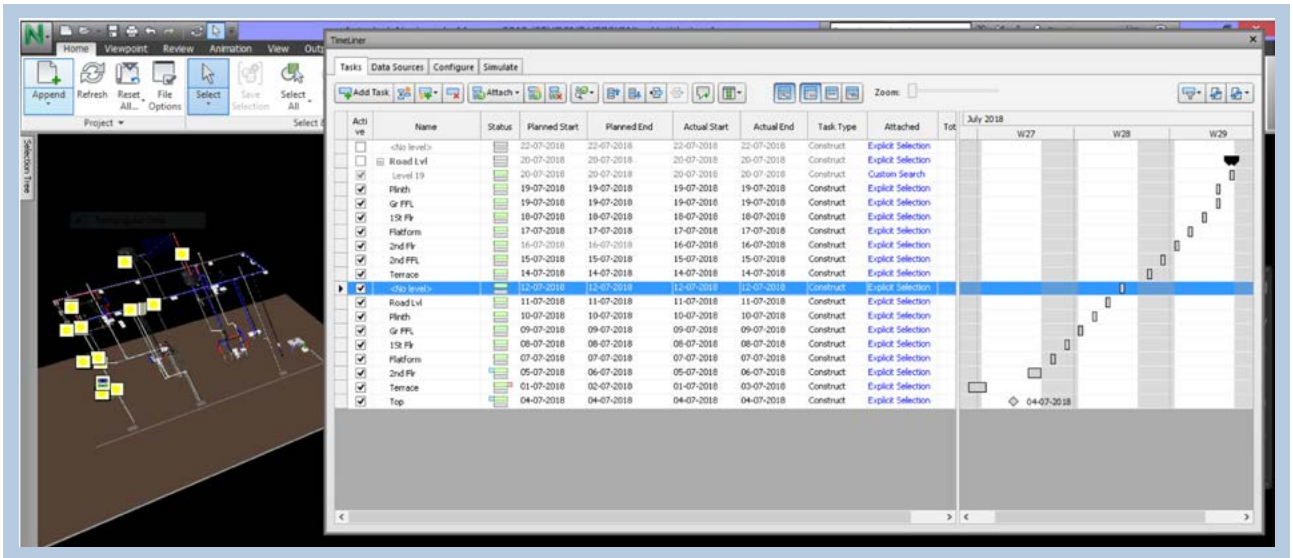

Fig 11: Work schedule of plumbing work (installation)

5 Dimension (Cost Estimation)

The modelled project now has enough information to carry on with the execution but the most essential one is the budgeting. To estimate the budget for the project the cost estimation has to be given based on the chosen material and products. This will generate the cost estimation for the desired systems in the building for the piping and pipe fitting. This is a time consuming process in 2 dimension where a draftsman has to look at each and every element and figure out the quantities. If there is any revision made in the model, this change can be updated automatically in the quantities, where as in 2d for every revision quantities have to be taken. Here, a single click generates quantities and the cost can be applied for the generated quantities and thus it gives the estimation.

<Pipe Schedule>

A	B	C	D
Cost	Diameter	Length	Total Cost
10.0000	38.1	80	0.801825
10.0000	38.1	97	0.974567
10.0000	38.1	101	1.012876
10.0000	38.1	235	2.349853
10.0000	38.1	250	2.496009
10.0000	38.1	264	2.642909
10.0000	38.1	395	3.947598
10.0000	38.1	418	4.18304
10.0000	40.0	81	0.81318
10.0000	40.0	86	0.855729
10.0000	40.0	89	0.893439
10.0000	40.0	124	1.236751
10.0000	40.0	127	1.271101
10.0000	40.0	136	1.35659
10.0000	40.0	136	1.35657
10.0000	40.0	139	1.393472
10.0000	40.0	144	1.435162
10.0000	40.0	159	1.59341
10.0000	40.0	199	1.990106
10.0000	40.0	358	3.583327
10.0000	40.0	411	4.10833
10.0000	40.0	469	4.686126
10.0000	40.0	490	4.895165
10.0000	40.0	552	5.518384
10.0000	40.0	1380	13.795842
10.0000	40.0	1656	16.561123
10.0000	40.0	1734	17.33849
10.0000	40.0	1950	19.501425
10.0000	40.0	2224	22.240967
12.0000	75.0	11	0.13672
12.0000	75.0	11	0.137249
12.0000	75.0	15	0.177537
12.0000	75.0	25	0.301206

Fig 12: Pipe quantities with rate

15.0000	110.0	188	2.814375
15.0000	110.0	209	3.13322
15.0000	110.0	243	3.649262
15.0000	110.0	298	4.468426
15.0000	110.0	337	5.052136
15.0000	110.0	403	6.045604
15.0000	110.0	437	6.552163
15.0000	110.0	449	6.730951
15.0000	110.0	465	6.974754
15.0000	110.0	500	7.494895
15.0000	110.0	501	7.510182
15.0000	110.0	510	7.642849
15.0000	110.0	515	7.721463
15.0000	110.0	530	7.942934
15.0000	110.0	712	10.679987
15.0000	110.0	713	10.691477
15.0000	110.0	928	13.925987
15.0000	110.0	1148	17.218723
15.0000	110.0	1417	21.257436
15.0000	110.0	1749	26.233231
15.0000	110.0	2790	41.846904
15.0000	110.0	2925	43.873865
15.0000	110.0	3071	46.064967
15.0000	110.0	3084	46.257594
15.0000	110.0	3112	46.677875
15.0000	110.0	3113	46.701893
15.0000	110.0	3142	47.130373
15.0000	110.0	3151	47.264967
15.0000	110.0	3337	50.060721
15.0000	110.0	3337	50.047835
15.0000	110.0	3395	50.926795
15.0000	110.0	6448	96.726442
20.0000	150.0	5030	100.598836
20.0000	150.0	5046	100.916872
20.0000	150.0	5220	104.395584
20.0000	150.0	6831	136.621496
20.0000	150.0	6929	138.572323
20.0000	150.0	7030	140.595346
		162903	2376.972113

Fig 12A: Pipe quantities with rate

In the above figure, an example where tentative rates are applied for a length of 1000 mm, so that BIM automatically calculates the total cost for pipes.

7 Dimension (Operation and maintenance)

For operation and maintenance, the model has to be imported in Archibus application. In this application role of the job has to be defined e.g. role of electrician, plumber, etc., in plumbing, operation and maintenance of the plant rooms i.e. WTPs and STPs and fire pump rooms are seen. Here with a single click on the equipment, the information relating to the O & M is obtained, that is, it gives us the schedule of the maintenance and the activities of the O & M to be carried out with the selected equipment. But there should be a regular up gradation of information (condition of the system or equipment) by the maintenance person into the application.

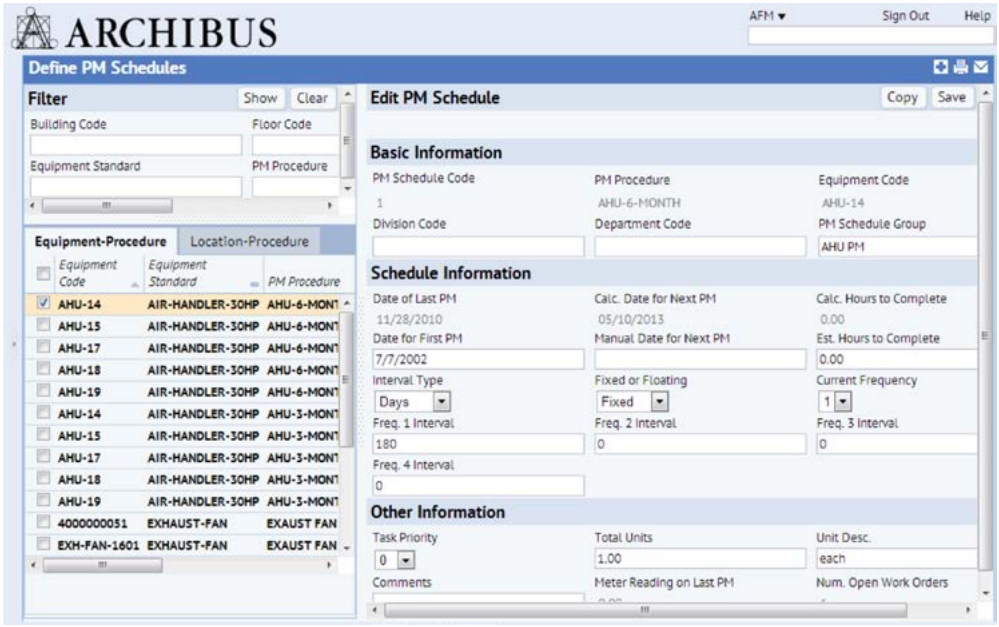

Fig 13: Preventive maintenance schedule

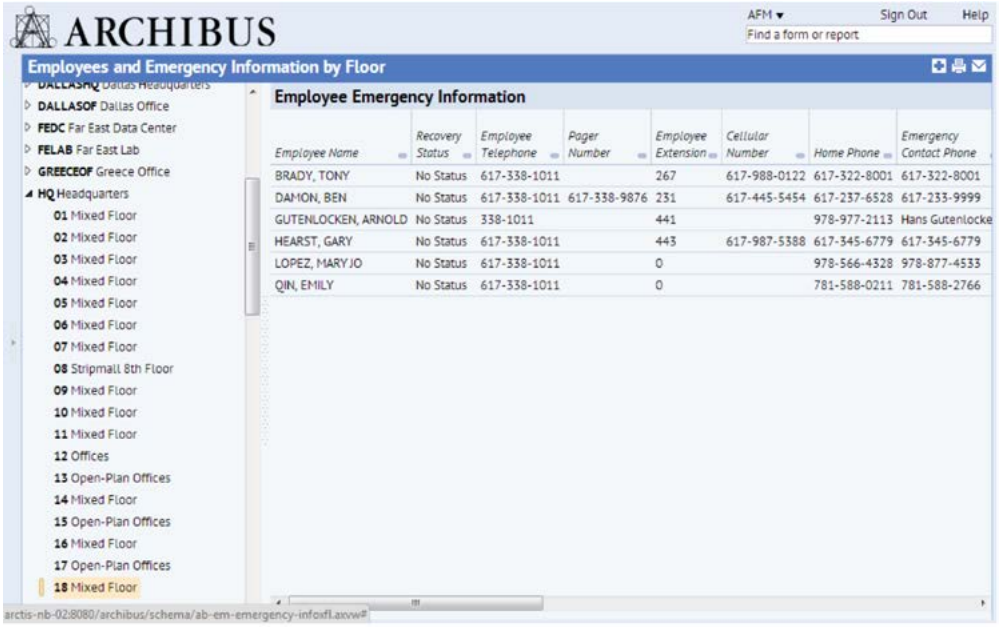

Fig 14: Maintenance employee details

Conclusion: It can be seen that Building Information Modelling software has got many advantages in designing and maintenance of Plumbing systems and undoubtedly it is the future of design.

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