BLUE STEEL, INCORPORATED

323 Mann Hall
North Carolina State University
Raleigh, NC 27606

February 12, 2008

Dear Tom,

Greetings from Blue Steel, a new design firm stationed in the Raleigh area. We focus on excellence in engineering design, careful consideration of the surrounding context, and commitment to our clients. Attached is our proposal for the engineering design and analysis of the West Parking Decks.

Although our firm has just recently been established, the members of our project team have come together with experience from a variety of backgrounds. Two of our team members are focusing on the transportation aspects of the parking decks, and four of our team members are focusing on the decks' structural aspects. As such, this proposal is divided into aspects of the project pertinent to the transportation group, the structures group, and the entire team. It includes the following considerations:

- OBJECTIVE (purpose statement, environmental considerations, assumptions)
- SCOPE (specific services, project deliverables)
- TECHNICAL APPROACH (background documents, standards, design resources, technology)
- MANAGEMENT PLAN (task responsibilities, weekly schedule)
- FINANCIAL PLAN (hours estimates)
- PRELIMINARY STRUCTURAL SYSTEMS and FRAMING STUDY

We are prepared to find an excellent final design for the parking decks by analyzing a variety of alternatives. As you narrow your search for the right company to design the West Deck, we trust you will find Blue Steel to be the best company for this job. Thank you for your consideration.

Sincerely,

Blue Steel, Inc. et. al.
323 Mann Hall
North Carolina State University
Raleigh, NC 27606

OBJECTIVE

The objective of our project is to build a parking deck in the existing West Lot location that provides safe and effective parking for commuting students, while preserving and enhancing where possible the surrounding natural and human environments. To this end, the structure may encompass additional uses such as retail and storage space and may provide parking for additional users.

Our design for the West Campus Deck largely stems from the University's Master Plan document, entitled, "A Campus of Neighborhoods and Paths." The "Campus Vision" section of the document describes the university's perspective toward projects such as ours:

> "The university judges all project proposals by their contributions to their neighborhood, the network of paths, the campus as a whole, nearby city neighborhoods, and the natural environment. The built environment shall be of the highest quality, responding to the campus and ecological contexts, and contributing to the traditions and missions of NC State University. Each project, however large or small, is a source of pride for the community and measurably moves toward making NC State a better place, achieving the Campus Vision." (*Master Plan*, page 17)

Our design recommendations will tailor to the needs of North Carolina State University and its students while providing the most cost effective solution. We want our design to be as efficient as possible for the University and the users of the deck. The structural design will be suited for the most convenient layout for drivers inside the deck while maintaining a low cost.

Natural Environment

Given the university's recent push toward a more sustainable campus, we are open to investigating a variety of deck characteristics that encourage the model being implemented by the university. The following list presents such possible characteristics:

- LEED certification;
- Water drainage system collecting rainwater from the decks for conservation and reuse in the surrounding natural environment;
- Preservation of the mature-growth trees that currently lie in the middle of the existing West Lot between the two proposed parking decks;
- Multi-modal integration with the campus environment supporting access for walking, bicycling, and bus-riding;
- Encouragement of bicycle use with secure bike parking facilities (so that students feel comfortable parking their bikes at the deck overnight);
- Encouragement of sustainable vehicle use with easily accessible (lower-level) spaces for carpool, compact, and hybrid vehicles and discouragement of unsustainable vehicle use with less accessible (top level) spaces for large vehicles such as SUVs; and
- Sustainable construction materials that minimize negative impacts to the surrounding natural environment.

Human Environment

The University's All-Campus Path is a major component of the human environment surrounding the West Deck. The Master Plan explains the path as follows:

> "The campus' most lively pedestrian movement zone, reserved for people-powered movement, that connects parts of campus and major exterior Hearths with a wide path and pedestrian amenities that create special places. It is to be the scenic route by which a pedestrian experiences key campus locales. It currently consists of various walkways around campus but over time will be enhanced to become a continuous path, a major design characteristic, and an outdoor amenity for the university." (*Master Plan, page 17)*

The West Deck is located between nearby university neighborhoods West Campus and Wolf Village. The path, which passes by the north side of the West Deck site, joins these neighborhoods and the rest of the campus. According to the Master Plan,

> "These neighborhoods are diverse in character, organized around attractive, lively open spaces, and developed in ways that invite human interaction and communication. They are woven into a coherent whole by a system of footpaths, streets, and transit—a pedestrian-oriented network featuring an All Campus Path that will become a distinguishing characteristic of the university." (*Master Plan*, page 17).

We realize that our project proposal will be judged by its contributions to the surrounding neighborhoods, network of paths, campus as a whole, and nearby city neighborhoods, according to the Master Plan. We will design it to contribute to the traditions and missions of NC State University, and we hope for it to be a source of price for the community.

Assumptions

In keeping with the surrounding natural and human environments, we will design the parking deck and surrounding areas in accordance with the following list of assumptions:

- In order to keep general deck traffic from further congesting traffic within the campus environment, we will place entrances and exits on the north side of the deck with access that encourages access from the surrounding city roads and discourages access from roads in the heart of campus.

- In order to keep the campus path visually appealing, we will keep the north (campus) side of the parking deck as open as possible by avoiding close distances between buildings that would cause narrow passageways along the campus path. We will limit visually distracting roads on the north side of the deck, and we will also consider means of improving the most visible (north and west) sides of the deck from an aesthetic point of view to avoid the appearance of a typical parking structure.

- In order to encourage vibrant life in the vicinity of the parking deck and to serve deck users and nearby neighborhood residents, we will look for opportunities to include retail such as a C-store, a coffee shop, an ice cream shop, a snack bar, and a bike locker facility in the design of the parking structure.

- In order to provide parking for between 1200-1500 commuting student vehicles, we will consider options of including surrounding land outside of the designated area for parking deck use while accommodating that land use in the structure. For example, staff parking spaces that may be taken away by southward site expansion will be replaced in the deck.

- In order to regulate deck use, there is no need for a system of fee collection given that all parking deck users will have permits. Depending on the university's plans for enforcement of parking regulations, gates may or may not be used in conjunction with patrolling officers.

- In order to keep the air in the parking decks free of high concentrations of exhaust chemicals, open-air ventilation will be used.

SCOPE

In order to accomplish the objectives of the project, our team will be comprised of two transportation engineers and four structural engineers to address technical aspects of the deck design in their respective areas of expertise. In addition to their specific duties, we will work together in more general studies to ensure that the finished design is cohesive in nature and appropriate for its context in the university environment. Therefore, members of the team will be performing duties outside of their particular fields of expertise, such as public involvement exercises, to ensure a successful project. Transportation engineering, structural engineering, and general project services within the scope of this design project are detailed below:

Transportation Engineering Services

Transportation engineering services will include study of the following aspects of the parking deck design:

- Multimodal integration with campus transportation system, including two alternatives for bus lane placement, the consideration of pedestrian access points, and facilities for bicycles.
- Entrance and exit locations for general parking deck traffic, including two alternatives for traffic flow into, out of, and between the two decks; and
- Analysis of the surrounding traffic system and recommendations for improvement. Intended alternatives for analysis include an additional access point on Western Boulevard between Weaver Labs and Grinnells Lab and a roundabout at the corner of Varsity Drive and the existing Butler Communications Building lot, where we plan to make the parking decks' primary access point.

Structural Engineering Services

Structural engineering services will include study of the following aspects of the parking deck design:

- Deck layout stemming from entrances, exits, and between-deck access locations determined by the transportation team;
- Construction materials recommendation between steel, pre-cast concrete, and cast-in-place concrete options;
- Inclusion of a completely covered transit stop as requested by University Transportation;
- Framing system design taking into consideration ramp design options depending upon one-way and two-way traffic systems; and
- Other structural issues such as ground elevation changes, environmental impacts of eliminating forestry, and overall height of the structures.

General Considerations

Outside of the technical aspects of the design, considerations of the human environment demands an investigation of the human environment in the vicinity of the deck. In order to better understand the opinions of potential users of the deck, we have sent one group member to attend a university-sponsored public involvement meeting, and we plan to conduct a simple survey to engage commuting students in

conversations about the relative importance of many aspects of the parking deck design. Students will be asked to rank the following five categories:

- Appearance;
- Sustainability;
- Access to Campus Transportation (walking, bicycling, bus riding);
- Vehicle Access to Surrounding Road Networks; and
- Cost of Parking.

In an effort to help the university best serve its intended users, we will also ask specific questions that help us to gain a better understanding of deck user profiles. The survey will take place at the existing West Lot location. We will also be meeting with the stakeholders about mid-way through the project to discuss any discrepancies or issues in the form of a charette. Valuable information gained from this charette will be compiled with our survey and public meeting research to analyze community impacts.

Project Deliverables

Included in our scope of services are informal progress reports, an interim stakeholder charette, and a final presentation of our findings in spoken and written formats. These milestones will include the following specific deliverables:

- a multimodal transportation plan
- peer evaluations and time sheets
- traffic analysis reports
- traffic figures
- traffic simulations and results
- structural design figures
- estimated construction costs and maintenance costs
- structural framing plans
- details of structural members

TECHNICAL APPROACH

Our technical approach includes research in many sources in order to determine existing and future conditions. It also includes the use of current standards and technology for accurate design and analysis. This section highlights the documents, standards, and technology that will provide a strong backbone for our design.

NC State Master Plan

NC State University has already provided us with data concerning the West Lot Parking Deck. Firstly are the constraints, which include two parking decks along with two administrative buildings to be built within the existing West Lot. The two administrative buildings will be positioned at the northwest end of the current west lot. The two parking decks are roughly the same size and shape (a 50,000 square foot footprint); one will be placed to the west and one to the east. Inside one of the decks, it will be necessary to provide for a 3,000 square foot storage room for equipment. Pedestrian walkways are also considered; an all campus pathway starting at Wolf Village apartments and ending at Fountain Dining Hall will cut through this area.

West Lot Parking Deck is intended primarily to be used by commuting students. Due to its function, it will be important to set up pedestrian, biking, and transit routes from the parking deck to classes located on north campus. Since a transit system will be incorporated, it may be a necessity to construct a parking deck with the essential clearance height. Concerns were raised regarding the height of the parking decks; if they were constructed too tall then the view of north campus would be obstructed. As a final point of interest, commercial-type store frontage is also a possibility.

NORTH CAROLINA STATE UNIVERSITY MASTER PLAN – WEST LOT

The figure above is the old master plan for this site. The new plan includes two decks and administrative buildings.

Background Information

The West lot is bounded by Varsity and Sullivan Drive on NC State's west side of campus. The lot is divided into two portions consisting of the western and eastern lots. The western portion has 531 parking spaces whereas the eastern portion only has 260. The size of the western portion is significantly larger than the eastern, with approximately 180,000 square feet. The eastern portion covers nearly 85,000 square feet.

The entire lot itself slopes toward the north in a gradual progression until it nears Sullivan drive, where the slope steepens down quite remarkably. West lot is almost entirely paved concrete with a median, and a large row of pine trees that separate the two lots. Since the eastern lot slopes slightly more, there will be some cut and fill during the constructions process, but cuts and fills will be minimized to keep the design cost efficient. The area is surrounded by buildings to the south, and two larger buildings are proposed to be built on the north side of the western deck. Our company will have topographic elevations and a soils report for the area to aid the structural design process. (*West Lot Parking Deck Handout, pg. 1*)

Design Resources

This project requires a great deal of research which is no small feat for our company. Fortunately, there are numerous resources available in various formats. The American Institute of Steel Construction, Precast Concrete Institute, and American Concrete Institute, all have published documents essential for construction of any structure requiring steel or concrete. The bulk of our material will be steel and concrete; therefore, the PCI and ACI are valuable for our research in construction materials.

North Carolina State University has a set of master plans for the West Deck, accessible to students and faculty alike. It will be a valuable reference tool for our company, and aid in our design.

A full set of parking deck drawings obtained from the company Bovis Lend-Lease will serve as another point of reference in our design.

Building Code Jurisdiction

To make the design of this parking deck as safe as possible, we will be following the building code jurisdictions and requirements as dictated by the University and the Precast Concrete Institute. We plan on using typical sizes for parking spaces, bay widths, and height clearances. Each parking spot according to code will have approximately 300-325 square feet. Typical floor heights will be 10'-00" for typical floors with possible 18'-00" for ground floors with bus thoroughfare. According to code, 30'-00" typical bay sizes will be used at minimum and this value will be consistent throughout the structure. The depth of the decking for the West Lot deck will be 6". These typical values will be followed during our design of the parking deck.

In order to conform to standards for handicapped users, ADA regulations will be cited in the design of the parking deck spaces and in accessibility considerations for all parking deck uses.

Traffic Forecasting

In order to project the traffic volumes for future build-out years of the parking decks, we will first begin with current count data. This data is available from Dr. Stone's transportation class from last semester. We will grow this traffic using a decided-upon rate according to university growth projections. In addition, we will add the additional project traffic estimates to these numbers for AM and PM peak periods. We will reference

ITE Trip Generation data to determine conservative estimates for traffic volumes and distribution as a result of the addition of multiple parking spaces. We will have to consider typical trends on the NCSU campus in conjunction with ITE Trip Generation data because NCSU has rates atypical of most development; much traffic floods into campus decks in the morning hours, whereas it leaves gradually throughout the day and is much less concentrated to a specific PM peak hour.

Traffic Analysis

In order to analyze the traffic after projected volumes have been determined, we will use Synchro traffic simulation software to determine projected levels-of-service for the parking deck intersections and the intersections in the surrounding area. For the roundabout scenario, we will use roundabout analysis software such as Sidra to analyze its capacity given projected future traffic conditions. These programs are based off of the Highway Capacity Manual, which we will use as a supplementary resource in our design and system analysis. In addition to levels-of-service, we will look at delay values produced in our analysis. We want to ensure that intersections work well and that each approach within each intersection also works well and in accordance with the surrounding transportation plan. For example, we don't want to design an intersection that encourages deck users to exit the decks and return to their places of residence by driving through campus when a road exterior to campus could work better and prevent campus congestion. In addition to modeling in Synchro, we will use SimTraffic traffic simulation software to get a real-time idea of how traffic may behave in the vicinity of the site.

Pedestrian and Bike Path Analysis

In order to determine the correct width of the campus path through the area of the West Deck, we will use pedestrian and bike level-of-service analysis as outlined in the Highway Capacity Manual. We want to prevent constructing a large deck that feeds excellent pedestrian and bicycle transportation routes only to find that the routes are inadequate to handle the volumes of pedestrian and bicycle traffic that will be generated.

Transportation Design Standards

In order to design decks and surrounding transportation environments that conform to correct codes, we will consult AASHTO, City of Raleigh, NCDOT, NCSU, ITE, AND HCM guidelines.

Transportation Design Figures

In order to produce images that convey the design of our decks to the public and to the client, we will use AutoCAD for official drawings and the program SketchUp for 3-D modeling.

Alternatives

Three basic scenarios will be analyzed for the surrounding transportation system. A sketch of each scenario is included in the appendix. Traffic enters and exits the parking deck from the south in all three scenarios by a road that runs along the north side of the Butler Communications Building.

The base scenario (Scenario #1) has retail that hugs the parking deck on the north and west sides. A bus lane connects from Wolf Village Way eastward along the north side of the parking deck and intersects Sullivan Drive. An additional bus lane extends along the east side of the parking deck to allow additional routing of buses.

Scenario #2 takes away the bus lane extension along the east side of the deck and adds a roundabout at the intersection of Varsity Dr. and the proposed access point at the existing Butler Communication Building parking lot. In addition, the retail space is pulled away from the main parking structure, allowing the bus lane to travel between the retail space and the parking structure. The retail space still hides the typical look of a concrete parking deck, and it provides further physical and visual separation between the campus path and the bus lane.

Scenario #3 is quite different from Scenarios #1 and #2 in that the parking decks are offset from one another. Retail wraps the west and south sides of the west half of the deck and wraps the north side of the east half of the deck. The bus lane is located away from campus on the south side of the deck, and no roundabout is considered along Varsity Dr.

Beyond the three scenarios, we will investigate the possibility of an additional access point on Western Boulevard. It will be either right-in only or right-in-right-out only, and it will provide additional access to the parking deck from the southeast. It will alleviate congestion from the southwest. Our analysis will decide whether or not this additional access point will be necessary and at what point in the future it may become necessary.

Upon analyzing all three scenarios, we will make a recommendation as to which scenario best solves the objectives of the parking deck. We feel confident that our scenarios will produce solid results that will support the construction of a parking deck in the near future.

MANAGEMENT PLAN

Transportation Task Responsibilities by Team Member

Mitch Danforth – Traffic forecasting and impact analysis

Mike Roselli – Footprint design and drafting

Structures Task Responsibilities by Team Member

Carol M. Ly – Structural framing system analysis

Jonathan Mertz – Construction and building materials

Hamid Sadri – Environmental impact and transit system integration

Matt Nichols – Site evaluation

Cooperative Efforts

Our company will convene for every meeting with both transportation and structures department, in order to discuss the best possible design for the West deck. It is imperative that every meeting consists of all members from each department. Our meetings will include decision-making in regards to the structural system, materials, and transit flow.

Weekly Schedule by Task and Milestones

January 14 – Site visit to West Lot and become familiar with given project

January 21 – Site visits to parking decks in Raleigh and discussed proposal content

January 28 – Develop outline for proposal

February 4 – Working on proposal to achieve goal of submission on February 12

February 11 – MD Proposal submitted

February 18 – Convene with transportation and structural groups to make decision on ramp system

February 25 – Analysis of loads, framing connections, and amount of construction material

March 3 – Begin site drawings and calculations for actual deck dimensions

March 10 – Transportation and structural groups to meet for progress reports

March 17 – Deck design drawings finished; Charette/workshop and stakeholder feedback

March 24 – Design drawings for first review and revisions

March 31 – Continue on reviewing calculations and error-checking

April 7 – Meet with transportation and structural groups to work on presentation

April 14 – Finalize presentation and practice

April 21 – Team Presentations; final product delivered

FINANCIAL PLAN

Although dollar estimates are outside of the scope of this proposal, effective time management is central to its success. The following plan shows the hours our individual team members and team as a whole have spent in developing this project. Time was taken in class and in lectures to discuss possible designs for our parking deck. Also, team members have worked outside of class individually and in groups in researching, preparing this proposal, and considering multiple scenarios. Much time is necessary in order to decide the framing system, parking system, traffic routes, and building materials that will deliver the highest quality parking deck at the most efficient cost. We traveled to numerous parking decks in the Raleigh area in order to better understand the design of parking decks. We also visited the West Lot to familiarize ourselves with the possible issues that need to be addressed in the design of the West Deck. The following table summarizes task hours to-date, from now until the project's end, and in total:

TEAM TIMESHEET TOTALS

Team Member	**Time Frame**		
	To-Date (hours)	**Future (hours)**	**Total (hours)**
Mitch Danforth	28.5	84.0	112.5
Carol Ly	30.0	88.0	118.0
Jonathan Mertz	30.0	88.0	118.0
Matt Nichols	30.0	88.0	118.0
Mike Roselli	28.0	84.0	112.0
Hamid Sadri	30.0	88.0	118.0
Time Frame Totals	**176.5**	**520**	**696.5**

Individual timesheets are included in the appendix.

PRELIMINARY STRUCTURAL SYTEMS and FRAMING STUDY

In terms of construction materials, steel, precast concrete, and cast-in-place concrete were the main considerations. Our company has decided to forgo the use of steel because it is uneconomical. Our deck will be primarily made out of reinforced concrete, because this will be the most cost effective material to use. Construction materials presented in this document for the West Deck are two types of reinforced concrete, precast and cast-in-place concrete.

Additional considerations are the framing system for the parking deck. We investigated two-way and one-way traffic systems in order to present options for ramp designs. A study was done for both systems, and based on our client's interests, the most cost-efficient and time-efficient design can be chosen.

Precast Concrete

One framing system that we are considering for the West Lot parking deck is precast concrete. This type of building material is being considered due to the low cost and ease of construction. Precast members are cast from the same forms and are used over and over. This type of construction is better suited for parking decks that have few special members and connections. The biggest advantage of precast concrete comes when cost is an issue. Cost remains low when building a precast deck, because we eliminate having to cast the concrete on-site, and we also save money and time not having to worry about quality control on-site and weather conditions. The quality of the concrete is always high with precast since the concrete is usually mixed on-site at the precast plant, and the same quality is maintained in each piece. Precast decks are extremely durable and can offer long term economy in the form of low maintenance and long life span.

Aesthetics are a concern for the West Lot parking deck, as we want the structure to be able to blend into its surroundings. Precast allows for many exterior finishes which can accomplish this goal. Form finished gray concrete can be used, painting, or sandblasting can be done to achieve a desired finish. Also, there are countless concrete colors and numerous aggregate combinations that are available to enhance the appearance of the parking deck.

Cast in place Concrete

Firstly, cast in place concrete describes primarily concrete in its ready mixed state that is transported to the job site and placed in forms. The first and most easily identifiable benefit to using this method in construction is waste minimization. You are in control of how much concrete is ordered. Any unused concrete is usually returned to the plant where it is recycled. Our company suggests sustainable design for the deck; with cast in place concrete, it is possible to use recycled elements in the concretes ready mix state (i.e. slag cement can substitute partially for cement and recycled aggregates can substitute for newly mined gravel).

As reported earlier, cast in place concrete is transported to the job site and then placed in forms. This provides you with manipulation of the materials; continuous forms can be cast and, as a result, joints can be more widely spaced. With this type of layout driving within the parking deck is much smoother since transitions can be applied at the ramps and the reduction of joints. Cracking is also reduced given that a common trouble spot, the joints, have been reduced in number. This means happier parking deck users and lower maintenance costs.

In addition, it's been stated that cast in place concrete can be manipulated however the user desires. This provides construction flexibility. Perhaps a longer span is necessary for a portion of the parking deck, or perhaps another goal is to improve its aesthetics. It is an adaptable system that is flexible for many uses.

Cast-in-place Concrete Deck

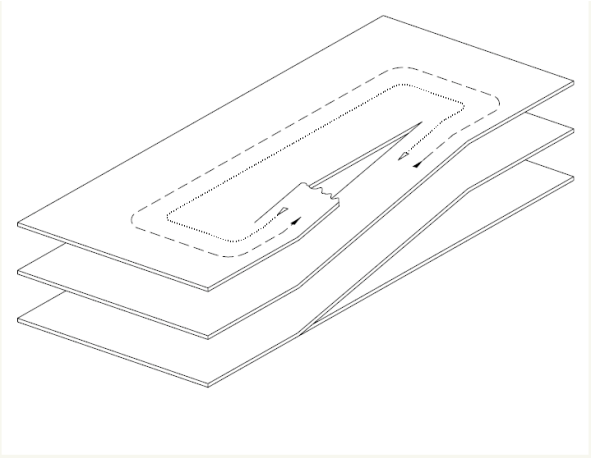
We can use cast-in-place concrete system which employs post tensioning methods. One benefit of using a post-tensioned system is water tightness. Water tightness is achieved by placing the concrete slab into a state of bi-axial compression, and is an important consideration for the preservation of the parking deck. Since the height of the parking deck is also a consideration (if it's too tall it will block the view to north campus) a post-tensioned system will reduce the structural depth, aiding in that factor and reducing other construction costs.

Structural Ramp Systems

In consideration of the eastern and western portion of the West lot, a simple framing design for two decks is favorable for ease of construction. Two smaller decks rather than one large deck will allow for drivers to move about through the deck without much complication. If a two-way traffic scheme is chosen for the deck design, our company has two proposed designs: Single Straight Ramp, and Continuous Sloping Floor Ramp (also known as Single Helix). These two decks are rectangular, and all traffic flow takes place within the deck.

Two-Way Traffic on Single Straight Ramp

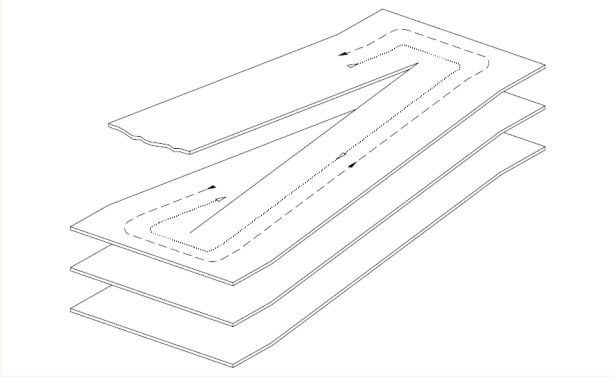
The advantage of the single straight ramp is the overall simplicity of the design—a major factor in calculating cost and construction time. Traffic moving through the deck will circulate in a rectangular spiral motion. The ramps are only on one side of the deck, above and parallel to one another, and stacked several stories high. The slope for these ramps are typically between eight and ten percent. For parking, each floor will carry spaces on both sides of the driving aisle. However, the ramps are only reserved for ascending and descending traffic. The advantage to having the ramps strictly for vehicle motion is for the safety of pedestrians.



Single straight ramp with two-way traffic

Continuous Sloping Floor Ramp with Two-Way Traffic (also known as a Single Helix)

This style is quite popular in today's deck designs, because the nature of the design is intuitive and its traffic flow is easily recognized. The floors are continuously spiraled up to the top, where each floor is a ramp. Ramp slopes are typically between 5 to 6 percent, much less sloped than the aforementioned single straight ramp. Slightly lesser slope allows for parking to take place on the ramps, with parking on both sides of two-way traffic. The only possible disadvantage to this framing style, are the blind spots drivers will experience when turning left and right corners.

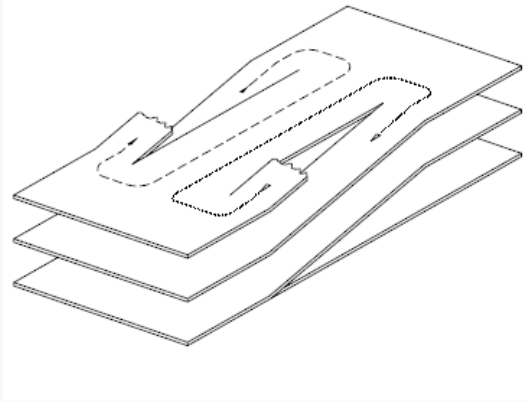


Continuous sloping floor ramp with two-way traffic
(single helix)

One Way Traffic Design

One-way traffic will shorten the lengths of structural spans and make the overall structural system more economical. One-way traffic would incorporate an up ramp and a down ramp on each side of the decks. The sloping ramps on each side of the deck could also serve as a lateral support and eliminate the need for shear walls in the decks. One-way traffic will also be less confusing and more convenient for users of the deck. Slanted parking will make it easier for drivers to get in and out of parking spaces safely. With only one way for students to go there will be a smaller chance of any accidents that may occur in the decks.

2.



Two parallel straight ramps, each with one-way traffic

REFERENCES

"Advantages of Precast Concrete". Accessed: February 10, 2008. <http://www.tpub.com/engbas/7-11.htm>.

"Designer's Notebook: Benefits and Advantages". *Precast Concrete Institute.* Accessed: February 8, 2008. . <http://pci.org/view_file.cfm?file=AS-02SP-6.pdf>.

"Cast in Place." *Portland Cement Association.* 2008. Accessed: February 9, 2008. <http://www.concretethinker.com/Papers.aspx?DocId=3>.

"Cast-in-Place Concrete Parking Structures". *Post Tensioning Institute.* 1992. Accessed: February 9, 2008. <http://www.crsi.org/pdf/ParkingStructures.pdf>.

"Cast-in-Place Concrete Parking Structures". *Post Tensioning Institute.* 2008. Accessed: February 9, 2008. <http://www.concreteparking.org/structures/>.

North Carolina State University Master Plans. Accessed: February 9, 2008. <http://www.ncsu.edu/facilities/maps_planning/small/index.htm>.

"Ramp Systems." *Open Deck Parking Structures.* 2003. Accessed: February 5, 2008. <http://courses.ncsu.edu/ce420/lec/001/wrap/Open%20Deck%20Parking%20Structures%20-%20innovative%20solutions%20in%20steel.pdf>.

APPENDIX

- Transportation Analysis Scenarios
- Cumulative Time Sheets
- Peer Evaluations