Introduction:

I was always asking myself, why line of balance method is not widely used in construction projects? Then I realized that because it is mainly used in the repetitive projects such as roads, pipelines, and other projects which have less dependencies between activities. Furthermore, I saw few graphs of the scheduling using Line of Balance and the first impression was it looks complicated. Accordingly, I decided not to proceed and study further about this planning technique and I kept the bar chart method as my main scheduling technique. However, during one of my training sessions with new engineers, we discussed the line of balance method, and I asked them to explain it to me as they understand. To be honest, at this point my information about the LOB method was very generic and I never thought it could be a useful planning method.

Surprisingly, the fresh engineers explained this method to me and I found it is very simple. Then, I start thinking and researching how we can use this simple method in our complicated projects? There are some software like TILOS which deal with LOB method similarly to Oracle Primavera which deals with Critical Path Method (CPM). However, I wanted to start my investigation using my favorite planning tool Microsoft Excel. Accordingly, I would like to share with you my results in this article, the application of LOB method in construction projects using Excel tool.

What is Line of Balance (LOB) Planning Technique?

According to Enzyme Designs (2017), “Line of balance (LOB) is a management control process used in construction where the project contains blocks of repetitive work activities, such as roads, pipelines, tunnels, railways and high-rise buildings. LOB collects, measures and presents information relating to time, cost and completion, and presents it against a specific plan.”

According to my understanding, LOB is a very simple method, it converts the dates into lines, you need to maintain these lines not crossed and near to each others as you can. Let us start with this example. We have 10 similar buildings, and we want to create the schedule using line of balance method.

First, we will draw the Plain concrete works under footings, each building will take 10 days to be completed, so it is a straight forward process, see the figure below:
The X Axis represents the unit number, and the Y Axis represents the Time. So now we know each unit when the PC under footings should start and when it should finish. For example, Unit No. 7 should start in 31-May-17 and should finish 9-Jun-17. Now we want to add the reinforced concrete for footings, but it will take 15 days to complete one unit. So, here is the first role for LOB method, if the successor activity takes longer time for execution, then start from bottom. In our case the reinforced concrete for footings should start immediately after the Plain concrete finish. I.E 11-April-17, see the Line of Balance graph below after adding the reinforced Concrete for footings.

Ok, now we want to start the foundation waterproofing, and let us assume that a subcontractor will come to do it for us, but in the subcontractor contract, the unit will take only 3 days to finish and if the work is not available, the subcontractor will claim idle time. So, the question here, when
the subcontractor should start to maintain continuous work without stoppage? This is one of the main benefits of the Line of Balance Method, in this case we will start our calculation from the top. I.E we will start from when the waterproofing work should finish and make backward calculation. In our case, the waterproofing should finish after the last unit of the RC foundation finish + waterproofing duration = 7-Sep-17 + 3 days = 10-Sep-17. See the figure below to know how it will look like.

As you can see, the perfect start timing for the waterproofing sub-contractor is 12-Aug-17, this will ensure the work continuity and will finish just after the last unit foundation. This is great, but not practical, it doesn’t make any sense to wait 109 days (between first unit RC completion and first unit waterproofing start). Construction projects are rapid and we want to start the successor activities such as backfilling, columns and so on. So, we can reach an agreement with our subcontractor (if applicable) to work in patches. Let us say, 3 units, 3 units, and 4 units. In that case, we need to modify our line for the waterproofing as per the following chart.

Now we made the planning more reasonable. The waterproofing subcontractor can visit the site three times in 20-May-17, 4-July-17, and 30-Aug-17. Every time will do 3 units except third time
will do 4 units, and the graph above showing the schedule of each unit and the buffer time. Even if you are not going to use a subcontractor, and you have several projects among your company, you can schedule your teams like this. Now we can schedule the backfilling team/equipment to follow the waterproofing. The backfilling is executed in layers, each layer is 25 cm and we have 1 meter to backfill, so we need 4 days to finish 1 unit. In that case, from where we should schedule? Top or bottom? Of course, bottom because the 4 days’ duration of backfilling is more than the 3 days required for the previous activity waterproofing which is 3 days. So, we can start immediately after the first unit waterproofing completion. i.e 23-May-2017. See the figure below:

Ok, now our construction site is safer with the backfilling (no excavation is left for long time) so we want to start the slab on grade as soon as possible and keep it going smoothly without stop. In that case, we need to find the best crew size to fit this situation and estimate the optimum duration for the slab on grade activity. Accordingly, the information we have are

1-The First Slab on grade (S.O.G) can start on 27-May-17

2- The Last Slab on grade can start on 15-Sep-17

The duration between the first start and last start is 111 days, if we divide it by the number of units we get 11.1 day per unit. So, we will make the duration for unit 12 days, draw the line and see how it looks like. (see the figure below).
As you can see, we have two intersections between S.O.G and Backfilling in units 4 and 7. Unit 7 has the biggest intersection, so if we solve this one our line will be fine. So we need to start the S.O.G in unit 7 on 6-Sep-17 instead of 13-August-17 and recalculate all other units dates accordingly. (see figure below)

Now we have the Slab on Grade perfectly aligned with our overall schedule. Let us think now of reusing the PC foundation team to start the columns. This team will finish the PC footings on 9-July-2017 so I can add to them steel fixers and establish a new team for the R.C columns, what would be the optimum size of this team to finish the unit in the best duration I want? The team size who would finish the pc footings in 9 days, could finish the R.C columns in 6 days, but the slope of the S.O.G is 12 days which means that there will be intersection between these two teams. What are the options we have here?

Option 1: delay the start date of R.C columns

Option 2: increase the duration of the R.C columns

My choice: is a mixture between option 1 and option 2. Let us think together, what if I can find the R.C columns slope which will make the columns finish just on time, increase the duration of
the columns with the same percentage I decrease the PC concrete productivity to end up with the PC footings team finish the footings and start the R.C columns immediately (without impacting the RC footings team)?

Since I am using excel template which calculate the dates based on simple formulas, changing any date will not be a problem because all the relevant dates will be changed automatically. So I need the R.C columns last unit start around 28-October-17 and first start after PC completion date. So, I am going to increase the PC footings duration by 2 days which gives me start date of the R.C Columns on 30-July-2017 and Perfect Finish date. (see the figure below).

Similarly, I can re-use the same crew of the R.C footings to execute the R.C slabs. In this scenario, I will wait one month after executing the columns for the R.C footings crew to finish their work. However, starting from 16-Nov-17 the R.C columns crew will join the R.C slabs crew to finish faster, can we do this scenario?

Yes sure, from 11-Sep-17 to 16-Nov-17, the R.C slabs will take 15 days to finish 1 unit. However, after 16-Nov-17, the duration should be reduced to 10 days only for 1 unit. 16-Nov-17 was during the execution of unit no. 5, so I will start the new duration (10 days) from unit 6. See the figure below:
I wish my example with clear and useful for you. You can now fine tune your line of balance schedule by giving the start and finish line same color for each activity and add a note how your manpower will move across project different activities. Also, do not forget to make the dates clear by moving dates that overlap each other’s, then you can print this schedule in A0 size and explain to your team how easy and effective the line of balance is. Figure below is the final output of our schedule:

You can download the line of balance excel template used for this demonstration from the following link: [click here]