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Ramp Design Standards for Carporch at Housing Sector in Double Storey House to Accommodate Low Clearance Vehicle

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ABSTRACT

This research aims to evaluate and propose effective gradient at car porch area for the housing sector. The dependent variable that acts as presumed effect is vehicle to stuck and become lodged but the independent variable is referring to the car clearances dimension, design of the ramp and guidelines in ramp design. In other words, the situation of the vehicles to stuck and lodged depends on the car clearances dimension, design of the ramp and guidelines in ramp design. Interview sessions were held with the professional architects and engineers in the engineering department at Majlis Bandaraya Seremban, DBKL, Majlis Bandaraya Melaka, Majlis Bandaraya Johor Bahru, Jabatan Kerja Raya (JKR) and consultant firms. During the interview session, four aspects of this matter were discussed to explore the existing standards and guidelines in ramp design for car porch at housing sector in double storey house to accommodate low-clearances vehicles. The feedback from the professionals was analysed by narrative analysis method and the result of the study will be valuable to the construction industry and tools for future design. These data can be used to estimate the suitable degree and percent for different categories of ground clearances which is useful for current development and current technology circulation.

1. Introduction

Ramps are sloped pathways used both inside and outside of the building used to provide access to different levels. There are five categories of ramps, i.e., ramps for heavy vehicles, ramps for home accessibility, ramps for driveways, ramps for car parking facilities, and ramps for metering for highways. Each of these categories has a different design and characteristics to avoid issues.

In this study, the ramp which has been explored is a ramp at the car porch, which involves a ramp at driveways and ramp entrances for the residential and housing sector. Length and gradient are the main items to pay attention to when designing a ramp. Gradient, rolling resistance, and ramp length area are the items that need to be given utmost attention when designing the ramp.

In this study, the ramp design that involves a straight ramp and parking ramp will be explored at Taman Bukit Kepayang, Seremban Negeri Sembilan. Due to the complaints from purchasers at

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Taman Bukit Kepayang, Seremban, Negeri Sembilan about the ineffective gradient for ramp design at their car porch after hand over. Therefore, this place has been chosen as the case study for this research. Majlis Bandaraya Seremban (MBS) is a local council at Negeri Sembilan, i.e., the responsible parties who approve all the drawings before the developer develops one development. As stated by MBS, they did not publish any guideline related to the straight ramp and parking ramp for landing in the housing sector. However, the technical department, i.e., the building and engineering departments, refers to the Building (Federal Territory of Kuala Lumpur) By-Laws 1985 and Selangor Uniform Building By-Laws 1986 as guideline in the design and planning stage.

There are some guidelines and standard which have been published as references to the professional consultant to design the ramp in the car porch area. The existing guidelines and standards related to the ramp at the car porch are Guidelines for Car Parking and Internal Traffic Circulation (Wilayah Persekutuan Kuala Lumpur 2018), Malaysian Standard (MS -1184), Malaysian Standard 2426: 2011, Selangor Uniform Building By-Laws 1986 and Neufert Architect's Data (Fourth Schedule). Each of the existing guidelines has a different gradient guide depending on the type of ramp. Referring to these guidelines, the range gradient for parking ramps is between 4% to 6%; and 15% maximum for straight ramps.

This study intends to report the findings from data collection and to propose the effective gradient for different dimensions between ground clearances vehicles, via interviews with professional parties such as engineers, architects, site managers, and authorities. The main analytic method that is used is grounded theory. Data collected from the field is transcribed and analysed based on their responses and literature survey, a coding method have also been utilised to identify the pattern of themes from the raw data. Finally, the input of discussion in interview session is used as a tool to propose effective gradients for a different type of vehicles.

2. Issues of Ramp

Clearances of vehicles from a local company and foreign car dimensions are getting lower. In fact, when a low clearance vehicle negotiates a high-profile ramp, especially at driveway entrances, the vehicle may become lodged or stuck on the 'hump'.

2.1 Factor that contributes to the ramp at the entrance house

Referring to Fitzpatrick *et al.*, [1], four factors that directly affect ramp are design consistency and simplicity, the roadway user, design speed and sight distance. Better understanding of the effects of design types would help improve the safety, mobility, accessibility and operation aspects for both freeway diverge areas and exit ramp sections [2][3]. Sze and Christensen [4] clarified that the slope, ramps, minimum, desirable clear width, dimension of landing, maximum gradient, and design protection, including curbs and barriers, were specified in the guidelines. In short, it shows that a design profile is the main factor and component which influence the ramp. Ramp geometry design is the core control element that must follow standards and guidelines [5].

Besides the ramp geometry design and design profile acting as the core control element to the design of a ramp, the length of the ramp also needs to be clarified before designing the ramp. Length of the ramp is the point that influences the ramp alignment and design [6]. The ramp length increase, the speed and throughput for the main motorway increase, as well as ramp delay [7].

However, if the factors were not considered during the design of the ramp, the possibility of an accident such the vehicle may become lodged or stuck on the 'hump' will happen [8]. As mentioned by Hanid *et al.*, [16], design stage determine successfulness of a construction project that

indirectly benefits the customers. For example, at Taman Bukit Kepayang the gradient of the ramp which is one of the factors when designing the profile of the ramp is not sufficient for the typical ground clearances, the purchasers at the residential area complained pertaining to the vehicles stuck in the ramp area. Every products sold to customers must meet their needs and wants [17]. In other words, the profile of the ramp is an important element because it affects potential damage to the vehicle and to the comfort of the vehicle. Profile ramp elements that are included for the factor of influence of ramp design are minimum width, maximum gradient, ramp geometry design and length of the ramp.

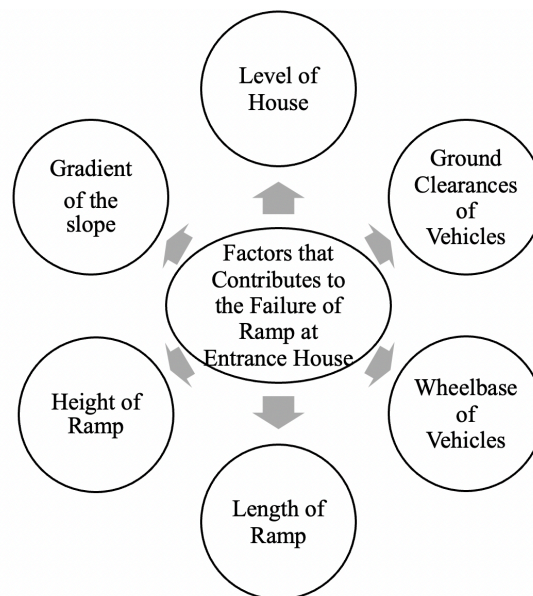


Fig. 1. Factors that contribute to the failure of ramp at entrance house

2.2 Ground clearances for vehicle

Ground clearances are the main factors which need to be considered when designing the ramp. Hence, each of the vehicles needs to investigate the dimension of ground clearances to suit the design. The history of the automobile is very extensive because, over time, it has undergone many changes both in design and capacities. In fact, a car is divided into five categories, i.e., hatchback, sedan, multi-purpose vehicle (MPV), sport utility vehicle (SUV) couple-convertible. Each of these types has different clearances ground.

According to [9], sedan is a three-box passenger car consisting of a bonnet, passenger cabin and trunk with a low-seat position (about 300 mm). SUV is a two-box car with high ground clearance (about 200 mm) and with a high –seat position. MPV is a single box or two-box car with the highest position (about 500). Thus, a sedan is comfortable and has a good appearance, whilst SUV and MPV excel in off-road capability and load capacity [9]. Sports utility vehicles (SUVs, MPVs, off-road vehicles) are defined as vehicles that feature more than 50 mm of ground clearance. SUVs have higher ground clearance than ordinary cars [10]. Ground clearance for sedan cars ranges from 140mm to 200mm [11]. In short, referring to these four statements from different individuals, it shows that in this era of technology, different types of cars have different ground clearances.

A lot of guidelines and standard for geometric ramp design in car porch area have been proposed, either in Malaysia or overseas. However, the limitation of accurate geometric design of

ramps with different specific dimensions of vehicles, including wheelbase, ground clearances and different situations, is not published and clarified.

This research focuses about vehicles that could be stuck and lodged depending on the cars' clearance dimension, design of the ramp and guidelines in the ramp design. Hence, to study these elements, several methods have been used to achieve the objectives. The scope of study for this research is located at Taman Bukit Kepayang, Seremban, Negeri Sembilan. The case study strategy is used to achieve the research objectives in qualitative methods which are observation and interviews.

A defect liability period (DLP) is a set period after a construction project has been completed during which the contractor has the right to return to the site to remedy defects. Hence, GUH Properties, as a developer at Taman Bukit Kepayang, is responsible for doing the remedial works at their own expense after getting complaints from purchasers. Referring to the records from GUH Properties Sdn. Bhd. and information from interviewees, 15 purchasers from 74 houses complained about the insufficient ramp design at their car porch.

Ground clearances are one of the main factors that need to be considered when designing the ramp [12]. In other words, the types of vehicles and the dimension of vehicles need to be explored to suit the design [13]. In this case, most vehicle which the purchaser drive at Taman Bukit Kepayang that contribute to the issue are Perodua Myvi, Toyota Vellfire and Perodua Alza. The ground clearance for sedan cars ranges from 140 mm to 200 mm. Although the ground clearance of Myvi is 160 mm, these vehicles still have an impact on the consumers. Vehicles, i.e., SUVs and MPVs such as Vellfire, Estima, Alza etc are defined as vehicles that feature more than 50 mm of ground clearances. Even though Vellfire has ground clearances of more than 50 mm, this issue still occur. Therefore, the consultant and developer need to explore the dimension for each type of vehicle to prevent this case from recurring.

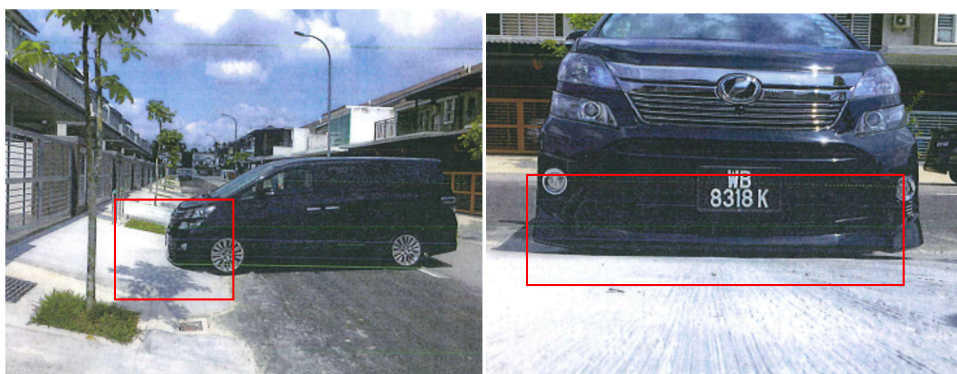


Fig. 2. The Vellfire touched the ramp at the car porch
(Sources: GUH Properties Sdn. Bhd.)

Designing the ramp in the housing sector is managed by the consultants who are the architect and consultant engineers. Then, the consultants who have been appointed by the developer will make the submission for the new development to local authorities. In fact, the engineer will indicate the level of road and platform of the house at the Road and Drainage Drawing, and the architect will show the level of each house and platform level in the Building Plan and Drawing. However, the drawing for Taman Bukit Kepayang, which had been endorsed with authority, shows the level between the platform level of the house and the road level has a big difference, so the ramp becomes stiffer, and the ground clearances for vehicles, especially which have a lower ground clearances vehicles such as Toyota Vellfire will touch the ramp. Building Plan approval which has been designed by the architect consultant specifies the difference level between road level and platform level should be at least or more than the gradient of the ramp, i.e., 150 mm. However, referring to the road and

drainage drawing from the engineer consultant, the difference between platform level and road level is more than 150 mm. For example, the road level finish floor level (FFL) is 67.90 mm, and the road level is 67.60 mm. In other words, it shows the level difference is 300 mm, which are more than 150 mm.

These differences were not captured during the design stage because the professional consultant have difficulties to refer the existing guidelines that did not indicate specific gradient at the ramp for housing. Hence, during construction stage, contractor may refer to the construction drawing which been issued by engineer and architect for their references to the road level and platform level for each units. Due to the discrepancies and lack of information for the specific gradient, the purchasers complained pertaining high gradient at the main entrance ramp. In short, the consultants who are engineers and architects should cooperate with each other and indicate the accurate platform level and the accurate road level to design the suitable gradient at car porch for a different types of vehicles. Then, they need to ensure the level between road and platform level is in suitable distance and gap, hence sufficient to all dimensions of ground clearances of vehicles.

3. Methodology

This research focuses on a conceptual framework because the main aim is to propose the effective gradient for different dimensions between ground clearance vehicles. The researcher will propose effective gradient to solve the problem of stuck and lodged for vehicles. Figure 3 shows that the dependent variable is the variable that changes in response to the independent variables. The two variables may be related by cause and effect. Hence, based on Figure 3, the situation of the vehicles to stuck and lodged depends on the dimension of the vehicles, which are wheelbase and ground clearances, the level of the house and the guidelines of ramp design, i.e., length and gradient of ramp. As a conclusion, the situation of vehicles to be stuck and lodged is the dependent variables and the dimension of vehicles that are wheelbase and ground clearances is the independent variables.

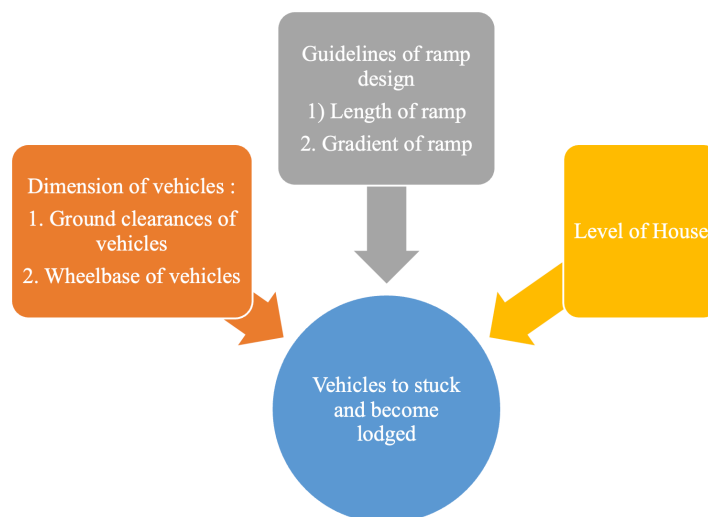


Fig. 3. Conceptual Framework

Therefore, to achieve the objectives in this research, qualitative methods have been used. The main reason interview sessions and observation have been used because the researcher intends to investigate the issue in depth regarding the problem of the ramp at car porch and the weakness

of the existing guidelines. Interview session with expert and professional parties who have experience in ramp design have been useful to obtain views and knowledge in this matter. Current and existing guidelines which are being referred to in the construction field and planning stage were also identified.

4. Results

4.1 Factors of Ramp Issue at Car porch Area

The factors that contribute to the ramp issue are the dimension and specifications of vehicle that are included wheelbase, angles of approach, angle of departure, minimum ground-clearances and ramp break-over angle [5]. Hence, to design or ramp, the specific dimension of each type of vehicle needs to be considered because each type of vehicle, which is SUV, sedan and MPV, has a different specific dimension [14]. Other than that, some of the people modified their cars, which added the skirting, so the ground clearances become increase, then their vehicles will touch the ramp when accessing the car porch [15].

Every designated building required approval from the authority. Then, each of the drawings, whether building plan or infrastructure plan, needs approval from authorities before starting work at the site [. Therefore, each drawing needs to refer to and follow the guidelines from the authority. However, based on the Majlis Bandaraya Seremban, the guidelines that refer to the ramp design in the housing sector is minimum design. So, the consultant who is responsible for designing the ramp at the car porch area has an issue with the guidelines due to the guidelines being the minimum guidelines. Attitude is also the factor which increases the complaint from purchasers. In addition, the purchaser who is too fussy and a perfectionist will complain about the design to the developer. In other words, attitudes are often the result of experiences or upbringing, and they have a powerful influence over their behaviour.





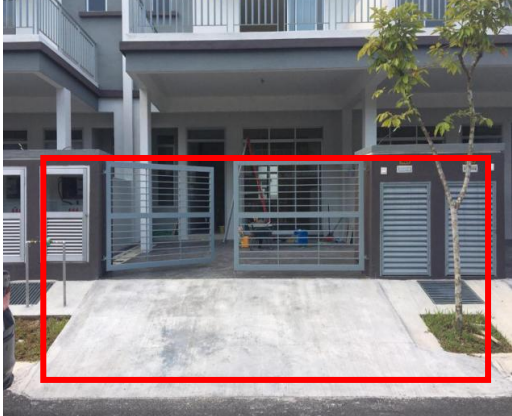
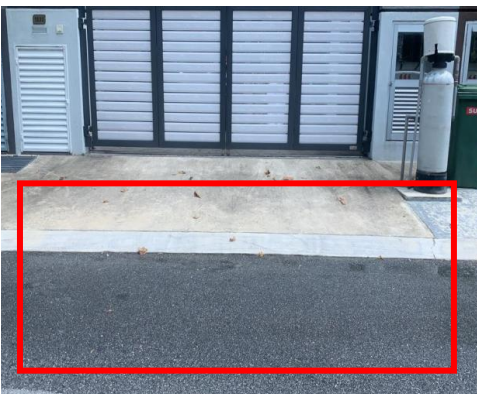
GUH Properties Sdn. Bhd. as a developer at Taman Bukit Kepayang, Seremban, discussed with their professional consultants to find the solution for ramp issues at their site. There are several solutions which have been studied by responsible parties to make sure the gradient is suitable for each type of vehicle. On the other hand, the main target to solve this problem and issue is to ensure the difference level between road level and car porch level is low.

4.2 Solution to Solve Ramp Issue

GUH Properties, who is the responsible party for solving the issue, take several steps to reduce the quantity difference between the level of the car porch and the level of the road. From Table 4.8, the developer changes the types of road kerb that can increase the level, increase the level road with the top up the premix road and ensure the gradient of the ramp should be less than 5%. However, if the unit has more than 500 mm different level between road level and car porch level, which is the worst situation in this issue, the developer rebuild the ramp at the car porch area.

Table

Summary of the solution to solve ramp issue by GUH Properties Sdn. Bhd.

Old Design	New Design
<p>The kerb which has been used before the redesign is rolled over the kerb.</p> 	<p>The kerb which has been used to solve the issue is a standing kerb.</p> 
<p>The existing road level before the redesign.</p> 	<p>Increase the level of the road with the top up the premix road.</p> 
<p>The existing ramp at the car porch at HSN 1630 which has 540 mm different level.</p> 	<p>Redesign the ramp at the car porch for HSN 1630 which has 260 mm different level.</p> 

5. Recommendation for Future Design

The design of the ramp for the car porch for the housing sector at Taman Bukit Kepayang, Seremban, is not complying with the current vehicles and all types of vehicles. In this case, the developer, i.e., GUH Properties Sdn. Bhd. have experience in handling and tackle for this issue. Hence, the developer discussed with their professional consultant to ensure the design complies with all types of vehicles, whether old version vehicles or new version vehicles. Then, to deal with this issue and the recommendation for future design, the design and different quantity between the level of road and level of car porch should be less than 180 mm and the most suitable between 150 to 180 mm. In addition, the guidelines related to ramps for car porch in the housing sector need to be specific and can use the worst case, i.e., Toyota Vellfire as a reference for the design.

Every building or development is required to get approval from the local authority centre. Therefore, for each development at Seremban need approval from technical department at Majlis Bandaraya Seremban which are Building Department, Planning Department, Engineering Department, Bomba Department, Environmental Department, One Stop Centre, Tenaga Nasional Berhad Department (TNB), Syarikat Air Negeri Sembilan (SAINS), Indah Water Konsertium (IWK) and Suruhanjaya Komunikasi & Multimedia Malaysia (SKMM) Department. Each technical department has a different scope. For example, for ramp design at car porch for the housing sector, the design needs approval from Engineering Department and Building Department. Hence, to get approval from the authority, all the designs related to ramp design for housing need to comply with the requirement published by the responsible authorities.

Meanwhile, the existing guidelines provided by Majlis Bandaraya Seremban are not specific and not suitable for all types of vehicles. Based on the interview session with the project executive from the developer side, she highlighted that the developer use and refers to different guidelines from other countries to solve the problem, which is the Guidelines from the Kingdom of Bahrain Ministry, as shown in Figure 4.13. The main reason the developer chooses the guidelines is that the published guidelines state the grade change for each sector and angle. Thus, for future proposals and suggestions, the future gradient and design of the ramp published by the local council should state the grade change for each angle as a reference for professional consultants.

Figure 5 shows the details and guidelines as per Guidelines for the Design of Off-Streetcar Parking Facilities by the Kingdom of Bahrain as a reference for GUH Properties solving the ramp issue and designing the ramp. Based on the guidelines, the grade change for sag grade needs to be less than 15% (A), and the grade change for summit grade needs to be less than 12.5% (B). As mentioned in interview session with client representative that are project manager and project executive, after they designed the ramp as per guidelines by Kingdom of Bahrain, the issue been solved. They completed all the calculation based on the approved gradient and the contractor rebuild again the ramp at the effected unit

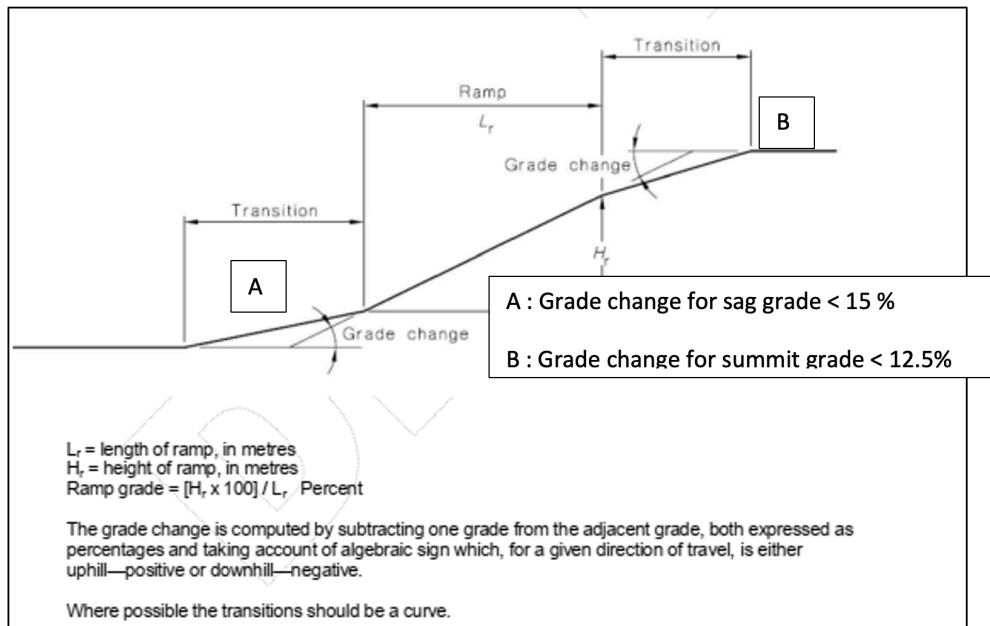


Fig.5. The diagram for change of grade on ramps

5. Conclusions

Referring to the findings, there are four factors that contribute to the issue of the ramp, i.e., the types of vehicles, responsible parties, existing guidelines and attitude of purchasers related to the ramp in the housing sector. For a first factor of the types of vehicles, it includes the dimension and specifications of vehicles, i.e., wheelbase, angle of approach, angle of departure, minimum ground – clearances and ramp break-over angle. Some people also modified their vehicles by adding the skirting, so the ground clearance becomes increases, and then their vehicles with scratch the ramp when accessing the car porch. In short, the lower the ground clearances, the highest the possibilities to scratch the ramp.

Next, the second factor is responsible parties that are the consultants and authority are the parties who are involved in the design stage of ramp design. After consultants complete all the drawings, whether the building plan or the infrastructure plan, the drawings need approval from the authority before starting work at the site. Hence, the professional consultants need to ensure and study the design of the ramp, and the design should not have a bad impact on purchasers, although the purchaser used vehicles which are low ground clearances. Besides, authorities in each local state need to verify all the designs by professional consultants and ensure they are following all the related guidelines. However, for this study, as highlighted by Majlis Bandaraya Seremban (MBS), the guidelines that refer to the ramp design in the housing sector is minimum design. Thus, the consultants have an issue with the guidelines due to the guidelines being the minimum guidelines, and they need to explore more to avoid any issues in the future. The attitude is also the third factor which increases the complaint from purchasers. In addition, the purchaser who is too fussy and a perfectionist will complain about the design to the developer. In other words, attitudes are often the result of experiences or upbringing, and they have a powerful influence over their behaviour.

In conclusion, the research has identified the four factors which contribute to the problem of the ramp at the car porch. The overview of the factors in straight ramp and parking ramp has been determined at this stage. In addition, the relevant parties involved in this matter are the architect, civil engineer, developer, and authorities. Based on the findings, each organisation involved in the

design stage should carry out their responsibilities to ensure the design does not have a bad impact on consumers.

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