Evacuation of Students to Dining Hall/Dormitory and Construction of Walls to Separate Classes

Saffron Livaccari
Alan Guo

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Abstract

The Global Innovation team is a group of Stony Brook students trying to help the town of Ileret with any problems they have. This project addresses the issue of a collapsing corridor in the main school. Classrooms 3, 4, and 5 are incredibly unsafe and students need to immediately leave those rooms. After many ideas, this project proposes the creation of a barrier in the dormitory to split the building into two classrooms, and move classes 1, 2, and 3 there and move classes 4 and 5 to classrooms 1 and 2. On June 7th, this plan was implemented.

1. Introduction

1.1 Program Description

Global Innovation is a community outreach program first conceived by Richard Leakey, world-renowned paleoanthropologist and founder of the Tukana Basin Institute, to improve the lives of the inhabitants of the local town of Ileret. In collaboration with the College of Engineering and Applied Sciences at Stony Brook University, the program was launched in the summer of 2017, in which faculty and students were sent abroad to Kenya. The goal of the program is to identify problems and provide solutions, either theoretical or practical, to be implemented in order to benefit and improve the lives of the local people. The future vision for the program is to expand to other impoverished areas around the world in hopes of bettering the lives of the people there as well.

1.2 Location

The current location of the program is in the town of Ileret, Kenya, near the Ileret facility of the Turkana Basin Institute. Located in the Turkana Basin area to the east of Lake Turkana, the availability of resources is limited, including basic needs such as food and water due to the arid environment and unpredictable rainfall.

1.3 Project Description

This project is the immediate removal of students in the collapsing area of one of the main school buildings in the primary school and placing them in either the dining hall or boy's dormitory, both of which are structurally sound. During site visits to the school, it was observed that the columns behind the right side of building were bowing outwards and in critical condition. The concrete was chipping off and crumbling, and with it the

large sandstones that it was meant to hold were falling out. The walls behind the building on the right side were also showing signs of imminent failure as there were large cracks and fractures developing along the length of the wall. The wooden trusses supporting the roof were also displaying signs of rot. It was evident that the right side of the building will collapse, and that the students currently occupying the critical areas would need to be evacuated and relocated as soon as possible. The available buildings that would be able to accommodate all the students are the dining hall and dormitory, after which walls will need to be constructed to partition the classrooms.

2. Existing Conditions

2.1 Description of Facility

There are three buildings used in this project; the dormitory, the dining hall, and the collapsing corridor.

The collapsing corridor, seen in appendix 1, pictures 1-7, is noticeably structurally unsound. It contains 5 classes, 1-5. It was made from concrete with large aggregates of sandstone. The cement separating these aggregates is cracking; there are very large cracks in the concrete going from the bottom of the wall to the top. This is most likely due to the concrete mix itself. The water used during the mixing and curing process may have been sourced locally, which contains high concentrations of chloride and fluoride, both of which have a negative affect on the adhesive properties of the concrete. As a result, its strength was significantly weakened and thus the walls and columns are crumbling under the weight of the roof and their own weight. Some sandstone aggregates have fallen out of the wall as well. The concentration of the largest cracks is outside classroom 5, shown in picture 1, although cracks do appear along all the classrooms in the building.

Classroom 5 is the most structurally unstable classroom. The column has a large portion of concrete missing (picture 2). The side of the classroom has rocks missing from the concrete (picture 4). The columns for classroom 4 and 5 are bowing outwards. The column for classroom 4 is shown in picture 3, and for classroom 5 picture 6. The columns for classroom 4 and 5 are cracking off the wall (picture 7). The columns do not support the ceiling weight at all. For classrooms 1, 2, and 3, the columns are still

attached to the wall and are not bowing outwards. The largest cracks for classrooms 1 and 2 are at the bottom of the wall, as seen with picture 5.

The dining hall is located to the left of the collapsing corridor. Its width is 22 ft 9 inches, and its length is 39 feet 8.5 inches. There is a 7.5 inch step going to a stage, occupying 9'3.5" of the total room. The kitchen is behind the hall, and there is a block of concrete out of a window connecting the eating area with the kitchen. There are 9 trusses, and the height from the floor to a truss is 9'4.5".

The dormitory is located right and behind the collapsing corridor. It has a length of 54'10" and width of 17'9", and has 9 trusses, not including the ones in the shower room. The height of the truss is 9'2.5" on one side, 9'1" on the other.

Both the dormitory and the dining hall are made from the same concrete, and the aggregate is finer than of the corridor. They are shown starting with picture 8.

2.2 **Assessment of Existing Facilities/Services**

The corridor may collapse at any moment. It is imperative to move the students immediately out of classroom 4 and 5.

The dormitory has not been used or cleaned for a while. Mud wasp nests run along the wall, and there are many birds' nests on the trusses. There are wild cats that live in the building; the building has a distinctive urine scent. There are many metal bed frames, about 24. The back end of the dormitory, there is a shower room and another personal bedroom. The shower room has four showers and a faucet. There is a door located in the back of the shower room. There are three doors to the dormitory, one in the back of the shower room, one in the far end of the dorm and one in the front end of the dorm; both facing the same side towards the school.

The dining hall is made from the same material as the dormitory and is structurally sound. The floor is a bit dusty, but it is not ridden with animals. These two building will be used temporarily for new classrooms.

2.3 **Other Considerations**

The dining room has 6 tables, each of the dimensions are 6'7" length, 3'10" width, and 2'5.75" height. The wood from these dining tables can be used in the making of a wall.

Classrooms 3, 4, and 5 need to be moved, but classrooms 1 and 2 are more structurally sound. The columns for those classrooms are not bowing and are still attached to the wall. If necessary, classroom 3 may still be used as a classroom, although it is safer to move them.

For using the dining hall as a classroom, the students may receive food anytime during the waiting period for a new corridor, which would render the temporary classrooms in the dining hall unusable. Fortunately, the students did receive a shipment of food on June 6th. The dining hall will not be used as a classroom, nor will the dining tables be used for the wall.

3. **Basis of Design**

3.1. **Proposed Service**

It is crucial to evacuate everyone out of the critical area as soon as possible as every second that they continue to stay within the collapsing classrooms results in a greater potential of the building collapsing with children inside. The teachers and students will be relocated to either the dining hall or the boys' dormitory, and walls will be constructed to separate the classrooms. As this is meant to be a temporary solution, the Kenyan government will be petitioned to provide for a new school building.

3.2 **Technical Background**

The walls are not meant to be load bearing, and as such, they will only need to be able to support their own weight and potential external forces acting on it (children hitting/bumping into it, etc.). The frame/studs will be designed to be able to do both. Between where each piece of wood meets another, there will be an angle section stud, which will be comprised of two angles welded together to provide support and stability. Welded between each stud will be rectangular sections that will act as horizontal supports along the middle and top of the wall. The studs will have metal plates welded to each end, which will then be secured to the trusses and to the ground with concrete screws or bolts and either epoxy or adhesive cement. Two bolts will be used for the trusses and four for the ground.

3.3 **Design Constraints**

There is limited material available, though TBI may be able to provide the materials necessary for framing. There are only six tables in the dining hall, which make up the majority of the materials readily available, and construction of a wall reaching the full height of the walls of the building is not feasible, and neither is constructing a ceiling. As a result, sound from the other classes will inevitably reach each other. The framing for the wall is also dependent on whether or not TBI is willing and able to provide the materials necessary. If the dormitory is to be used, it will need to be thoroughly cleaned and refurbished, as presently there are wild cats, birds and wasps living in the building.

As of June 6, 2017, it seems that the school will be receiving regular shipments of food again, and so the dining hall can no longer be used nor the tables. However, TBI has 4'X8' plywood boards that can be used in place of the dining tables instead, of which they can spare five. That is enough for two 10 feet walls, which will leave a 7 foot gap between the wall and the wall of the building. The walls will be 8 feet high, which would not be enough to reach the trusses, which are 9 feet high. Sound will inevitably travel up and over as well as around the walls.

TBI is sympathetic to the cause, and is willing and able to provide the materials and means necessary to construct one full wall within the dormitory. The wall will remain 8 feet high, but will be completely closed, reaching from one side of the dormitory to the other. Sound will still travel up and over the walls as well regardless of the fact that it will only be 8 feet high as the building had an open ceiling, though the wall should dampen most of the sound. The school does not have blackboard paint, and so the walls will need to be painted green with normal paint, which may not retain powder from the chalks as well.

3.4 **Environmental Considerations**

The proposed plan is contingent upon the approval of the school and the faculty. The dining hall and dormitory are also being effectively vandalized if a wall is constructed within them. The children may not adapt well to the change in environment either, which may hinder their learning capabilities, especially if they are distracted by sounds from other classes. The younger children (grades 1 and 2), may have an easier time adapting to the change environment as they haven't been attending the school for nearly as long as the children in grades 4 and 5. The construction sounds will also be

extremely loud, which will distract the students and potentially hinder their learning ability for the duration of the project.

Given that the two walls in the dormitory will have a seven foot gap that the children can see into other classes through, it will be extremely distracting, especially if and when they start talking or gesturing to each other during class. The teachers will be affected as well, and will have to learn how to adapt to such a drastic change in the classroom dynamic compared to what they are used to considering the large amount of open space that will be present between the classrooms.

Combining two classes is a significant change to the school structure. The students will require time to adapt to the change in environment, which may be something that they may never be able to fully do. The students will need to deal with the effective doubling of their class size as there will be an influx of potential strangers, which may change the social dynamics of the class, for better or for worse. The teachers will also need to learn how to work together to effectively run the class, and during this learning phase their teaching ability may not be the best that it can be, which may reflect in the performance of the students. This change will persist for each incoming class as the students move up in grade until a new school building can be built and each class will have its own classroom again.

3.5 **Social Impact**

Should the walls in the dining hall or dormitory be constructed, it will change the structure of the school, however temporary or permanent. The children that were in the critical area of the original school building will be safe and free from harm, which will ensure that the community will retain the trust they have in the school, something that would have been lost if the school building should collapse, regardless of if anyone was inside. This will also ensure that the parent will continue to send their children to school knowing that no harm will come to them, which will allow the children to continue receiving education, which may be life changing for them.

4. **Project Goals**

4.1 **Expected Performance**

The expectation is to move kids from classrooms 3, 4, and 5. The first step is to move classes 4 and 5 to classrooms 1 and 2, and move the classes 1, 2, and 3, to a new room which is manually constructed.

The sound will travel throughout the classrooms, based on the fact that there is not enough material to make a full wall. The position of the teachers will be determined based on the least amount of sound transfer.

It is expected that the school will have food again, making the dining hall a difficult place to put students. On June 6, this came true. The dining hall became infeasible, and the boy's dormitory became the only place to make classrooms.

4.2 Future of Proposed Work

There are not enough materials at TBI to be able to fully rebuild or repair the building that is collapsing. In the meantime, while waiting for the government to respond, the children will be kept in the dormitory. The metal frame in the dormitory will be permanent, and as such if the school gets new mattresses and a new corridor, the dormitory will have to be two rooms.

4.3 Evaluation Criteria

The effectiveness of our plan will be determined by SIX factors; How long the wall stays standing, how effective the sound barrier is, if the school keeps the classrooms there rather than moving them back to the collapsing corridor, the aesthetics of our classrooms, the change in the student's performance in school, and if the government responds to the letters.

How long the wall stays standing: The durability of our wall is important. The kids may hit it or bump into it, and the wall needs to remain sturdy and strong to support any environmental impacts for a while. The government may not build a new school building for a year or longer, so our wall needs to be durable.

How effective the sound barrier is: Idealistically, no sound would travel between classrooms. However, taking into account our resources, the least amount of sound transfer needs to be considered during planning.

If the school keeps the classrooms there rather than moving them back to the collapsing corridor: The effectiveness of the classrooms must be determined by the willingness of the school to use temporarily use them as classrooms.

The aesthetics: The classroom should be nice looking, with painted walls and a chalkboard. The classroom should be inviting for the school children.

The change in the student's performance: If the room doesn't have a chalkboard, then teaching the students will become difficult. If the students are distracted by noise or by the change in environment, their academic performance may drop. This is an academic institution, and the performance of the students is very important.

If the government responds to the letters: The letters the TBI group will write to the government about replacing the corridor must be effective, considering the dormitory classrooms are only temporary.

5. Assessment of Alternatives

5.1. Description of Alternatives

Alternative 1: Move all three classes to the dining hall only and building two walls to separate the classes.

Alternative 2: Move two classes to the dining hall and one class to the boys' dormitory. Build one wall in the dining hall.

Alternative 3: Move two classes to the boys' dormitory and one class to the dining hall. Build one wall in the dormitory.

Alternative 4: Move two classes out of the critical area to the dormitory and build one wall. (The middle classroom is not in extreme critical condition)

Alternative 5: Move all three classes to the dormitory and build one wall. (Two classes will be combined)

Alternative 6: Repair the collapsing school building.

Alternative 7: Construct an entirely new school building.

5.2. Maintenance and Operations Comparisons of Alternatives

Alternative 1: Will require the most materials as well as involve the most construction/damage to the building. Given that all of these alternatives are only temporary solutions if the government is able to provide a new school building, this alternative will require the most work for the same end result. The walls will not be able to reach the trusses either, which allows for more sound to propagate, especially when there will be three classes sharing the same space. There is only one entry point in the

dining hall, which means that the walls will not stretch from end to end so that there is room for the children to move around and go to their respective classrooms.

Alternative 2: Will only require one wall to be built in the dining hall. However, it will still not be able to reach the truss, but the sound will be less of a problem as there are only two classes instead of three. The dormitory will need to be cleaned and renovated to ensure that it is safe for the children, and the bed frames will need to be removed.

Alternative 3: Will require one wall to be built as well as less material since the dormitory is narrower and shorter compared to the dining hall. The wall will be able to reach the trusses as well, which will help to dampen the sound. There are two entry points in the dormitory, one on either end, which means that the wall will be able stretch across the entire length of the building.

Alternative 4: Will require the least amount of work and is the one of the only realistic options available given that that the dining hall has recently been reopened and that the dormitory is not large enough to partition into three classrooms.

Alternative 5: Will require the same amount of work as Alternative 4, and will ensure the safety of all the students currently located in the critical area. This is the other realistic option available aside from Alternative 4.

Alternative 6: May be an ideal choice if it isn't completely unfeasible due to the fact that the walls are crumbling and the columns along the right side of the building are crumbling and barely attached to the wall. The expertise and materials required to undertake such a project is not readily available, and the building may be well beyond repair.

Alternative 7: Would be an ideal choice as well but isn't feasible either; neither the resources nor the means necessary are available, and is something that a large organization such as the government will need to fund and oversee. The new building will also need to be well designed so that the current situation doesn't occur for a second time

5.3. **Social Implications**

All of these alternatives will ensure that the students remain safe and that the community retains its trust in the school.

Alternatives 1-5: The students and teachers will remain safe, though they may have to adapt to the change in setting.

Alternative 6: The students and teachers will be able to remain in the school building that they have grown used to, minimizing the effect on their learning/teaching capabilities.

Alternative 7: Will put the school in the center stage of the town. The community may realize the importance of the school if they see that such a costly and large scale project is underway, and may even provide more of an incentive for parents to send their kids to school.

6. Recommended Plan

6.1. Rank of Alternatives

See Appendix 2.

Safety of Students: All of the alternatives aside from Alternative 4 will ensure that all three classrooms in the critical area of the school building will be moved out to a safe location. (1=safest, 10=least safe)

Materials Required: Alternative 7 and 6 will require the most material given that an entirely new building will need to be built or major repair work will need to be done. Alternative 1 would require more materials than the remaining four due to the fact that the dining hall is the largest building and two walls will need to be constructed. Alternative 2 would only require one wall, which would require less material than the two walls in the dormitory for Alternative 3. Alternatives 4 and 5 require wall to be built in the boys' dormitory, which is much smaller in width, and so the walls do not need to be as big as the ones in the dining hall.

Space Needed: Alternatives 7 and 6 will require the most space as a new building is to be constructed/the old building repaired. Alternatives 2 and 3 will require more space than the remaining three as both the dining hall and dormitory will be utilized, with Alternative 2 requiring the most since a wall need to be built in the dining hall rather than in the dormitory. Alternative 1 will also require more space compared to Alternatives 4 and 5 as the dining hall is larger than the dormitory.

Construction Required/Noise Level: Alternatives 7 and 6 will require the most construction and therefore cause the most noise. Alternative 1 will require more construction compared to the remaining four since two large walls are to be built. This category follows the same logic as "Materials Required" given that the more material needed the more construction is required.

Sound Pollution (Classroom Noise): Alternative 1-5 will have open ceilings, which will facilitate sound travel. Alternative 5 will have the most sound as there are effectively three classrooms in a smaller building compared to three classrooms in the dining hall in Alternative 1. Alternatives 3 and 4 will have more noise since they are in the dormitory, which is a smaller space and so sound have less opportunities to dissipate before reaching the other classroom compared to two classrooms in the dining hall in Alternative 2. Alternative 6 and 7 will have the least amount of sound reaching other classrooms as the ceilings are closed in the school building and will be closed should a new school building be constructed.

Degree of Change to Classroom Setting/Dynamics: Alternative 5 will see the greatest change due to the fact there will be two classes sharing one classroom. Alternative 1 is also a big change since the dining hall is farther away from the main school area where the original classrooms are, and also it used to be (and now is again) a place where the kids would eat. The alternatives involving the use of the dormitory (2, 3 and 4) would be the less drastic depending upon the number of classes in the dining hall, if any, considering that it is closer the main school area and also the classrooms will be similar in size. Alternatives 6 and 7 will affect the classroom dynamic the least given that the students will remain in the same building with the same class set up or in a very similar building if a new one is constructed.

Possibility/Practicality: Alternative 6 and 7 are unreasonable given the time and resources required. All of the alternatives that had children in the dining hall are no longer feasible since the school has begun to receive food again, which means that it will be functional again. As a result, the dormitory is the only space available left to move the students to (Alternatives 4 and 5). (1=most practical, 5=least practical)

See appendix 2.

6.2 **Recommendation**

Alternative 5 would be the best choice based on the decision matrix as well a the fact that it was the only other possible choice aside from Alternative 4, which is risky and puts the children's' lives at stake. The older children in classes 4 and 5 will be moved to the classrooms where classes two are given that they have gone to the school for much longer than the younger students and would have a hard time adjusting to such a sudden change in environment. Classes 1, 2, and 3 will be moved to the dormitory, and the school will decide which two should be combined. One wall will be built to separate the two classrooms using 4'X8' wood boards and angle beams once the building has been thoroughly cleaned and the bed frames have been removed. TBI will bring a generator and tools so that the frame for the wall can be cut and wielded onsite.

6.3 **Detail Design**

The wall will cover the width of the building, which is 17 feet 3 inches. The frame will consist of two 1.5 inch angle beams on each wall and will be secured using concrete screws. There will be two studs, which are two angle beams wielded together. One will be placed 8 feet from the front wall and the second 8 feet from the first. Both will have metal plates wielded at the ends, which will be secured to the ground using concrete nails and to the truss using nuts and bolts. Four angle beams will be cut and placed diagonally in a triangular orientation to provide support for the studs. These will be wielded to the studs to secure them. Four half inch thick wood boards (4'X8') will be placed long side down and secured to the frame with screws. A fifth wood board will be cut to size (1 foot 3 inches by 8 feet) and secured to the frame to close the wall. (See Appendix 2B, 2C and 2D)

As built: The will be one angle beam along the bottom of the wall that will be secured to the ground using concrete nails and welded to studs on the sides of the building. The will be four support studs in the middle of the frame comprised of two angle beams welded together. All studs will be welded to the truss above and the angle beam below, and the side studs will also be secured to the wall using concrete nails, which will then be welded to the angle beam itself. The five wood boards (four 4'X8' and one 1'3"X8') will be arranged short side down and secured to the frame using screws. The walls of the building will be painted caramel and green paint will be used for the chalkboard. (See Appendix 2E, 2F and 2G)

7. Project Implementation

7.1 Description of implementation

The implementation of the project began June 7th, when the TBI group went to the school to clean the dormitory. First, the metal bed frames were moved from the boy's dormitory to the girls. Then, the dirt was swept out of the dorm. Lastly, the floor was moped. Only some bird's nests were taken down from the trusses; however, not all is needed to be taken down. The next day, the students began to paint the room's walls with brown paint. The plan was to finish the paint and the metal frame that day, however, the first two coats were painted around most of the building, and the metal frame is almost complete. It will take one more visit to completely finish building and painting.

Appendix 1: Pictures

Picture 1

Picture 2

Picture 3

Picture 4

Picture 5

Picture 6

Picture 7

Picture 8

Picture 9

Picture 10

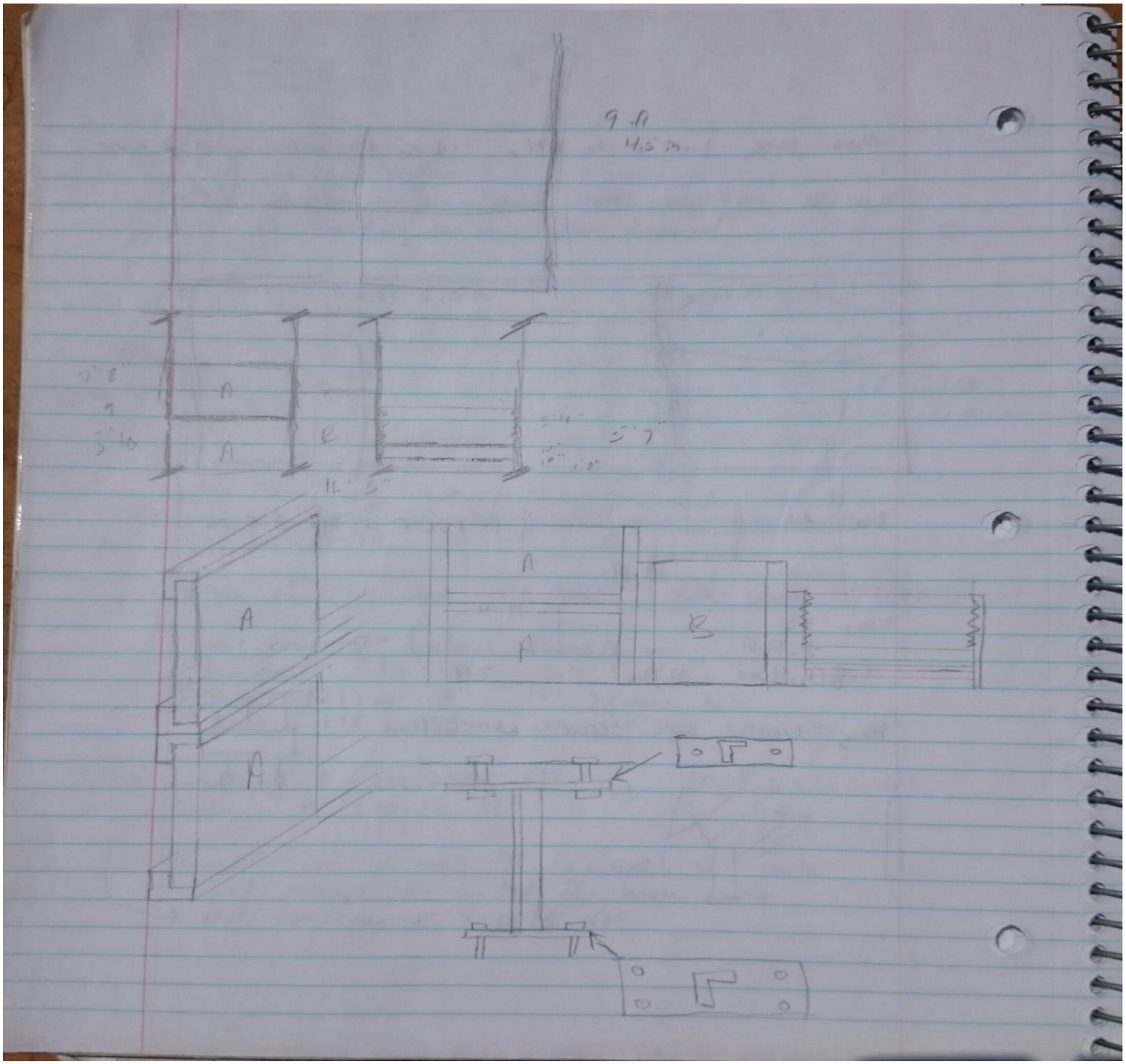
Appendix 2: Tables

Alternatives	Safety of Students	Materials Required	Space Needed	Construction Required/Noise Level	Sound Pollution (Classroom Noise)	Degree of Change to Classroom Setting/Dynamics	Possibility/ Practicality
1	1	5	3	5	6	6	5
2	1	3	5	3	3	5	5
3	1	4	4	4	4	4	5
4	10	2	2	2	5	3	1
5	1	1	1	1	7	7	1
6	1	6	6	6	2	1	5
7	1	7	7	7	1	2	5

Alternative	1	2	3	4	5	6	7
Total	31	25	26	25	19	27	30

Appendix 3: Design Details

A



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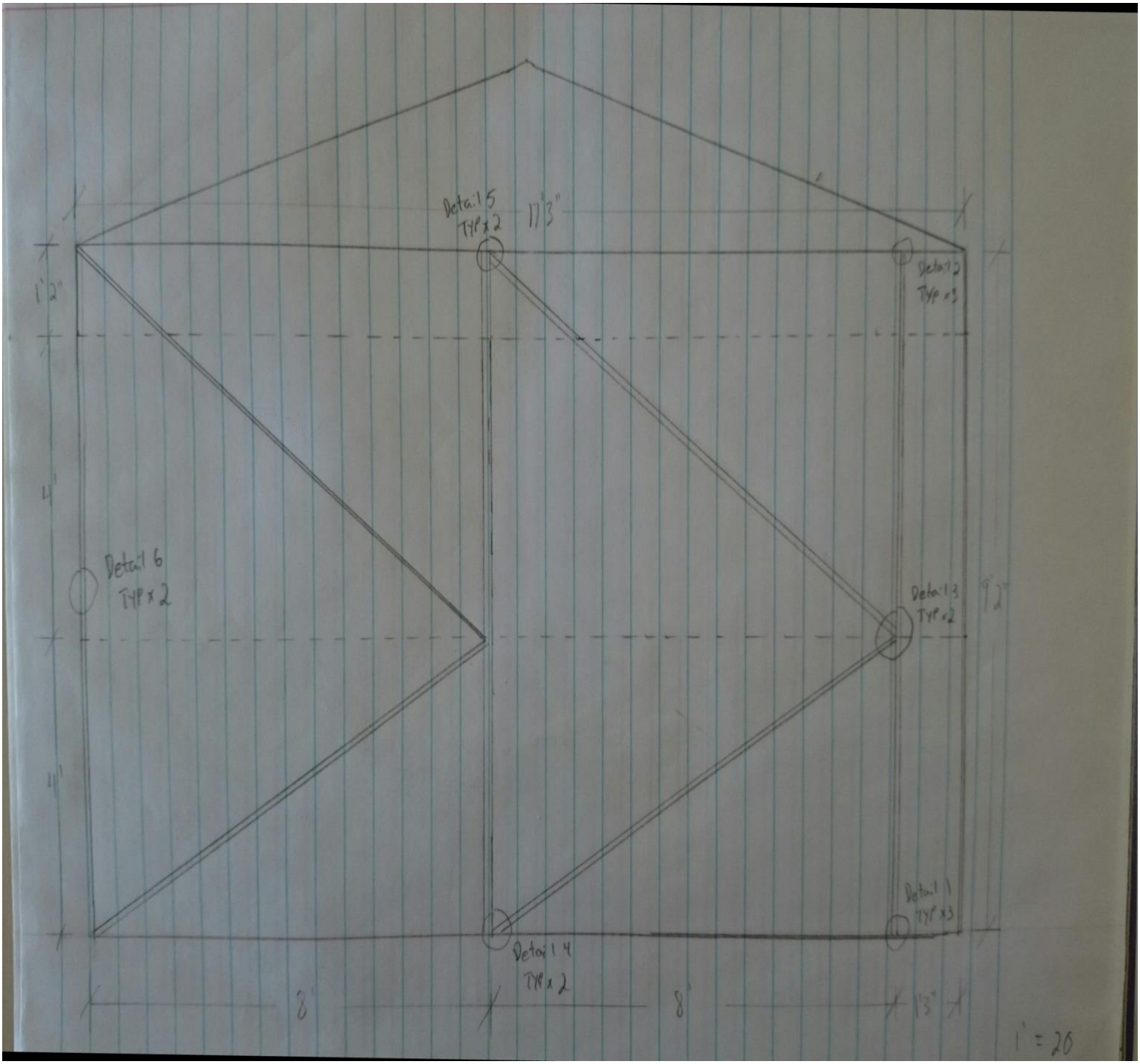
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Detail 2
TYP x 3
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Detail 6
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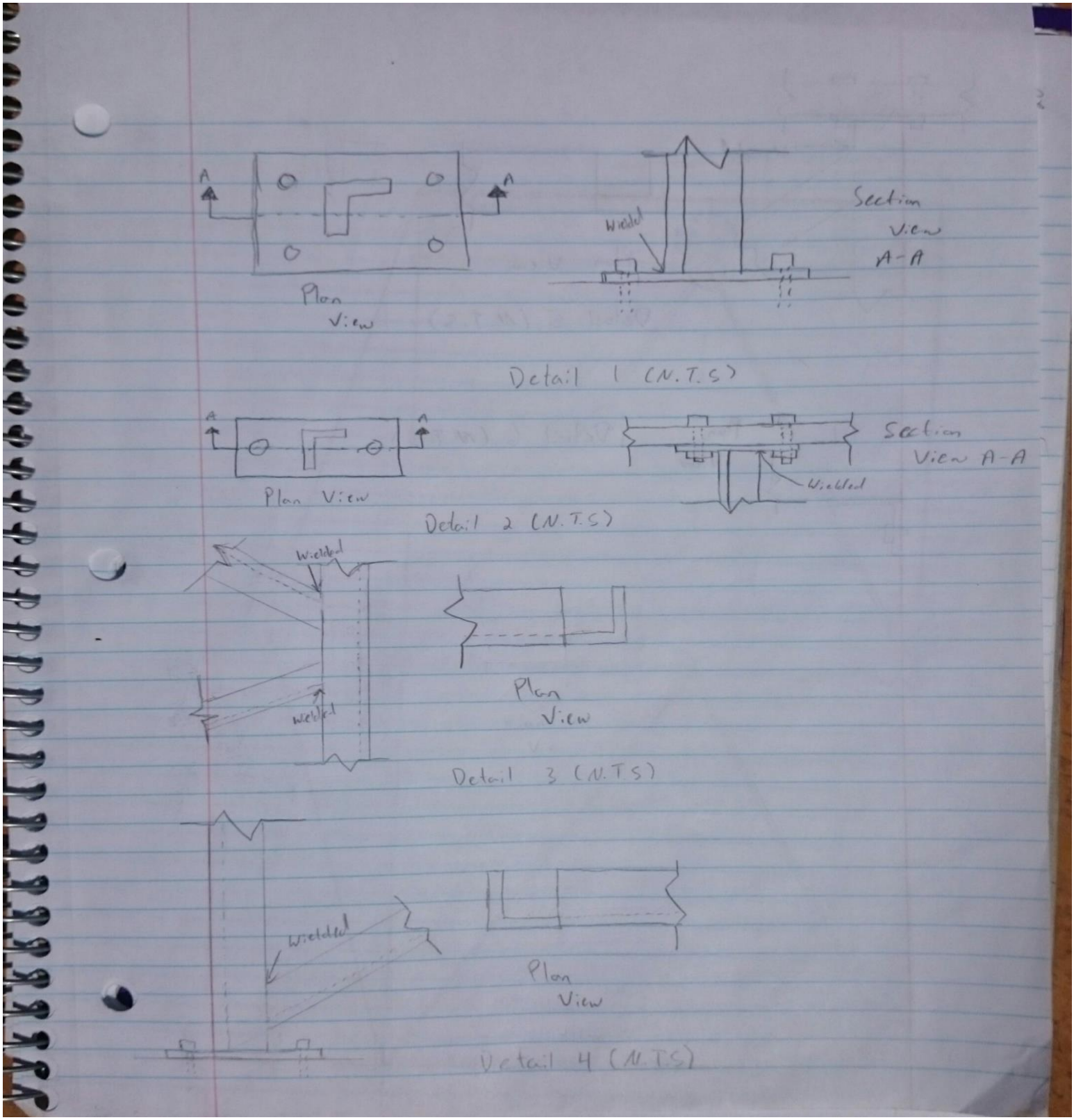
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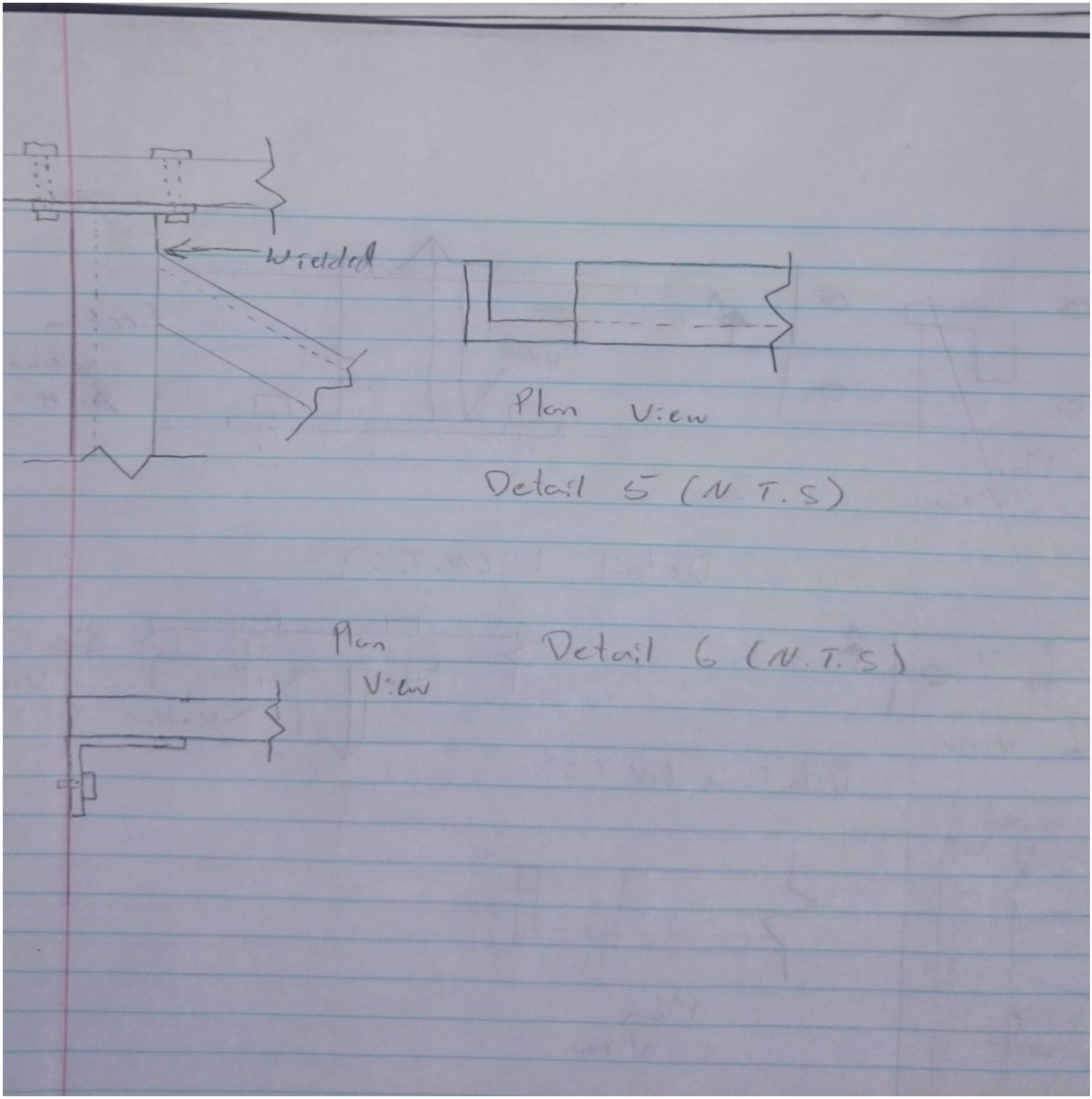

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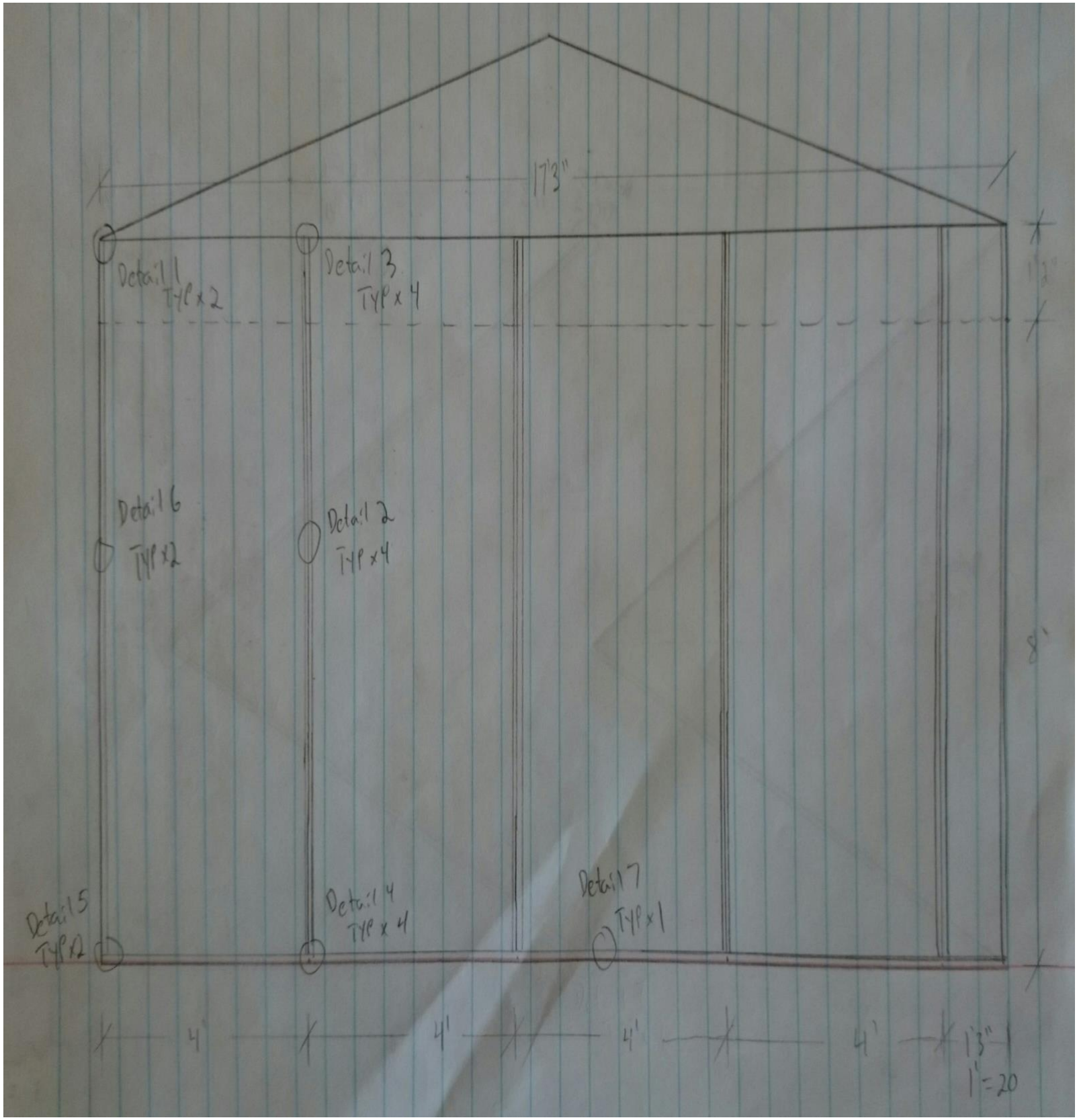
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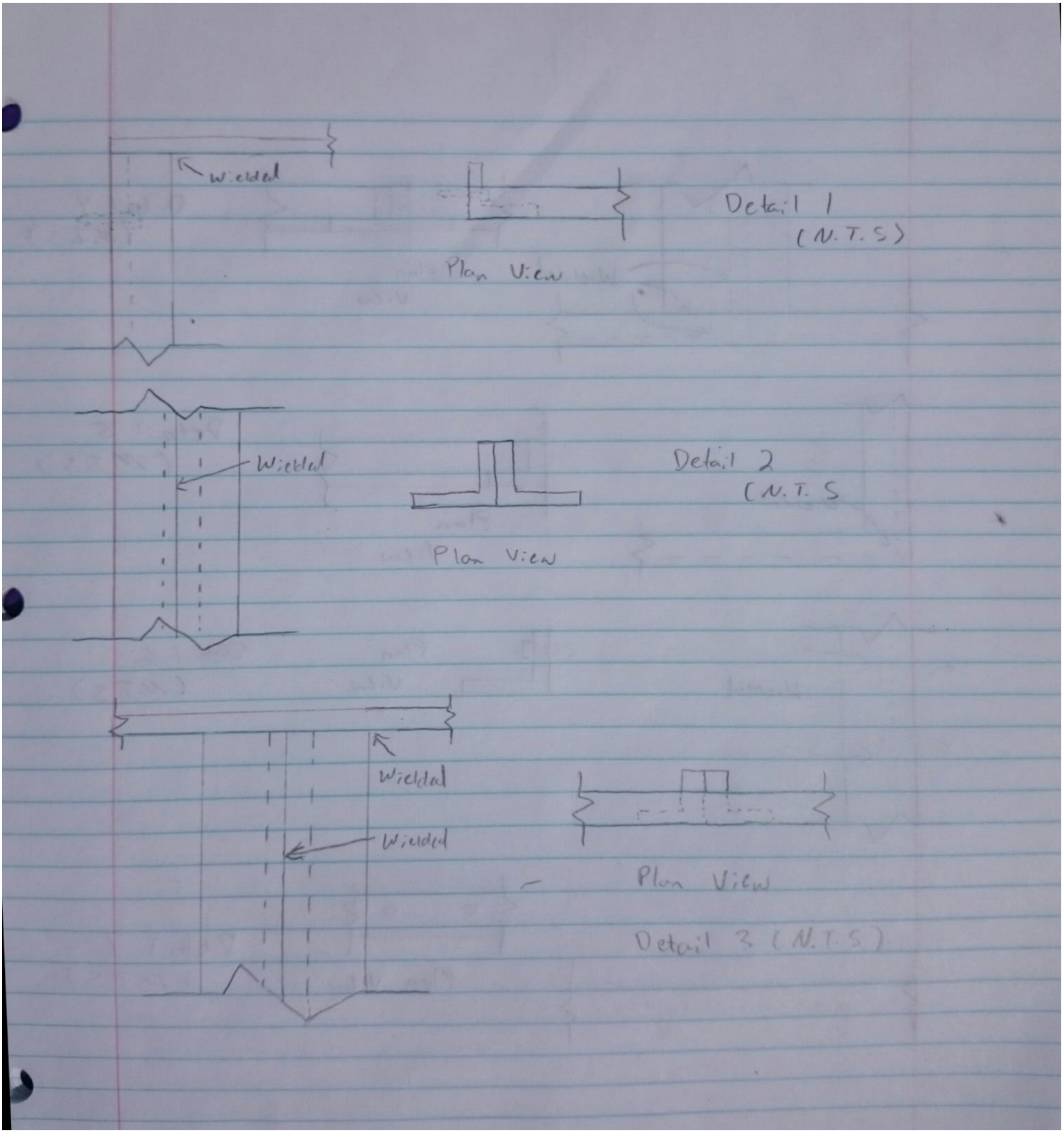
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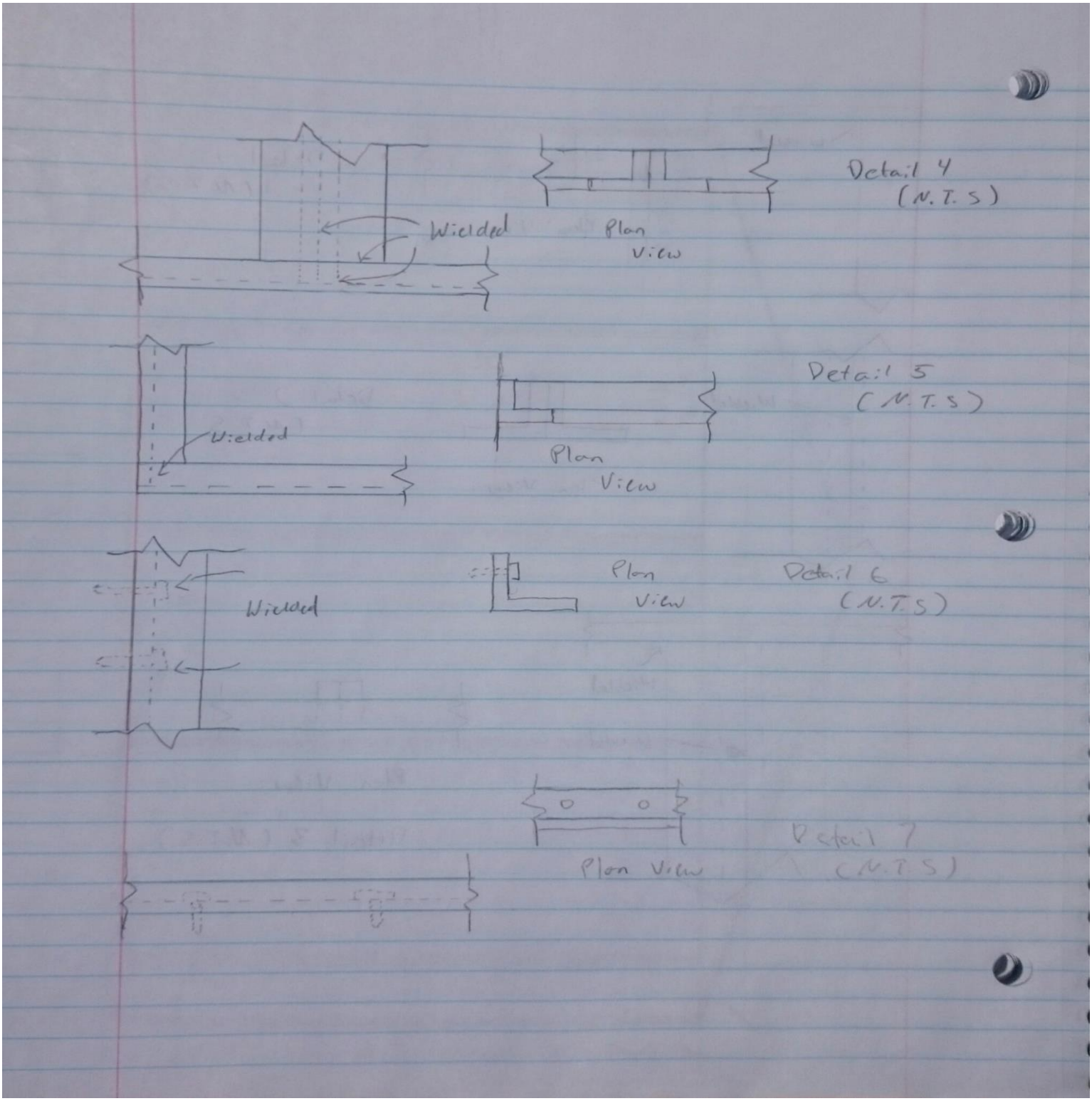
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